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China's Galloping Economy: Prospects, Problems and Implications for the United States

EDITED BY MARK MOHR

ABSTRACT In this Special Report, **Barry Naughton** of the University of California, San Diego, details the "unprecedented" challenges facing the Chinese economy in 2008. **Steven Dunaway** of the International Monetary Fund outlines a reform prescription for "rebalancing" the Chinese economy, while **Jeffrey Logan** of the Congressional Research Service notes the direct relationship between China's industrial policy, its energy needs, and its environmental woes. **Cong Cao** of the State University of New York describes China's aspirations to be a world leader in science and technology by 2020, thereby making a crucial contribution to China's sustained economic growth.

INTRODUCTION

MARK MOHR

China's economy has grown on average at the rate of 10 percent a year over the last decade, lifting hundreds of millions of people out of poverty. Political commentator Fareed Zakaria has noted that in the last two decades, China has experienced the same degree of industrialization, urbanization, and social transformation as Europe did in two centuries. In 2007, China contributed more to global growth than any other country in the world, including the United States. A recent World Bank study has concluded, however, that rather than having a $10 trillion economy, China's economy is actually "only" a $6 trillion economy. Thus, its economy is 40 percent smaller than previously thought. By whatever measure, however, a country of 1.3 billion people with an economic growth rate in double digits is a power to be reckoned with.

Is China's economic growth a challenge or threat to the United States? Especially in Congress, there is the perception that the tremendous trade imbalance between China and the United States has been arrived at through less than fair means. Specifically, it is believed that China's currency is vastly undervalued against the dollar, creating an unfair advantage for China's exports to the United States. Periodically, U.S. legislative proposals appear to pressure China to revalue its currency, with the threat of punitive tariffs or trade sanctions if Beijing refuses to comply.

What is the truth regarding the current state of the Chinese economy, and how did it arrive

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there? Can China continue its impressive economic growth without major adjustment, or is the present path of the Chinese economy in need of correction? These and other questions were examined at a January 22, 2008, symposium at the Woodrow Wilson International Center for Scholars. The event was co-sponsored by the Center's Asia Program and Program on Science,Technology, America & the Global Economy. The four essays that follow examine China's economic challenges in 2008; the most effective monetary policy to rebalance China's economy; the energy challenges it faces; and the progress and problems ahead as China aspires to world-class status in science and technology.

In the first essay, **Barry Naughton**, So Kuan-lok Professor of Chinese and International Affairs at the Graduate School of International Relations and Pacific Studies of the University of California at San Diego, characterizes the Chinese economy as facing "unprecedented" challenges in 2008, although he hastens to add that there is no danger of an acute economic crisis. Naughton points out that in recent years, economic factors had been aligned in China's favor. This situation has changed, and presently, Chinese policymakers are facing an environment of increasingly difficult choices and tough trade-offs.

One of these challenges is inflation. Consumer price inflation rose above 6 percent in August 2007, and has remained stubbornly high since then, creeping up to 7.1 percent in January 2008. In response, China's central bankers have toughened their stance,and shown a renewed determination to restrict credit growth and push up interest rates. Short-term measures, Naughton believes, will likely slow the momentum of accelerating inflation, but China is probably entering a new era of rising prices, which includes rising prices for wages. These inflationary pressures have made China more willing to allow its currency, the *renminbi* (RMB), to appreciate. Between July 2005, when the currency was de-linked from the U.S. dollar, and October 2007, the RMB appreciated a little more than 10 percent against the dollar; but since October it has appreciated even more. Indeed, since November 2007, Chinese imports have been growing only slightly faster than Chinese exports. These policy changes, Naughton contends, are clearly in the right direction and will have the right long-run effects.

Additionally, China's economy has developed in a distinctly unbalanced way in the past decade. The investment rate has been unusually high—over 40 percent of gross domestic product (GDP) for the past three years. Correspondingly, the rate of household consumption is unusually low, below 40 percent of GDP. In Naughton's view, the ultimate fix for this situation is obvious: China should increase the share of household consumption, and gradually reduce the share of investment and net exports (by shrinking the trade surplus).

As a result of the leadership changes announced at the 17th Party Congress of the Chinese Communist Party (CCP) last fall, a new team is coming in to make the necessary economic policy choices to guide China's economy. This new team, states Naughton, has substantial talent, and will certainly rely on today's experienced technocrats for a transitional period. Then, they must learn to work together, and to make smart choices in the face of difficult conditions. As China's economy grows, its success or failure is increasingly important to the world, and especially to the United States. More-

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over, China's astonishing record of growth shows how deeply rooted Chinese economic dynamism is, and cautions us against overestimating the obstacles to future growth. At the same time, there is no room for complacency based on the past. What is needed, concludes Naughton, is a sober evaluation of the complex challenges facing China in 2008.

In the second essay, **Steven Dunaway**, deputy director in the Asia and Pacific department at the International Monetary Fund (IMF), argues that despite China's impressive economic growth, there is nonetheless considerable unease, in both China and abroad, about the state of China's economy and the economic well-being of its people. Income on a per capita basis is still very low in China relative to other major countries; the benefits of economic development have been unevenly distributed across the country and across sectors of the economy; and an estimated 150-200 million workers are still underemployed. To deal with these problems, asserts Dunaway, China badly needs to sustain rapid economic growth. Up to now, that rapid growth has been primarily achieved by heavy reliance on investment and exports. But China cannot continue indefinitely to rely principally on these sources for economic growth. This concern was prominently articulated at the National People's Congress in March 2007, when Premier Wen Jiabao cautioned that "the biggest problem with China's economy is that the growth is unstable, unbalanced, uncoordinated, and unsustainable."

Dunaway continues that while the need for policy action has become more urgent, this final reckoning has been put off in recent years by the surge in exports and increased substitution of domestically produced goods for imports. This has effectively absorbed much of the capacity put in place by rapid investment growth. However, the resulting substantial rise in China's external surplus coupled with its efforts to continue to tightly manage the exchange rate have led to rising international reserves and more liquidity pouring into the banking system, fueling further lending and investment and a push for more export growth and import substitution. Policy measures used thus far—especially heavy reliance on administrative measures and financial repression (moral suasion against lending)—have been ineffective in breaking this cycle and reestablishing macroeconomic control. To make matters worse, inflation has now emerged as a new concern.

The way to rebalance China's economy and shift from investment and exports as the main drivers of growth to consumption seems relatively straightforward, according to Dunaway. Price distortions need to be removed, he asserts, and other policies have to be changed to remove inefficiencies or distortions that have substantial influences on investment and consumption decisions. His prescription for reform includes the following: liberalize key prices to reflect market conditions and underlying resource costs, reform financial markets, and shift government expenditures to social spending.

Dunaway notes that the Chinese authorities have recognized the major macroeconomic challenge they face—the need to rebalance output growth away from heavy reliance on investment and exports toward consumption. They have laid out a set of policies to deal with this rebalancing challenge, and economic analysts generally agree on the broad elements of the approach that they have adopted. The authorities have made progress on many of these policy undertakings. However, concludes Dunaway, more progress is needed, and growing concerns both about China's domestic and external position point to the need for a faster pace of policy implementation.

Jeffrey Logan, specialist in energy policy at the Congressional Research Service (CRS), examines in the third essay the interplay between China's growing economy and its energy needs. Logan notes that Chinese energy demand has doubled since the year 2000. While this unprecedented growth has helped drive China's economic development, particularly in urban areas, it has also caused worrisome dislocations. Within China, strong growth in energy-intensive heavy industry has exacerbated air pollution, energy insecurity, and resource dependence problems. Globally, the Chinese industrial surge is fueling inflation and volatility in global commodity markets, and concerns over greenhouse gas emissions.

Perhaps most worrisome is that China's central government appears unable to control the country's economy, as policies regarding energy use seem to be mainly formed at the provincial and lower levels.

In Logan's opinion, the main cause of the tremendous surge in Chinese energy demand is the enormous growth and investment in energy-intensive heavy industry, such as steel production, chemicals and building material. One unfortunate concomitant of this growth is that these industries are capital- as opposed to labor-intensive, so they have added to China's GDP growth with little ability to absorb excess rural workers. China's entire steel sector, which now accounts for 35 percent of world supply, employed only 3 million people in the year 2000.

Logan further points out that there is a direct relationship between China's industry-led economic growth, its concomitant energy requirements, and pollution, which wreaks havoc on the environment. Pollution has become so bad in many regions of China that the central government is desperate for solutions to quell social unrest. China now consumes about 2.5 billion tons of coal each year and is the global leader in carbon dioxide emissions. Internationally, China's industrial surge has contributed to high prices for metals, industrial inputs, and fuel. China now also has the opportunity to impact like never before the volatility of global commodities, both upstream and downstream. Any sudden slowdown in Chinese demand for iron ore or steel, for example, could quickly result in oversupplied global markets and rapidly declining prices.

One of the most visible steps China has taken to control the surge in energy demand is contained in the 11th Five Year Plan (2006-2010). A high-profile goal of the plan is to cut energy intensity (the amount of energy needed to produce a unit of economic growth) by 20 percent by 2010. China has taken other measures as well, and preliminary evidence shows a moderating of energy demand in China. Although the country is still not on target to achieve its energy intensity target, it is moving in the right direction. Logan concludes that the United States could assist China by funding capacity building for market-driven clean energy projects, assistance for clean energy investment, and assistance in data gathering and analysis to better inform energy policymaking. Clearly, what happens in China, he states, is of interest to the United States, since it affects American trade, environmental, civil society, and geopolitical interests.

In the final essay, **Cong Cao**, senior research associate with the Neil C. Levin Graduate Institute of International Relations and Commerce, the State University of New York, focuses on China's attempt to move its economy forward in the long term by becoming one of the world's leaders in science and technology (S&T) research. Cao notes that since the early 1990s, research and development (R&D) expenditure in the People's Republic of China (PRC) has been increasing at a rate approximately twice that of overall economic growth. Additionally, Chinese institutions of higher education are turning out an increasing number of well-prepared graduates in science and technology, representing the world's highest output in terms of overall numbers.

In early 2006, states Cao, China's leadership issued a new "Medium to Long-Term Plan for the Development of Science and Technology 2006-2020" (MLP). The MLP builds on important S&T-related policy initiatives since the mid-1980s. It sets ambitious national priorities and formalizes the leadership's commitment to allocate substantial financial and human resources to turn China into an innovation-oriented nation by 2020. In addition, the MLP specifically defines enhancing indigenous innovation capability, leapfrogging in key scientific disciplines, and utilizing S&T to support and lead future economic growth as its major objectives.

While notable progress has been made and many more achievements from the MLP can be expected in the coming years, Cao points out that a balanced perspective on the prospects for Chinese science and technology requires attention to some of the challenges that China faces in realizing its ambitions. First, China has yet to establish an enterprise-centered national innovation system. At face value, enterprises account for two-thirds of China's R&D expenditure; in reality, they have few financial resources to carry out innovative R&D activities. Second, it is always questionable whether money has been well spent. Misuse of research funds is widespread. More seriously, the rampant corruption in science and research has not only eaten a significant part of the research money, but also eroded the morale of the research community. Third, China still has a long way to go to perfect its intellectual property right (IPR) regime. Fourth, China faces a serious talent challenge as it seeks to sustain domestic economic growth and technological

advance. Demand seems to be exceeding supply, quality problems are rampant, and the talent already in place remains difficult to manage and retain.

Finally, there is the question of whether China can become an innovation-oriented nation without being open to different ways of thinking. This is more than just a question of philosophy, states Cao. While Chinese researchers and entrepreneurs are encouraged to think outside the box and not to be afraid of failure, at least equally important is that other ingredients of innovation—autonomy, free access to and flow of information, and especially dissent (scientific as well as political)—are not tolerated. In Cao's opinion, tolerance is as critical as talent and technology in driving creativity and growth. Therefore, allowing "blooming and contending" is more important than purely worshiping innovation as a new "religion." If the former is not allowed, he warns, the success of the innovation strategy is called into question.

In conclusion, the essays that follow are in accord on the need for rebalancing the Chinese economy, to shift the emphasis from investment (especially in heavy industries which consume a great deal of energy) and export, to consumption. One key measure to accomplish this is for China to continue to allow its currency to revalue, but at a faster rate. This would have the fortuitous effect not only of improving the Chinese economy, but also of reducing Chinese exports and therefore reducing the U.S. trade imbalance with China—thereby removing a serious irritant from U.S.-China relations.

The essayists make the case that Chinese leaders are wholly aware of the need to rebalance their economy, but whether they are doing enough remains to be seen. It will be interesting to monitor the benchmarks for economic reform suggested in the essays that follow to see how successful China can be in sustaining its remarkable economic growth. This is not just idle academic musing: the way China manages its economy will determine not only whether China's rise will be successful, but also how China impacts the rest of the world, including the United States.

2008: YEAR OF RECKONING FOR THE CHINESE ECONOMY?

BARRY NAUGHTON

The year 2008 is shaping up as one of unprecedented challenges for the Chinese economy. It is not that China faces economic collapse or crisis. Far from it: the fundamentals of economic growth remain strong, and China will continue to grow. But China is emerging from a period in which all the economic factors were aligned in its favor. In this benign environment, policymakers had been able to sit back and enjoy the benefits of growth, while sketching out ambitious plans to improve the quality of growth. Today, policymakers face an environment of increasingly difficult choices and tough trade-offs. Like policymakers worldwide, the Chinese must navigate for example the newly difficult trade-off between inflation and growth. That trade-off will be especially difficult in China because of domestic economic factors, because of the slow-down in the U.S. economy, and because of the uncertainties as a new leadership team grapples with the multiple incomplete agendas proposed by the Chinese Communist Party.

LOOKING BACK OVER THE RECENT CHINESE BOOM

Back in the mid-1990s, China faced a similar, even more dire, period of tough policy choices. At that time, delay in addressing problems with the state-owned sector had led to declining profitability, a fiscal crisis, and a surge of inflation. Growth slowed and economic challenges mounted. But while outside commentators bemoaned the stagnation of China's reform agenda, inside China policymakers ultimately faced the problems and made some tough choices. During the latter half of the 1990s, thousands of loss-making factories were closed, and the Chinese state enterprise sector was chopped in half. Austerity policies brought inflation down, while tax reforms brought the government budget back into financial health. After the budget was rehabilitated, policymakers pumped billions of dollars into the state-run banking system, ultimately allowing the state banks to be taken off life support and restructured. After some difficult concessions, China signed the agreement to be admitted into the World Trade Organization in 2001. These tough choices had significant short-run costs, leading to several years of slower growth, increased unemployment, and a seriously frayed social safety net.

However, the tough choices made during the 1990s have had a huge payoff so far in the twenty-first century. From 2001, China's economic and export growth accelerated dramatically. The newest growth phase had some distinctive characteristics compared to China's recent growth. New private actors began to play significant roles. For example, domestic private firms came from nowhere to provide 20 percent of China's exports in 2007. Moreover, the restructured state sector became much more effective, more flexible and, crucially, more profitable than it had been a decade earlier. Instead of weighing on the economy, the state sector became a reasonably effective instrument of government policy, above all providing the rapid growth in infrastructure—transportation, communication and electricity—that supported overall growth. With soaring investment, China revived its traditional heavy industries—steel, cement, and machinery—which had grown slowly in the preceding decade. High investment and rapid growth of heavy industry produced a virtuous cycle of self-supporting growth. Nothing exemplifies this process more than the explosion of steel production,

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which leaped from 151 million metric tons (MMT) in 2001 to 489 MMT in 2007, making China far and away the largest producer in the world.[1]

As it has happened, China's growth surge has contributed to, and been supported by, growth in the rest of the world economy. In the wake of September 11, 2001, U.S. monetary and fiscal policy became highly expansionary. A consumption boom—fueled by low interest rates—and a large government deficit led to a historically unprecedented trade deficit. The Chinese, of course, were happy to supply American markets, and a very large Chinese trade surplus developed in the course of the decade. While this imbalance made a lot of people uncomfortable—since it was so obviously "unsustainable"—the truth was that in the short run it worked well. U.S. growth recovered quickly after the 2001 recession. Anchored by the United States and China, global growth raised demand for commodities, including energy, and gradually spread the benefits of growth to commodity producers in the Middle East, Latin America and Russia. The years 2003-2007 were the best for global growth since the 1960s, as every region of the world, even Africa, grew at historically rapid rates. The odd couple of the United States and China set up this brief golden period, which is now over.

TODAY'S SITUATION

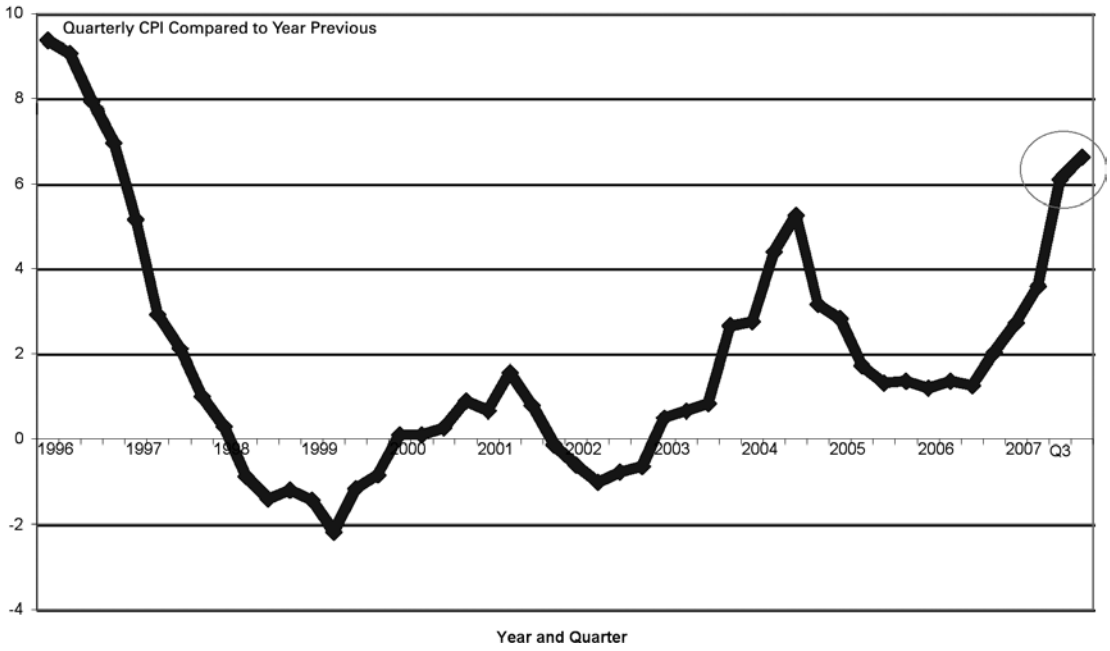
The immediate cause of change in the world economy today is the breakdown of crucial parts of U.S. credit markets, beginning with mortgage markets. But even before the problems with U.S. credit markets, the global economic boom was showing signs of fragility. The rapid pace of world growth put pressure on commodity prices, including sensitive food and energy prices, and was leading to adjustments in economic policy to deal with inflationary pressures. Policymakers in every country were beginning to face tough challenges relating to inflation vs. growth, though the specifics were different in every country.

In China, the inflationary challenge was especially difficult. First, the under-valued Chinese currency inevitably tended to make the inflationary problem worse. By holding down the value of its currency, Chinese policymakers encouraged an especially rapid growth of the trade surplus and large inflows of capital. In order to prevent appreciation, the Chinese central bank bought up hundreds of billions of dollars worth of foreign exchange reserves. By the end of 2007, the Central Bank held a mind-boggling US $1.528 *trillion* in foreign exchange reserves. Each dollar of reserves was purchased with an equal value of domestic currency, of course, which was released into the Chinese economy, increasing the money supply and creating inflationary pressures. We would expect this rapid monetary growth to create inflation, and for years the mystery was why there was so *little* inflation in China. In fact, the Chinese central bank worked hard to "sterilize" the monetary impact of foreign exchange reserve accumulation, reducing central bank domestic lending, selling bonds, and increasing reserve requirements for domestic banks. Combined with surging productivity and falling manufacturing costs, these measures mostly succeeded in keeping the lid on inflation until mid-2007. And then they stopped working. Consumer price inflation rose above 6 percent in August 2007, and has remained stubbornly high since, creeping up to 7.1 percent in January 2008. In response, China's central bankers have toughened their stance even further, and shown a renewed determination to restrict credit growth and push up interest rates. (Figure 1, next page, shows the rate of China's consumer price inflation from 1996 through the fourth quarter of 2007.)

The under-valued Chinese currency inevitably tended to make the inflationary problem worse.

Short-term measures will likely slow the momentum of accelerating inflation, but China is probably entering a new era of rising prices. Along with the change in monetary conditions is a fundamental shift in the nature of Chinese society. A flood of migration from the countryside to urban factories has powered the Chinese indus-

Figure 1: China Consumer Price Inflation



trial explosion of the past twenty years. Wages for unskilled labor have stayed low, because of the virtually unlimited supplies of labor available at the going wage. This is now beginning to change. In an important survey of 2,750 villages in 20 provinces, it was found that in 75 percent of villages, *all* of the young, able-bodied workers have already left the villages.[2] In these more accessible villages, positioned to provide workers for coastal factories, the out-migration is basically complete. As a result, wages in coastal cities have been rising since 2005, and China's export prices have been rising as well since 2006 or 2007, depending upon which measure you use. Moreover, new Chinese labor laws, designed to strengthen worker protections and enhance economic security, will further push up labor costs in 2008. Thus, China is likely to be facing a future of gradually increasing wages and costs for the foreseeable future.

These inflationary pressures have made China more willing to allow its currency, the *renminbi* (RMB), to appreciate. Currency appreciation is a powerful tool against inflation, lowering costs for imported commodities and easing off demand for exports. Between July 2005 when the currency was de-linked from the U.S. dollar, and October 2007, the RMB appreciated a little more than 10 percent against the dollar; but since October it has appreciated more than 1 percent per month, more than three times as fast. Indeed, since November 2007, Chinese imports have been growing slightly faster than Chinese exports, though exports are so much bigger than imports that the differential has not yet begun to shrink the trade surplus. These policy changes are clearly in the right direction and will have the right long run effects. In the short run, though, Chinese exporters are likely to feel squeezed from three directions: overall rising RMB costs, increasing value of the RMB, *and* a slow-down in demand from U.S. and perhaps European consumers. Chinese policymakers will have to navigate among these cross-currents without damaging (or alienating excessively) their most successful economic sector.

MACROECONOMIC DILEMMAS: WHY IT MIGHT BE MORE DIFFICULT THAN IT APPEARS

While the modest changes in China's economic policies in recent months are all in the right direction, they are part of a larger transition that

might not be easy. This is because China's economy has developed in a distinctly unbalanced way in the past decade. The investment rate has been unusually high, over 40 percent of gross domestic product (GDP) for the past three years. Correspondingly, the rate of household consumption is unusually low, below 40 percent of GDP. (The remainder is made up of government consumption and net exports.) The ultimate fix for this situation is obvious: China should increase the share of household consumption, and gradually reduce the share of investment and net exports (by shrinking the trade surplus). Currency appreciation, already underway, can contribute to this transition by giving domestic households more purchasing power (because it makes imports cheaper), and reducing the trade surplus. Appreciation combined with higher interest rates certainly should slow investment growth. Yet it may be difficult to implement these changes smoothly. In the first place, investment is inherently unstable, and the Chinese economy is highly dependent on investment. The virtuous circle described in the first section can quickly reverse into a vicious circle: if demand for heavy industrial products declines, excess capacity will quickly emerge in those industrial sectors. With excess capacity, the incentive to invest in those sectors will largely disappear, leading to a further decline in demand for heavy industrial products. Under such a scenario, the temptation to dump excess supplies of goods like steel and cement onto the world market would be great. China has already become a large net exporter of steel. Although it has already taken steps to restrain steel exports, by adjusting tax rates on steel exports, a sudden sharp fluctuation in the Chinese economy could easily overwhelm these modest measures. In that case, developed countries would almost certainly take protectionist measures that would greatly complicate global economic adjustment. China's dependence on investment creates a built-in vulnerability to economic turbulence.

A further challenge comes from the "post-Olympics" effect. In Beijing, the government is close to completing a burst of Olympics-related construction. An event like the Olympics naturally creates economic down-draft after the event, because the completion of so much activity and investment is synchronized, and labor and investment resources are inevitably idled after the games. Both Japan and South Korea experienced economic slowdowns immediately after their breakthrough Olympics games. As a result of these real effects, there is sentiment among the investment community in China that the Chinese stock market will stay robust until the Olympics, and then turn down. If enough investors believe this folk wisdom, it may become a self-fulfilling prophecy.

Indeed, the Chinese stock market has a number of characteristics that might contribute to volatility in 2008. Long known for its unpredictability and extreme sensitivity to government policy decisions, the market has already soared dramatically, nearly quadrupling in value between late 2005 and late 2007. Since peaking on October 16, 2007, the Shanghai market has fallen 25 percent by January 2008. An additional factor that may put downward pressure on prices is that the supply of new shares may increase significantly in 2008. Not only are there many new firms set to make initial public offerings during 2008, but in addition, many already listed state-owned firms are nearing the end of the three-year lock-up periods they entered as part of share conversion after 2005. Government shareholders will theoretically be free to sell shares on the open market as these lock-up periods expire. These factors mean that the Chinese stock market may contribute a substantial element of volatility in what is already a challenging economic environment.

China is unlikely to be a shelter from a global economics storm, but is instead likely to at least reflect—and perhaps magnify—global economic shocks.

In short, China faces challenges not only from a slowing U.S. and world economy, but also from some built-in features of its own economy. These mean that China is unlikely to be a shelter from

a global economics storm, but is instead likely to at least reflect—and perhaps magnify—global economic shocks. On the trade side, a slowdown in U.S. demand might make it harder for Chinese policymakers to do what is in the interests of the Chinese economy: let the Chinese currency appreciate more rapidly, perhaps in a quick, one-off, jump. To fight inflation, China needs to let the currency appreciate, keep a tight rein on bank credit, and raise interest rates. To keep growth from faltering, China needs to stimulate domestic consumption, and ensure that the global trading system stays healthy. These things can all be accomplished at the same time, but they will require substantial policymaking skill.

HOW SHOULD WE EXPECT POLICYMAKERS TO RESPOND?

The recent record of China's policymakers has been mixed. China's leaders have been given breathing space by rapid economic growth and by abundant and unanticipated budgetary revenues created by growth. They have responded to this breathing space by addressing some of the social problems China faces and articulating a vision of an improved pattern of economic growth. Under the slogans of the "harmonious society" and "scientific developmentalism," China has declared its intention to spread the benefits of growth more equally and reduce some of the costs of growth, especially environmental costs. These policies, in some respects long overdue, have already produced some concrete results, particularly in lowering rural tax burdens and beginning to improve rural health and education services. Generally speaking, however, the successes of the new policies have come in distributing the "growth bonus," the leeway in budgetary politics that has come from the booming economy.

At the same time, the government has developed a series of ambitious policy blueprints. Over the past five years, the government has promulgated a series of increasingly far-reaching programmatic documents, covering the banking system, capital markets, corporate restructuring, growth and the environment, and growth and technological change. As the scope of these programs has grown, they have become increasingly expansive and less practical. In many cases, these programs have proclaimed admirable goals, but without specific policy instruments that can be used to reach those goals. A great deal of thought has gone into critiquing the "growth at any cost" orientation of the past, in an effort to develop a more efficient growth path that is socially and environmentally beneficial. Such a "re-think" has clear benefits. But it has also led to unrealistic targets and unfulfilled expectations.

For example, the quest for a more efficient growth path led Chinese policymakers to call, in the 11th Five Year Plan (2006-2010), for growth with a smaller "environmental footprint," and for a 20 percent improvement in energy efficiency per unit of GDP by 2010. But the plan did not lay out any specific policy for achieving these outcomes, and policymakers have flailed about since trying to come up with appropriate policy tools. Given the tilt toward heavy industry in China over the past decade, there is virtually no possibility of achieving the energy conservation goal by 2010. In a related fashion, planners have sought to foster technological creativity and ownership of indigenous brands and technologies. They have called for "technological progress" to make up 40 percent of total output growth in the near future. Again, this is a noble goal, but it is not at all clear which government policies are likely to provide the right incentives to the companies that ultimately make these decisions. Sharp increases in the costs of using energy and emitting pollution would be the first step, but

A great deal of thought has gone into critiquing the "growth at any cost" orientation of the past, in an effort to develop a more efficient growth path that is socially and environmentally beneficial.

so far policymakers have hung back from these tough measures.

The result is that Chinese policymakers now have a large backlog of noble objectives that have been proclaimed, and promises made. Growth should be more "balanced," and balance includes everything from a greater stress on consumption instead of investment; to a more inclusive pattern of benefits both geographically and across income classes; to a more environmentally friendly, knowledge-intensive and creative process of growth. To be sure, no reasonable person actually expects that the varied promises of politicians will all come true. But Chinese policymakers face the danger that their grand proclamations will begin to be seen as empty. The worry is not just that the targets will not be achieved, but that the system will not even move in the right direction. For four years, the Chinese government has been declaring that it will slow the economy to prevent it from over-heating, and yet despite this, inflation has now reached its highest level since 1996. Additional stumbles could call into question the credibility of the broader vision of the Chinese leadership.

A NEW TEAM IN PLACE

Who will have the responsibility for delivering on these promises? Overall, the Hu Jintao-Wen Jiabao administration will remain in place, probably for the next five years. This was decided at the 17th Communist Party Congress, which took place in October 2007. Hu and Wen were "re-selected" as top leaders, and only four new members (out of nine total members) were named to the Politburo Standing Committee. Thus, the basic outlook is for continuity. However, there are some important changes. The key organ for the implementation of economic policy is the State Council. The Communist Party, specifically the Standing Committee of the Politburo, passes on all major policies, but day-to-day implementation of economic policy is in the hands of the State Council, the top executive organ of government.

A new State Council was selected in March of 2008, when the National People's Congress met.[3] Unlike the Politburo Standing Committee, the State Council saw significant changes. On balance, those changes have left the State Council with fewer technocrats and more politicians than has been the case in the recent past. The new politicians are a generally talented bunch. Executive Vice Premier Li Keqiang has an advanced degree in economics (although from a specialized course for serving bureaucrats), and Wang Qishan, who heads the economics and industry portfolio, has substantial experience in the financial sector, and also in crisis management, which often comes in handy in economic posts. Nevertheless, these leaders are all politicians who cut their teeth as executives at the provincial level. They're good at the balancing of interests and the rough-and-tumble bargaining that characterizes local politics. What we do not see on the new State Council are leaders with a strong bureaucratic or technocratic background, such as was brought to the previous State Council by Zeng Peiyan and Wu Yi.

Why is this? Ironically, it is an unintended consequence of the modest political reforms that the Communist Party has imposed on itself. In the first place, the Party has adopted a much more regular set of career paths, with education requirements, de facto term limits, and, most crucially, mandatory retirement ages. These norms funnel successful politicians upward, into contention for the top spots. But since only a few spots have been vacated at the top, in the Politburo, lots of the other Party barons have ended up being parked in the State Council. Secondly, the Party introduced a modest amount of intra-Party democratic evaluation this year. All Central Committee members voted on

Figure 2: New State Council (2008)

Wen Jiabao, 温家宝, Premier (Age 65).
Li Keqiang, 李克强, Executive Vice Premier (52).
Zhang Dejiang, 张德江, Vice Premier (61).
Hui Liangyu, 回良玉, Vice Premier (63).
Wang Qishan, 王岐山, Vice Premier (59).
Liu Yandong, 刘延东, State Councilor (62).
Liang Guanglie, 梁光烈, State Councilor (67).
Meng Jianzhu, 孟建柱, State Councilor (60).
Dai Bingguo, 戴秉国, State Councilor (66).
Ma Kai, 马凯, Secretary General of State Council (61).

the acceptability of candidates to the Communist Party Politburo and Politburo Standing Committee. This process provided a huge boost to Xi Jinping, who vaulted over Li Keqiang to become the most likely successor to Hu Jintao as Party head. But it had the unintended side effect of stunting the political careers of the most prominent economic technocrats. Ma Kai, the former head of the National Development and Reform Commission (NDRC) super-ministry, and Zhou Xiaochuan, head of the People's Bank of China, both failed to be selected to the Politburo. Chen Deming, the presumptive head of the NDRC, failed even to be selected on to the Central Committee. For some reason, economists just aren't very popular inside the Communist Party!

The top leadership has scrambled to cope with this outcome in the months since the 17th Party Congress. The leadership of the National Development and Reform Commission was ultimately given to Zhang Ping, who was seen as the only qualified candidate still available. Even more significant, Zhou Xiaochuan was pressed to stay on as Central bank head. Previously it was widely expected that Zhou would step down as head of the central bank. But in the face of recent financial turbulence originating in the United States, it was recognized that Zhou had the experience and international credibility needed to anchor China's policy-making that no other plausible candidate for the job possessed. Only in February 2008 was it leaked that in addition to Zhou, the rest of the central bank leadership and all the major financial regulators—heads of the banking, securities and insurance sectors—would remain in place as well.[4] This is the right decision, in the face of an unusually complex and difficult financial environment, but it also shows that the grooming and promotion of a next generation of leaders is not working very effectively in the key financial institutions.

WHERE DO WE STAND?

Chinese policymakers will be navigating stormy seas over the next year. In addition to the basic macroeconomic policy challenges described above in the third section, the leaders must grapple with the broader policy agenda. Reducing pollution, providing labor security, and providing improved social services are likely to add to costs in the short run. If the economy is squeezed already between its need to reduce inflation and its desire to maintain competitiveness, these additional challenges will make choices even more difficult. But not to pursue these objectives would be even more costly in the long run. Everywhere we look, the Chinese economy is confronted with difficult choices.

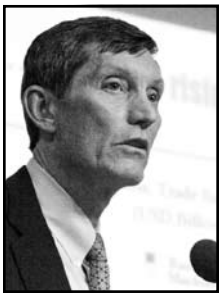
A new team is coming in to make those choices. This new team has substantial talent, and will certainly rely on today's experienced technocrats for a transitional period. Then, they must learn to work together, and to make smart choices in the face of difficult conditions. As China's economy grows, its success or failure is increasingly important to the world, and to the United States. China's astonishing record of growth shows how deeply rooted Chinese economic dynamism is, and cautions us against over-estimating the obstacles to future growth. At the same time, there is no room for complacency based on the past; what is needed is a sober evaluation of the complex challenges facing China in 2008.

ENDNOTES

1. "World crude steel output increases by 7.5% in 2007," *International Iron and Steel Institute*, January 23, 2008, accessed at http://www.worldsteel.org/pictures/newsfiles/2007%20Summary.pdf. The second largest producer, Japan, accounted for 120 MMT in 2007. China produces 36 percent of total world output of steel.
2. Han Jun, "Nongcun Laodongli Gongqiu Guanxi de Xinbianhua" {Recent Changes in the Supply and Demand for Rural Labor}, *Zhongguo Jingji Guancha* {China Economic Survey}, Vol. 2, (2007): 165–175.
3. For further discussion of these leadership changes, see Barry Naughton, "China's Economic Leadership After the 17th Party Congress," *China Leadership Monitor*, No. 23 (Winter 2008). Available at http://media.hoover.org/documents/CLM23BN.pdf.
4. Wang Xiangwei, "Leaders Settle on Top Roles in State Council," *South China Morning Post*, February 4, 2008.

MEETING CHINA'S MACROECONOMIC CHALLENGE

STEVEN DUNAWAY



In the past 20 years, China has added about $2 trillion to world gross domestic product (GDP), created 120 million new jobs, and pulled 400 million of its people out of poverty. Over the past decade, output growth has averaged more than 10 percent annually, while inflation has averaged less that 3 percent. During this period, China has become one of the largest economies in the world and the third largest trading nation.

These are remarkable achievements, but there is nonetheless considerable unease about the state of China's economy and the economic well-being of its people. Income on a per capita basis is still very low in China relative to other major countries, the benefits of economic development have been unevenly distributed across the country and across sectors of the economy, and an estimated 150-200 million workers are still underemployed. To deal with these problems, there remains a critical need for China to sustain rapid economic growth. Up to now, that rapid growth has been primarily achieved by heavy reliance on investment and exports. But it is increasingly recognized that China cannot continue indefinitely to rely principally on these sources for economic growth.

This concern was prominently articulated at the National People's Congress in March 2007 when Premier Wen Jiabao cautioned that "the biggest problem with China's economy is that the growth is unstable, unbalanced, uncoordinated, and unsustainable." The key concern is that the imbalances in the economy could in time slow growth, perhaps significantly, putting China's economic miracle at substantial risk, unless the country shifts policies to foster increased reliance on domestic consumption.

As a result, the need for policy action has become more urgent. Over the past four years, continued rapid credit and investment growth has sowed the seeds of overcapacity in certain sectors, undermining the asset quality of the banking system, and could ultimately lead to a sharp growth deceleration. This final reckoning has been put off in recent years by the surge in exports and increased substitution of domestically produced goods for imports that has taken place, which has effectively absorbed much of the capacity put in place by rapid investment growth. However, the resulting substantial rise in China's external surplus coupled with its efforts to continue to tightly manage the exchange rate have led to rising international reserves and more liquidity pouring into the banking system, fueling further lending and investment and a push for more export growth and import substitution. Policy measures used thus far—especially heavy reliance on administrative measures and financial repression (moral suasion against lending)—have been ineffective in breaking this vicious cycle and

Premier Wen Jiabao cautioned that "the biggest problem with China's economy is that the growth is unstable, unbalanced, uncoordinated, and unsustainable."

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reestablishing macroeconomic control. To make matters worse, inflation is a new concern that has now emerged. High food price increases have persisted in a few categories and begun to spread to other key food commodities, creating the potential for a shift in inflationary expectation that could trigger a more generalized inflation process.

What is driving these imbalances? A combination of distortions in key prices—including the cost of capital, the exchange rate, energy, other utilities, land, and pollution costs—and other policies and the structure of the economy have served to favor investment over consumption. These are the principal factors that have contributed to the current economic situation. To resolve it, the basic macroeconomic policy actions needed to carry the economy ahead and sustain growth and development include further liberalization of prices, greater reliance on monetary policy (especially to deal with short-term problems of macroeconomic control), additional financial market reform and development, and changes in government expenditure policies.

MOUNTING IMBALANCES AND THE THREAT TO SUSTAINED GROWTH

Major reforms launched in 1994 set the stage for the acceleration in China's development and the export boom of the past decade. These reforms had three key prongs: the unification of the official and market exchange rates and the removal of restrictions on foreign exchange payments for international transactions in goods, services, and income; the liberalizing of foreign direct investment in the export sector; and the reform of the state-owned enterprises (SOEs). The first two changes encouraged growth in the export sector and the third unleashed domestic entrepreneurship.

Foreign firms used this opening to take advantage of China's low labor cost enterprises and helped to convert the coastal regions into the "world's workshop" and a critical node in the global supply chain. State-owned enterprises, relieved of costly social responsibilities and not required to share profits with the government, began to invest in new technologies, expand rapidly, and seek out new markets. Domestic private sector firms also developed. A plethora of incentives provided to all firms by both the central and the local governments—in the form of tax breaks, cheap land, and low utility prices—helped to keep production costs low and raise profits, which were reinvested in further expansion. At the same time, with capital controls and an underdeveloped capital market limiting investment choices, China's large pool of savings tended to provided capital-intensive, state-owned enterprises with a captive and cheap source of financing intermediated by the state-controlled banking system.

China cannot sustain rapid economic growth with such heavy reliance on investment and exports.

The net result of all of these developments was that China began an economic expansion of unprecedented pace driven by investment and exports. Domestic consumption could not keep up with the growth in capacity created by the rapid rise in investment. As a share of GDP, investment rose sharply while consumption declined. Increasingly, the capacity generated by investment was directed toward both export industries and domestic industries that competed with imported products. Consequently, China's current account balance improved in the early 2000s and the surplus ballooned after 2004.

Nevertheless, it is becoming very clear that China cannot sustain rapid economic growth with such heavy reliance on investment and exports. Continued large investment that is significantly concentrated in a few sectors of the economy could create (as it has in the past) substantial excess capacity leading to significant price declines, declining profits, and eventually ending up as new nonperforming loans in the banking system, as loans that were made to finance these investments go unpaid. At the same time, the ability of exports to serve as an outlet for additional sharp increases in capacity will diminish. China already accounts for a large share of world trade and to expand its export mar-

ket penetration further will be increasingly difficult for China to do without cutting export prices and profitability. Moreover, the external environment that China faces could become enormously more difficult and complicated in the period immediately ahead if the global economy slows and competition from other countries rises as a consequence. Protectionist pressures in China's trading partner countries are likely to rise substantially, especially if China is trying to boost its market share in such an unfavorable global economic environment.

WHY IS INVESTMENT SO HIGH?

There is no big mystery as to why investment in China is so high. Profits of Chinese companies have risen sharply over the past several years, suggesting that returns on investment are very attractive. In part this reflects the fact that key input costs, including energy, other utilities, and land prices, as well as pollution abatements costs are low. But the most important factor is the low cost of capital. Investment accounts for nearly 45 percent of China's GDP, and 90 percent of that investment is financed domestically (which is not surprising when the national savings rate is 55 percent of GDP). Foreign direct investment amounts to less than 5 percent of GDP. Domestic bank lending and reinvested earnings of firms fill the bulk of the financing needs of firms. But lending is overwhelmingly directed by the banking system to the large, capital-intensive state-owned enterprises. Lending rates are low because the government fixes deposit rates at a low level, and households not having much in the way of viable alternatives pile their large savings into these low yielding assets. At the time, the government (until very recently) has not sought dividends from SOEs, not even from those that are listed on the stock exchange and pay dividends to their private shareholders. With the alternative use for these funds being to sit in low-yielding deposit accounts, it is no wonder that firms are eager to reinvest their profits. Rising corporate saving has been the main reason that China's overall savings have gone up. Corporate savings roughly equal household savings—at about 23–24 percent of GDP. In addition, the undervalued exchange rate and widely held expectations among investors that the currency will appreciate only gradually have biased investment toward exports and import substitution, adding to the rise in the trade surplus.

The bias that the low cost of capital has created in China's output and employment growth becomes apparent looking at comparisons across major groups of countries. Since 2001, real GDP growth in China has averaged about 10 percent a year, while the real cost of capital has hovered around 1–2 percent, in sharp contrast to normal expectations. It would be expected that over time that real cost of capital would converge to the growth rate of real GDP (which proxies for real returns on investment). This is in fact the case in advanced economies where the gap between real interest rates and real GDP growth is negligible. In most emerging market economies, this gap tends to be positive, but nowhere is there such a wide gap as in the case of China. Consequently, it is not surprising that investment growth is so much faster in China and that investment's share of GDP is one of the highest in the world. However, the cost of capital in China is not just low; it has fallen relative to wages, despite the country's abundant labor supply. As a result, this has contributed to the skewing of production toward capital-intensive processes and slower job creation. In sharp contrast to many advanced and emerging market economies, where 3–4 percent real GDP growth tends to generate 2-3 percent employment growth, China with its average 10 percent real GDP growth rate is managing only to generate about 1 percent employment growth.

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WHY IS CONSUMPTION LOW?

Consumption growth has been reasonably strong in China, but it has failed to keep pace with output growth. Real consumption has grown at an average annual rate of 8 percent since the early 1990s, while GDP has grown at around 10 percent. As a result, household consumption's share of GDP has fallen by more than 12 percentage points, to about 40 percent at present, one of the lowest levels among advanced and emerging market economies. Precautionary savings by households rose in the early 1990s, as reforms permitted SOEs to shed much of their social responsibilities in the areas of education, health care, and pensions, and the government has been slow in moving in to effectively fill this void. Nevertheless, household savings in China in more recent years has not changed much; in fact only about 1 percentage point of the 12 percentage point decline in the share of consumption relative to GDP is attributable to rising household savings.

Nearly all the decline in the consumption relative to GDP is attributable to a falling share of national income going to households in the form of wages, investment income, and government transfers. Many countries have seen their wage shares decline. But, in most countries, overall household income has held up reasonably well because rising dividend and interest income have offset falling wage shares. In China, however, household investment income has declined from more than 6 percent of GDP in the mid-1990s to less than 2 percent today, mainly because of low bank deposit rates and limited household ownership of equities either directly or indirectly through institutional investors (see Aziz and Cui, 2007).

MEETING THE CHALLENGE OF REBALANCING THE ECONOMY

The way to rebalance China's economy and shift from investment and exports as the main drivers of growth to consumption seems relatively straightforward. Price distortions need to be removed and other policies have to be changed to remove inefficiencies or distortions that have substantial influences on investment and consumption decisions. Among the key steps that should be taken are:

Liberalize Key Prices

These prices need to reflect market conditions and underlying resource costs. In the past few years, the government has begun to raise the price of industrial land, electricity, and gasoline, but more needs to be done, especially to bring energy prices more in line with world prices. The government has also sought to introduce stricter environmental standards and better enforcement of pollution controls, but it is recognized that much more needs to be done. The government's goal of cutting energy use per unit of GDP by 20 percent over the next five years should help not only in improving energy efficiency and reducing pollution, but also in curbing investment growth by raising business costs.

The more immediate problem in China is curbing rapid investment growth. This has been the main goal of macroeconomic policy over the past four years. The authorities have tried to control investment directly by using a combination of administrative measures and window guidance to the banks to limit lending growth, but these actions have not provided a lasting solution, while imposing costs in terms of the distortions that they have created. Instead, the cost of capital has to be significantly raised, and that cannot be done without relying more on monetary policy. And to be able to use monetary policy, the authorities have to permit a more rapid rate of appreciation of the exchange rate. The authorities also need to lift the ceiling on deposit rates. With all of these measures, not only will the financial cost of capital increase, but, over the medium term, a stronger currency will help curb investments in the export and import-substituting sectors, and real household incomes will be boosted by the rise in both the exchange rate and

The way to rebalance China's economy and shift from investment and exports as the main drivers of growth to consumption seems relatively straightforward.

in bank deposit rates. At the end of the day, the basic objective for China's economic policy should be to make both interest rates and the exchange rate increasingly market-determined, so that the right price signals are provided to investors and households.

Reducing investment growth will require more than just monetary tightening. On the tax front, the government is unifying the enterprise income tax rate, but at the same time it needs to remove the tax and other incentives favoring investment that have proliferated over the past two decades, including those incentives provided by local governments. Raising the cost of capital also requires the government to exercise better corporate governance over the State-owned enterprises, including asking profitable firms to transfer dividends to the budget. A program has been initiated in which some central government-owned SOEs will pay dividends to the budget in 2008, for the first time since 1994. This is a step in the right direction, but the program needs to be expanded, and at a minimum companies listed on the stock exchange should be paying dividends to the budget through their holding company parents (which are state-owned enterprises) that are the same as they pay to their private shareholders.

Reform Financial Markets

While weak corporate governance by the government has allowed SOEs to accumulate large savings, private enterprises—especially the small and medium-sized ones—have behaved the same as SOEs because poor financial intermediation limited their access to bank credit (see Aziz, 2006). In the early 2000s, China embarked on an ambitious bank reform program and has made substantial progress in cleaning up nonperforming loans, recapitalizing banks, and opening the sector to foreign participation and competition. As a result, however, banks have become more conservative in their lending practices—in large part owing to weak internal risk management and risk pricing systems—and have continued to direct most credit to large SOEs, expanding credit only modestly to private firms and households.

Capital (bond and equity) market reform and development is needed to provide alternative sources of financing for firms and a much broader array of assets for households to invest in. Small- and medium-sized firms have had to rely largely on retained earnings or the assets of their owners to finance investment. Consumers also have not had much access to credit for almost all large purchases, including education, health care, pensions, housing, and durable goods. Equity market reforms of the past few years have revitalized a languishing stock market.

Better financial intermediation is one of the government's priorities. More needs to be done to complete the reform of the banks. The Agricultural Bank of China will only be reformed and recapitalized some time in 2008. All of the banks need to further improve their management information systems and internal controls and their ability to assess risk and price their loans appropriately. Lifting the cap on deposit rates would not only help push up the cost of capital, but it would also allow smaller and more aggressive banks to compete better against the large state-owned banks and provide an incentive for big banks to expand credit to new customers, like small and medium-sized enterprises and households. China is also looking to expand its bond and equity markets. Greater access to credit would reduce the incentives of both firms and households to hold large savings. Moreover, better access to credit and higher yielding assets to invest in would raise household incomes and diminish household saving over time.

Shift Government Expenditures to Social Spending

The government has an important direct role to play in the rebalancing of the economy; it needs to improve the provision of key social services, especially education, health care, and pensions. Reducing the uncertainties surrounding the provision of these services will substantially diminish households' strong precautionary saving motive and give households the confidence to raise their consumption. In the 1994 SOE reforms, the provision of health care, education, and pensions was transferred from companies to local governments. However, in general, local governments were not provided with adequate resources to discharge these new responsibilities. Consequently, households have had to bear an increasing portion of the costs of health care

and education. Chinese households pay about 80 percent of health care costs out of their own pockets, one of the highest proportions in the world. They also face considerable uncertainty about pensions, because reforms in this area have not produced a new, viable pension system, although China's one-child policy has intensified the aging of the population and boosted the need to save for old age (see Dunaway and Arora, 2007). The government has increased spending for education and health care in recent budgets, but the increases have been limited. In essence, households have self-insured against uncertainties associated with pensions, health care, and education. As a result, they have saved significantly more than they would have if these risks were pooled socially.

The government has an important direct role to play in the rebalancing of the economy; it needs to improve the provision of key social services, especially education, health care, and pensions.

CONCLUSION

Imbalances in China's economy have already reached critical levels. If left unchecked, they will continue to grow, and in time they will pose a major threat to the country's economic growth and stability. The Chinese authorities have recognized the major macroeconomic challenge they face—the need to rebalance output growth away from heavy reliance on investment and exports toward consumption in order to address this situation. They have laid out a set of policies to deal with this rebalancing challenge, and there is general agreement among economic analysts on the broad elements of the approach that they have adopted. The authorities have made progress on many of these policy undertakings. However, more progress is needed, and growing concerns both about China's domestic and external position point to the need for a faster pace of policy implementation.

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CHINA'S ENERGY SURGE: REASONS, IMPLICATIONS AND RESPONSES

JEFFREY LOGAN

Chinese energy demand has doubled since the year 2000. While this unprecedented growth has helped drive China's economic development, particularly in urban areas, it has also caused worrisome dislocations. Within China, strong growth in energy-intensive heavy industry has exacerbated air pollution, energy insecurity, and resource dependence problems. Globally, the Chinese industrial surge is fueling inflation and volatility in global commodity markets, geopolitical concerns, and greenhouse gas emissions.

Perhaps most worrisome is that China's central government appears unable to control the country's economy. The recent surge in steel, cement and aluminum production, for example, has emerged from provincial level investment despite other central government priorities. Although the Chinese government is taking steps to rebalance the economy and slow energy-intensive growth, it remains to be seen if Chinese policymakers can use the invisible hand of the market to accomplish what the iron fist of the state once dictated.

As China geared up for the annual Spring Festival in early 2008, unusually heavy snow hit hard the country's energy and transport sectors. The cold weather stranded passengers in train and bus stations throughout south and central China, and prevented coal from making the long southeasterly journey from the fields of Shaanxi to the coastal provinces.

The weather highlighted a long-existing tension in China's energy system: in an increasingly market-driven economy, one cannot have liberated upstream prices (on coal), and controlled downstream prices (on electric power). Well, perhaps one can, but it should come as no surprise when even state-owned companies refuse to generate electricity given their losses on each additional kilowatt-hour generated. This, more than the temporary impact of the storms or any limitation in coal transport capacity, is the fundamental reason for the current power shortage.

THE CHANGING ENERGY-ECONOMIC RELATIONSHIP

As economic reforms began in the late 1970s, China's industrial sector resembled that of the former Soviet Union: geographically diffused for reasons of self-sufficiency, habituated to low-cost energy, and outdated.[1] Chinese government planners quickly realized they would face unacceptable shortages of energy and transport capacity if they did not control demand growth. Policymakers responded with funding to: replace outdated industrial equipment, train enterprise energy managers in conservation and efficiency, consolidate small facilities into more efficient larger ones, liberalize energy prices in stages, and educate end-users on the benefits of saving energy.

From 1980 to 2000, these investments paid rich dividends. China's energy intensity—the amount of energy needed to produce a unit of economic output—declined by over 4 percent annually, and offset the need to burn hundreds of millions of tons of coal each year. The so-called "income elasticity of energy demand" was held at roughly 0.5 (meaning that energy demand grew only half as quickly

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Suddenly, China's energy demand was growing at double-digit rates

as GDP), a unique achievement for a rapidly developing economy.

But all of that changed starting in the new millennium. Suddenly, China's energy demand was growing at double-digit rates (see Figure 1) and shortages emerged around the country. First and foremost, the electric power sector went into deep shortage in 2003 and 2004. This shortage commenced soon after China emerged from massive overcapacity in the late 1990s, when the twin economic braking effects of the Asian Financial Crisis and "break-the-iron-rice-bowl reforms" left the country with too much generating capacity. Next, coal demand shot up to feed the need for power and other industrial activities, and strained the already weak linkages in the coal supply-demand chain. Then, as repeated in early 2008, central planners wanted low-priced coal to keep inflation in check, but state-owned companies refused to deliver it at a loss. Finally, oil demand surged uncontrollably, growing by over 15 percent in 2004, driven by the need to fuel oil-fired back-up power generators to keep factories and facilities running in the absence of available coal and hydro generation capacity. China had to import this petroleum since domestic output couldn't keep up with demand. China's 850,000 barrels/day incremental call on global oil markets in 2004 raised alarms around the world that China had risen onto the global energy stage[2] (See Figure 2).

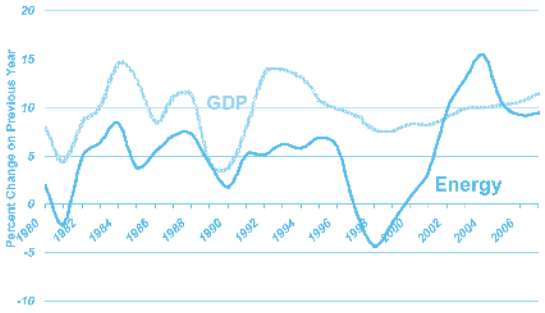
One of the most overlooked aspects of China's growing search for energy security is seen in the power sector. This sector—which saw many foreign participants flee in the late 1990s when take-or-pay controls were not honored during the period of oversupply—is now almost completely controlled by domestic actors, but sparked the surge in global oil prices in 2004 that had deep international repercussions. Clearly, China had grown so quickly that it was affecting the world without even trying.

WHAT CAUSED THE SURGE?

What caused the tremendous surge in Chinese energy demand? Was the economy growing more quickly than statistics indicated? Not likely, since electric power use is a good physical proxy for economic activity and showed relatively "normal" behavior. Was there a sudden surge in consumer demand for energy to power air conditioners, cars, and other appliances associated with the new-found "good life" in China? Again, no, the available data do not indicate this.

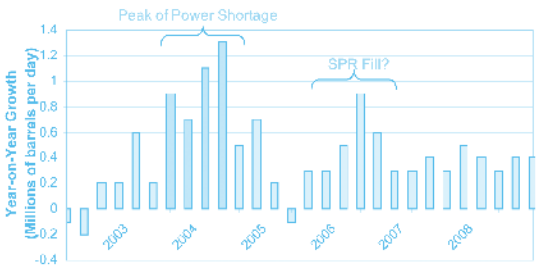
What data do show is enormous growth in energy-intensive building material, chemicals, and metals production. China went from supplying 15 percent of total global steel output in 2000 to 35 percent in 2005; the aluminum sector followed a similar trajectory (See Figures 3 and 4, next page.) China now makes half of total global

Figure 1: China's Energy-Economic Relationship



Source: *China Statistical Yearbook*, National Bureau of Statistics, Beijing, 2007.

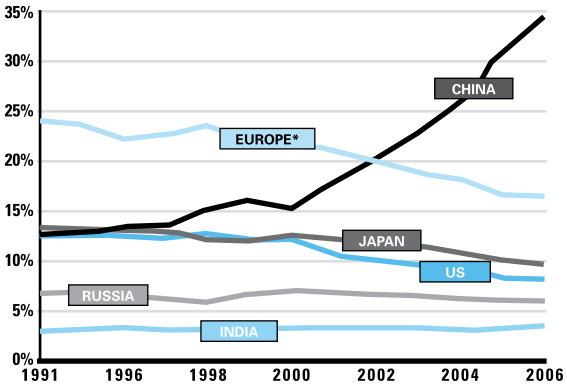
Figure 2: China's Marginal Oil Demand Growth



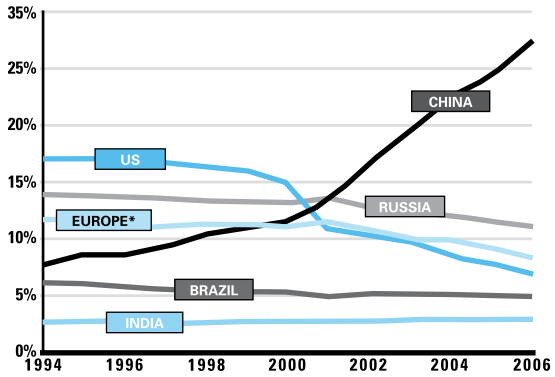
Note: SPR stands for strategic petroleum reserve.
Source: *Oil Market Report*, various years, International Energy Agency, Paris.

Figure 3: Surging Output of Chinese Heavy Industry Products

a) China's Share of Global Steel Production

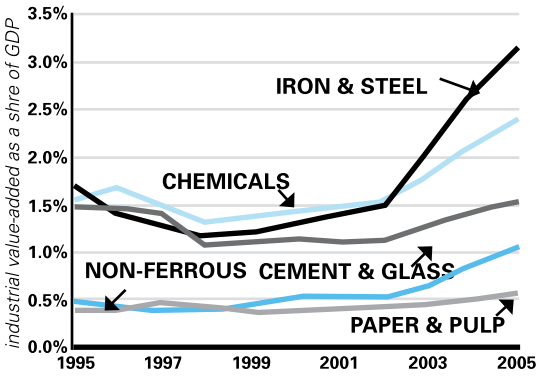


b) China's Share of Global Aluminum Production

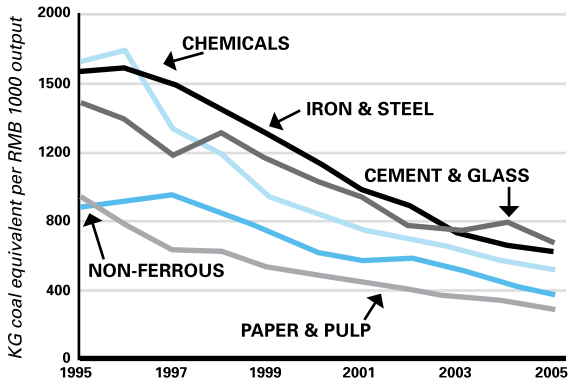


Taken from: *China Energy: A Guide for the Perplexed*, D. Rosen and T. Houser, Peterson Institute for International Economics, Washington, DC, 2007.

Figure 4: Changes in Heavy Industry Contributions to the Chinese Economy



Source: CEIC from China Statistical Yearbook



Source: CEIC from China Statistical Yearbook

Taken from: *China Energy: A Guide for the Perplexed*, D. Rosen and T. Houser, Peterson Institute for International Economics, Washington, DC, 2007.

cement output (about 1.35 billion tons in 2007) and uses almost all of it for new roads, buildings, and airports at home.

The reasons for the surge in energy-intensive industrial production are not fully understood, especially with so-called "herd tendencies" in China. Part of the reason is the dramatic rise in urbanization in China, requiring more buildings, roads and infrastructure for each new urban dweller. But other drivers have pushed investment as well. Dan Rosen and Trevor Houser argue that the energy-intensive building materials and metals sectors are the most natural targets for the excess capital that has built up in China over recent years.[3] These capital-intensive sectors have provided increasing profits for investors given their goals and constraints. Given their capital intensity, these sectors are natural targets for the mountains of money that investors control in 21st century China. Compared to conditions outside of China, land and environmental compliance costs inside China are often low, especially when local government officials have a stake in the investment outcome. Finally, profitability, at least until recently, has improved for these industrial sectors compared to earlier returns.

Worth noting, provincial and local actors have largely driven this phenomenon despite efforts by the central government to hold it in check.

IMPLICATIONS FOR CHINA AND THE GLOBE

While heavy industry-led growth has created rich profits for firms in China, it has also created a number of dislocations, both at home and abroad. The building material, metal, petrochemical, and electric power industries are capital-, as opposed to labor-intensive, so they have added to China's GDP growth with little ability to absorb excess rural workers. China's entire steel sector, which now accounts for 35 percent of world supply, employed only 3 million people in the year 2000.[4] Why would the central government of China, desperate to employ as many newly-urbanized workers as possible, create a policy that favors this type of investment, especially given all the other externalities?

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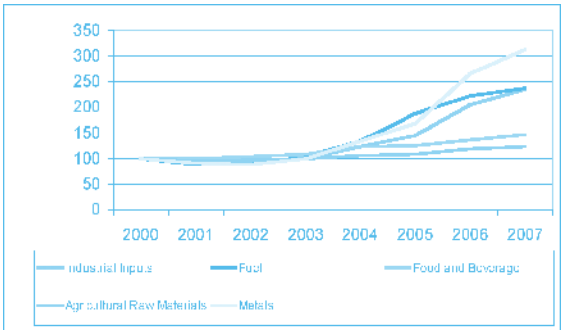
These sectors are also heavily dependent on coal and stress the country's already overloaded transport capacity. It is common to hear a criticism in China of the country's "resource-intensive" growth. Indeed, why would China build its economy on aluminum or fertilizer production—enormously energy-intensive goods—when other countries (with abundant electricity and natural gas supplies) seem much more suitable hosts?

Perhaps most importantly, these investments are often driven under provincial and local leadership that have less incentive to control environmental pollution. After years of declining "local pollutants," China's emissions of sulfur dioxide, for example, have grown significantly. Pollution has become so bad in many regions of China that the central government is desperate for solutions to quell social unrest. China's international image is on the line starting in August 2008 as Beijing struggles to curb increasingly dangerous air pollution for the Olympics.

Internationally, China's industrial surge has contributed to high prices for metals, industrial inputs, and fuel (See Figure 5). Some critics blame China unfairly for the impact that it has had on global commodity markets, or at least fail to acknowledge that China had helped keep inflation in check around the globe by supplying low-cost goods during the early part of this decade.

China now also has the opportunity to impact like never before the volatility of global commodities, both upstream and downstream. Any sudden slowdown in Chinese demand for iron ore or steel, for example, could quickly result in oversupplied global markets and rapidly declining prices. Investment-led growth is inherently more volatile than consumption-led growth, so China will continue to impact global markets until there is greater balance between the two. Although it seems unlikely, China could continue to absorb market share in building material production and thus create ever more sensitive markets in the future. One impact of the weather-induced power and coal shortages of early 2008 was a temporary suspension of Chinese coal exports so that they could be reserved for domestic needs. The overall global impact on coal prices may be minimal, but it will clearly raise pressure on Asian coal prices.

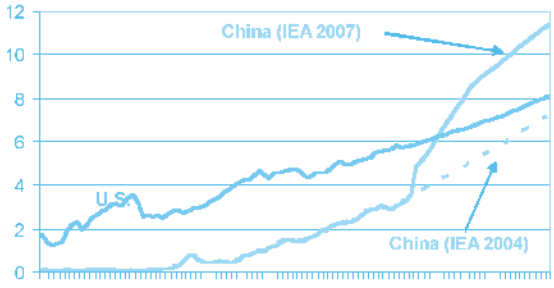
Figure 5: Global Commodity Prices



China now consumes about 2.5 billion tons of coal each year and is the global leader in carbon dioxide emissions (See Figure 6). It is a signatory to the Kyoto Protocol, but is not required to reduce emissions through the end of the first commitment period (2012), nor does it seem willing to take on a binding mitigation target in the near future. Climate scientists at the Intergovernmental Panel on Climate Change (IPCC) state that the imperative to cut greenhouse gas emissions immediately and deeply has never been stronger.[5] China has accounted for nearly three-quarters of the incremental increase in global carbon dioxide emissions from 2000-2006; without some effort to limit the growth of coal-fired emissions in China, any global effort to stabilize greenhouse gas (GHG) concentrations seems impossible.

But China's recent surge in GHG emissions may not be as dire as it initially seems. Much of China's new coal use is used to further fuel urbanization of the country, something that would have happened eventually as Chinese incomes rise. Also, as the "workshop of the world," China now exports a large amount of embedded energy and carbon emissions in the products it sends to other countries.[6] In this regard, China is blamed for energy use and emissions that probably belong, in some way, on the accounts of other countries. Solving the equity issues related to embedded energy and greenhouse gas emissions will be an enormous challenge for international negotiators in coming decades.

Figure 6: A Century of Chinese and U.S. Carbon Dioxide Emissions



Source: *World Energy Outlook 2007*, International Energy Agency, Paris and *International Energy Outlook 2007*, Energy Information Administration, U.S. Department of Energy, Washington, DC.

HOW IS CHINA RESPONDING TO THE ENERGY SURGE?

The central government has been concerned with overinvestment in some industrial sectors of China since at least 2004, when surging coke production caught policymakers' attention. Since then, new concerns have emerged and a number of steps have been taken to hold the investment in check. Selected measures are outlined below.

China now consumes about 2.5 billion tons of coal each year and is the global leader in carbon dioxide emissions.

Demand Side Measures

One of the most visible steps China has taken to control the surge in energy demand is a new focus on limiting the demand for energy. A high-profile goal of the 11th Five Year Plan (FYP) is to cut energy intensity (the amount of energy needed to produce a unit of economic growth) by 20 percent by 2010. Other more targeted programs, such as the Top 1000 Enterprises Program, aim to cut energy use in the largest industries in China, even though it is the small, old facilities that have the greatest potential to save energy through equipment upgrades and consolidation.

Tax and Fiscal Measures

In mid-2007, China cut tax rebates on nearly 3,000 export lines, including metals and textiles, to help rebalance the economy and discourage companies from making low-value, energy-intensive goods. It also raised bank reserve requirements and interest rates in an effort to slow bank lending across the board. China's monetary policy and exchange rate goals limit the impact that these measures can achieve.

Personnel Evaluation

The 11th FYP claimed that provincial level officials would be evaluated more comprehensively for

potential future promotions. How much energy their provinces consumed in order to drive economic growth would be one such factor, especially if their province didn't meet the 20 percent energy intensity target. This measure has enormous potential to impact local incentives, but depends greatly on the rigor of central government implementation.

Energy Price Liberalization

China has allowed some energy prices to rise significantly, while keeping others in check to help staunch inflation. Electric power and petroleum product prices, in particular, have been controlled to such an extent as to create distortions in the larger supply-demand equation. Chinese authorities will continue to have only partial control of the energy and industrial sector until they allow market pricing, including a greater representation of external costs, to influence both investment and consumption decisions.

OUTLOOK FOR THE FUTURE

Preliminary evidence shows a moderating of energy intensity in China. In both 2006 and 2007, the income elasticity of energy demand declined below 1.0 for the first time since 2002. Although the country is still not on target to achieve the energy intensity target, it is moving in the right direction. There is a well-recognized need to rebalance the economy from export-led growth to a system that depends more on domestic consumption.

The central government's ability to continue reigning in industrial investment will be a key short-term challenge. Pollution has become so bad in many regions of China that social stability is called into question. Energy insecurity, as illustrated in early 2008, is another key challenge. Chinese decision-makers, unfortunately, face challenges ranging from corruption and inflation to healthcare and food safety that often require contradictory responses.

Preliminary evidence shows a moderating of energy intensity in China.

What can the United States do to help China move beyond the energy surge? This is a difficult question since China would no doubt consider the surge a domestic issue, even if there are enormous global implications resulting from Chinese domestic policies. Furthermore, it is difficult for the United States to get traction in suggesting alternatives to Chinese energy and environmental policy since China does not view the United States as an energy and environmental leader. Recent U.S. legislation to tighten automobile efficiency standards, for example, is a step in the right direction in giving the United States greater standing in Chinese policymaking.

The United States could also assist China by funding 1) capacity building for market-driven clean energy projects; 2) financial assistance for clean energy investment; and 3) assistance in data gathering and analysis to better inform energy policymaking.

Clearly, what happens in China is of interest to the United States since it affects our trade, environmental, civil society, and geopolitical interests. We now have too much at stake in the relationship and must work closely with China on issues of mutual interest.

ENDNOTES

1. For a history of China's energy efficiency policy, see J. Sinton, M.D. Levine, D. Fridley, F. Yang, and J. Lin, *Status Report on Energy Efficiency Policy and Programs in China*. Berkeley: Lawrence Berkeley National Laboratory, 1999.
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4. Thomas Brizendine and Charles Oliver. "China's Steel Sector in Transition," *China Business Review*, January-February issue, Washington, DC., 2001.
5. See Intergovernmental Panel on Climate Change, *Fourth Assessment Report*, http:///www.ipcc.ch.
6. A recent study by the Tyndall Centre, for example, estimates that about 23% of net Chinese energy demand in 2004 went to making products that were exported to other countries. Importers of Chinese goods have, in effect, exported their emissions to China. (T. Wang and J. Watson. "Who Owns China's Emissions," Tyndall Briefing Note Number 23, Tyndall Centre for Climate Change Research, Sussex, United Kingdom, October, 2007.

CHINA'S INNOVATION CHALLEGE

CONG CAO

In the span of less than three decades, China has evolved from being a peripheral player to become the most potent engine in the global economy. Along with its rapid economic progress and the many improvements in the quality of life for large numbers of the Chinese population, a variety of indicators suggest that China's science and technology (S&T) capabilities also are on a sharply rising trajectory (Table 1). Since the early 1990s, research and development (R&D) expenditure in the People's Republic of China (PRC) has been increasing at a rate approximately twice that of overall economic growth. In 2006, China spent renminbi (RMB)300 billion (approximately U.S. $37 billion) on R&D, or 1.42 percent of its increasing GDP, highest among countries with similar economic development level—though the percentage is still lower than that of most of the major developed economies. In terms of overall R&D expenditure, this put China sixth in the world, after the United States, Japan, Germany, France, and the United Kingdom.[1] Chinese institutions of higher education are turning out an increasing number of well-prepared graduates in science and technology. In 2006, China graduated some

TABLE 1: China's Science, Technology, and Education: Some Indicators

	1998	1999	2000	2001	2002	2003	2004	2005	2006
R&D Expenditures									
Gross Expenditures on R&D (GERD) ($1billion)	6.65	8.2	10.8	12.6	15.56	18.61	27.75	29.91	36.79
GERD/GDP (%)	0.69	0.83	1.00	1.07	1.22	1.31	1.23	1.34	1.42
R&D Performance									
Enterprises (%)	44.83	49.59	59.96	60.43	61.18	62.37	66.83	68.32	71.08
Basic Research (%)	5.25	4.99	5.22	5.33	5.73	5.69	5.96	5.36	5.19
Papers Cataloged by *Science Citation Index*									
Share of the Total (%)	2.13	2.51	3.15	3.57	4.18	4.48	5.43	5.30	5.90
Rank	12	10	8	8	6	6	5	5	5
Human Resources									
Scientists/Engineers Engaged in R&D (1,000 persons-year)	485.5	531.1	695.1	742.7	810.5	862.1	926.2	1,119	1,224
Graduate Student Enrollment (1,000 persons)	198.9	233.5	301.2	393.3	501	651.3	819.9	978.6	1,100
Undergraduate Student Enrollment (1 million persons)	3.41	4.09	5.56	7.19	9.03	11.09	13.33	15.62	17.39

Source: National Bureau of Statistics and Ministry of Science and Technology (comps.), *China Statistical Yearbook on Science and Technology* (Beijing: China Statistical Press, various years.)

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159,000 students with masters and doctoral degrees, on top of 1.34 million engineering undergraduates as well as 197,000 science undergraduates. Unequivocally, this represents the world's highest output in terms of overall numbers.

In recent years, there also has been a steady increase in the number of international papers published by Chinese scientists. Measured by the number of papers included into the *Science Citation Index (SCI)*, a bibliometric database published by Thompson Scientific, China in 2006 ranked fifth in the world. Although China lags behind the world's leaders in many areas of science and technology, notable achievements have been recorded in a number of emerging scientific fields such as genomics and nanotechnology. In nanotechnology, for example, in terms of published papers, China is second only to the United States.[2]

Foreign investment as well as imported technology and equipment continue to pour into China, making it one of the largest recipients of foreign capital and know-how in the world. While most attention has been focused on the rapidly expanding export side of China's foreign trade, it also must be remembered that China has become one of the world's largest importers. And, most recently, many of the world's technologically most innovative companies have decided to move beyond setting up manufacturing facilities in China to establishing advanced R&D centers to develop new products and services for global markets as well as the Chinese domestic market. By the end of 2007, there were well over 1,000 foreign R&D centers operating in the PRC.

In early 2006, with a great deal of fanfare, China's leadership issued a new "Medium to Long-Term Plan for the Development of Science and Technology 2006-2020" (MLP). A remarkable piece of policy in a variety of ways, the MLP builds on important S&T-related policy initiatives since the mid-1980s, including the 1995 commitment to "strengthen the nation through science, technology, and education" (*kejiao xingguo*) and the more recent notion of "empowering the nation through talent" (*rencai xiangguo*). In addition to setting ambitious national priorities and formalizing the leadership's commitment to allocate substantial financial and human resources to turn China into an innovation-oriented nation by 2020, the MLP specifically defines enhancing indigenous innovation (*zizhu chuangxin*) capability, leapfrogging in key scientific disciplines, and utilizing S&T to support and lead future economic growth as its major objectives.[3] In a word, once considered one of the more backward developing countries, China today stands as one of the world's most robust and dynamic economic forces. These trends have led many observers to ask, in a similar vein, whether China also is poised to become a global leader in science and technology.

PROBLEMS AND VULNERABILITIES

China's current trajectory in supporting the development of science and technology is, in its ambitions, attracting the attention of observers around the world. While notable progress has been made and many more achievements from the MLP can be expected in the coming years, a balanced perspective on the prospects for Chinese science and technology requires attention to some of the challenges that China faces in realizing its ambitions.

Many of the world's technologically most innovative companies have decided to move beyond setting up manufacturing facilities in China to establishing advanced R&D centers to develop new products and services for global markets as well as the Chinese domestic market.

First, China has yet to establish an enterprise-centered national innovation system. At face value, enterprises account for two-thirds of China's R&D expenditure;[4] in reality, they have few financial resources to carry out innovative R&D activities.

According to a comprehensive survey of the nation's R&D resources in 2000, the latest with detailed, micro-level information, firms within high-tech parks spent an average 1.9 percent of their sales on R&D, far below the 5 percent standard by the Chinese definition of a high-tech firm, while those outside the parks spent merely 0.63 percent Chinese enterprises as a whole do not do better, as they cannot afford to spend money on technology. The 2006 statistics indicates that only a quarter of large and medium-sized enterprises had set up S&T institutes, with only 1.5 percent of the sales revenue being used for S&T activities and 0.8 percent of revenue spent on R&D. Equally serious is the dearth of qualified personnel because of a severe "brain drain" of Chinese talent to foreign countries as well as to foreign-invested enterprises in China.

As a whole, Chinese enterprises spend more money on technology importation than on R&D.

In pursuing a quick and short-term pay-off, Chinese enterprises are keen to import foreign technology as the way to upgrade production technology; in such purchases, equipment dominates over software such as patents, know-how, blueprints, and so on. As a whole, Chinese enterprises spend more money on technology importation than on R&D. And once the equipment is imported, almost no financial resources are given to absorption, assimilation, and innovation, thus resulting in a vicious cycle of "importing, lagging behind, importing again, and lagging behind again."

Enterprises also lack the interest in engaging domestic institutions of learning for R&D efforts. The reform in the S&T system since the mid-1980s has to some extent activated the enthusiasm of researchers in these institutions (the supply side of technology), but enterprises (the demand side) have been reluctant to acquire technology from domestic sources. That is to say, the deeply-rooted problems of the separation of innovation and the economy and of the organizational rigidity between enterprises and institutions of learning have not been solved.

Second, it is always questionable whether money has been well spent. As noted, enterprises are mainly interested in acquiring technology from foreign sources. It is no secret that a significant portion of the research carried out in China, even those under the major national programs, is derivative of what has been done elsewhere, which surely has wasted increasing but still limited resources. This explains why Chinese science has not yielded significant breakthroughs consummate with the rising investment in R&D. In fact, citations to the increasing number of Chinese S&T papers have been quite disappointing.

Misuse of research funds is widespread. More seriously, the rampant corruption in science and research has not only eaten a not-so-small-part of the research money but also eroded the morale of the research community. For example, Chen Jin from Shanghai Jiaotong University grabbed hundreds of millions worth of funds from various government agencies, including the Ministry of Science and Technology, the Ministry of Information Industry, and the National Development and Reform Commission, by using a purchased chip as his innovation. Although Chen Jin was fired by the university, his various honors removed, and some of the research money recovered, Chen himself has never been prosecuted for his cheating, nor have the government agencies involved been investigated for their responsibility in this scandal known to the world.[5]

Therefore, with the MLP supporting mega-science and engineering projects whose investment will be at the scale of billions of RMB, and the revised Law on the Progress of Science and Technology promoting greater innovation and creativity by fostering a "tolerance for failure,"[6] the question of money being well spent is more than an issue of governance in scientific research; rather, it relates to whether China will eventually achieve its ambitious goals and play a more significant role in the frontier of international science and technology. Along with the money, there is a major responsibility to create a new economic development model that is not capital-intensive, labor-intensive, and

resources-intensive. It is in this sense that one of China's senior science policy-makers commented that the scientific community will not have another opportunity if it does not succeed in implementation of the MLP.

Third, China still has a long way to go to perfect its intellectual property right (IPR) regime. At first glance, China's IPR laws and regulations are as perfect as those promulgated by other countries; the problem lies in the enforcement. In fact, a decentralized China has made IPR protection at the local level difficult, if not impossible. China's weakness in IPR protection has been a major concern for foreign investors. But entering the 21st century, two of the three initiatives—patents and technical standards—put forward by China's scientific leadership are IPR-related (the other is about the development of talent). This is not only because the leadership realizes that the nation has been overwhelmed by the current international IPR regime. In the long run, an innovative China has to and will generate its own IPRs. In other words, China will not become innovative unless it takes more seriously the issue of IPR protection.

Fourth, China faces a serious talent challenge as it seeks to sustain domestic economic growth and technological advance. There is little doubt that China's current S&T talent pool is impressive: The number of scientists and engineers in China is the world's second largest, after only the United States; the evolving pipeline seemingly remains full as Chinese universities graduate the world's largest number of students; and the quality of graduates from key Chinese institutions of higher education is internationally acclaimed. Despite this fact, however, complaints continue to proliferate from multiple segments of the economy and society—from among Chinese government officials to enterprise CEOs, including the country heads of most multinational corporations (MNCs) that operate in China—about the problems that plague the local talent pool. Demand seems to be exceeding supply, quality problems are rampant, and the talent already in place remains difficult to manage and retain.

The active members of China's professional community are young when compared to their counterparts in the West—many being fresh out of school—so they lack the concomitant experience

China faces a serious talent challenge as it seeks to sustain domestic economic growth and technological advance.

of their peers abroad, especially in many leadership positions in the Chinese research system. China's lack of talent is most serious in the 50 to 60 year-old group and at the high end of the talent spectrum. In fields as well as locations where there is an apparent surplus of professionals, many problems limit the value and impact of these individuals. In some instances there is a gap between the knowledge students acquired in college and the precise skills required for their jobs; in other cases, the structure and distribution of the talent pool at senior, middle, and junior levels is misaligned or does not match up well in terms of disciplines with the exact skill needs of the immediate region. A number of programs, offering generous incentives, have been initiated to recruit Chinese scientists working abroad to come back to China, and as the condition of the Chinese research environment continues to improve, it is expected that the volume of the "reverse brain drain" will increase.

The talent shortage could have a negative impact in the near-to-medium term. The ability of employers to attract "the best and the brightest" will be affected by the shortage and China could experience the onset of a real "talent war." Foreign direct investment (FDI) will continue to be one of the key drivers for the demand of scientists and engineers in China, and if there is not enough talent available for foreign-invested enterprises, especially MNCs, FDI might decline not only in level but also in quality. Consequently, China's pace of economic growth, especially in terms of the development of new, technology-intensive sectors and its ability to attract higher value-added foreign investment, might be jeopardized.

More seriously, China's capacity for overcoming its S&T talent shortage, including its ability to provide training-related quality improvements, will determine the extent to which the PRC can

develop indigenous innovation capabilities and reduce its current dependency on foreign technology and invention. These are the MLP mandates. It is under these circumstances that a rapid response is needed to moderate, if not ameliorate, any possible negative impact, and that first and foremost the "fix" must be focused on closing the experience gap.

Last but not least, there is the question of whether China can become an innovation-oriented nation without being open to different ways of thinking.

Last but not least, there is the question of whether China can become an innovation-oriented nation without being open to different ways of thinking. This is more than just a question of philosophy. While Chinese researchers and entrepreneurs are encouraged to think outside the box and not to be afraid of failure, at least equally important is that other ingredients of innovation—autonomy, free access to and flow of information, and especially dissent, scientific as well as political—are not tolerated. However, it is generally believed that tolerance is as critical as talent and technology in driving creativity and growth.[7] For example, Thomas L. Friedman, the *New York Times*' columnist, has stated that censoring Google in China is equivalent to "curtailing people's ability to imagine and try anything they want."[8] Therefore, allowing "blooming and contending" is more important than purely worshiping innovation as a new "religion." If the former is not allowed, the success of the innovation strategy is called into question.

ENDNOTES

1. According to the Organization for Economic Cooperation and Development (OECD) in its *Science, Technology and Industry Outlook 2006*, using the purchasing power parity (PPP) measure, in 2006, China became the world's second largest spender on R&D ($136 billion), ranking only behind the United States ($330 billion). Of course, it should be noted that attempts to measure China's economic output in PPP terms are subject to discussion, as its PPP- based GDP was reduced by forty percent in a recent recalibration. It should also be recognized that the gap in spending between China and the United States remains substantial, with the United States spending more than twice that of the Chinese.
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4. This increase in part reflects the fact that many government R&D institutes have been "corporatized," or converted into enterprises themselves.
5. See, for example, David Barboza, "In a Scientist's Fall, China Feels Robbed of Glory," *New York Times*, May 15, 2006; Hao Xin, "Scientific Misconduct: Invention of China's Homegrown DSP Chip Dismissed as a Hoax," *Science*, Vol. 312 (May 19, 2006): 987.
6. Hao Xin, "Science Scope: When It's Okay to Fail," *Science*, Vol. 317 (September 7, 2007): 1309.
7. Richard Florida, *The Rise of the Creative Class: And How It's Transforming Work, Leisure, Community and Everyday Life* (New York: Basic Books, 2003).
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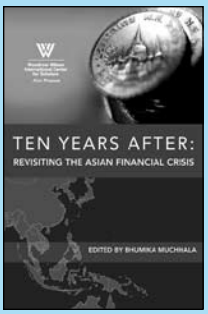

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