The Global Knowledge Economy: Challenges for China's Development

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The Global Knowledge Economy: Challenges for China's Development[1]

Two central facts provide the motivation for this paper, and the intersection between them provides the central question. The first fact is the fundamental transformation of global economic activity which is taking place, and which is sometimes referred to as the emergence of the global knowledge economy. When our grandchildren sit back and reflect in the middle of the new century, the years between about 1985 and 2020 will stand out as a period at least as pivotal in human affairs as that between 1760 and 1820, which ushered in the Industrial Revolution. For what we are in the midst of is the emergence of a quite new set of economic activities, arrangements and institutions – the global knowledge economy. This new economy will be as different from what preceded it as was the industrial era from feudalism, and it is already beginning to have a comparable impact on social relationships and institutions.

The second fact is the remarkable and sustained growth which has taken place in the Chinese economy since the beginning of the reform period in 1979. With an average annual rate of growth in per capita GDP of about 8% between 1978 and 1998, per capita GDP in China has risen from 9% of the average of the main European countries in 1978 to over 20% by 1998. In spite of some current concerns about the sustainability of rapid growth, such a performance over a twenty-year period raises the question of whether we are witnessing in China the fourth great catch-up performance (that is, following USA/UK and Europe in the late 19th century, Japan/USA in the decades after the Second World War and the Asian NICs/Japan and USA after 1965). Whatever the answer here, the fact of rapid growth sustained over two decades remains.

Taken together, these two facts pose an inevitable question: how will the emergence of the knowledge economy impact on China's economic development, in its attempt to catch-up with living standards in advanced economies? What is clear is that the global context in the next century, in which China seeks to catch-up with the West, will be fundamentally different from that of the industrial era, in which Japan achieved advanced country status or in which the Asian NICs caught up substantially. What will the emergence of the knowledge economy mean for China's attempt to catch-up with the West, and for the development strategy which it should pursue to do so? These questions are the subject of this paper. But this is a vast topic, and I will attempt only to define the questions further and make some comments, rather than attempt to provide any definitive answers. I also hope that this approach will serve to place some of the key issues being actively debated in China in a broader international context.

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1. The Global Knowledge Economy

In this paper I follow OECD (1996) and other authors in describing the newly emerging set of activities, structures and arrangements as a knowledge-based economy, and use the term *the global knowledge economy* (see also World Bank 1998 and Sheehan and Tegart 1998). The central technological facts leading to the global knowledge economy derive from the revolution in information technology. They include the ability to deliver codified knowledge, assembled on a global basis if necessary, very quickly and very cheaply to the area where it is needed, to transform such knowledge extensively as required and to make it effective in machines and other production and service delivery processes. The central policy fact is the global trend to the deregulation of the flow of goods, capital, technology and services, and of national processes of production and distribution.

These two factors have had mutually reinforcing effects, and many other forces are also contributing to shaping the new global economy. The term *global knowledge economy* makes explicit reference to what we take to be the defining characteristics of the world economy emerging as a result of these causal factors – the rise in the knowledge intensity of economic activities and the increasing globalisation of economic affairs. But this term is intended to refer to the overall economic system which is emerging, rather than to these characteristics alone.

1.1 The Driving Forces

The Information Technology Revolution

The 'information technology revolution' has been widely documented and discussed, and does not need to be dwelt on here. The last twenty years have seen an explosion in the application of computing and communications technologies in all areas of business and community life. This explosion has been driven by both sharp falls in the cost of computing and communications per unit of performance and by rapid development of applications relevant to the needs of users. Both of these trends seem set to continue, for at the heart of both falling costs and improved performance are a range of quite remarkable technological advances, such as:

- continued dramatic progress in chip technology;
- the development of photonic communications technologies, as well as major improvements in both wire-based and wireless communications systems;
- the digitalisation of products, processes and services, and the development of open systems and common standards;
- rapid development in supporting technologies, such as those for scanning and imaging, memory and storage, and display and copying;
- the creation of appropriate software, and of new tools for the development of software, and
- the explosion of Internet technologies.

While the Internet is only one element of the overall picture, its growth provides a good illustration of the scale of the developments under way.

According to the figures compiled by the Network Wizards company, the number of Internet hosts worldwide (defined as a domain name which has an IP address assigned to it) was very small up to the late 1980s, so that by October 1989 there were 159,000 hosts. In the period of less than four years to July 1993 the number of hosts increased more than tenfold, to 1,776,000, and there was a more dramatic increase to 26,053,000 in the next four years to July 1997. The number of hosts has continued to increase rapidly, so that by July 1998 there were an estimated 36,739,000 million Internet hosts worldwide, implying total users of more than 60-70 million.

A large proportion of Internet usage at the present time is located in the US and other developed countries, but usage in other countries is growing rapidly. Most analysts anticipate that, as penetration continues in the US and other high-use countries and as other nations come on stream, a further tenfold increase will take place by the early years of the next century, so that by that time some 600 million people across the globe, or of the order of 10% of the world's population, will be users of the Internet. Even if some slowdown occurs and these forecasts are not fully achieved, it is clear that the Internet is without precedent in terms of the extent of global penetration within a decade or so, and that it is likely to have profound economic and social effects. However, the immediate commercial significance of these trends, and particularly the speed and timing of expansion of electronic commerce, is less clear.

National and International Deregulation

The rapid process of international deregulation over the past two decades has been an equally important driver of the global knowledge economy. The period since the early 1970s has seen a widespread movement to economic deregulation, manifested principally in three areas:

- liberalisation of trade, that is reduction of tariff and non-tariff barriers to trade in both goods and services;
- liberalisation of capital markets, including floating of currencies, deregulation of financial markets more generally and reduction of barriers to foreign direct investment and to other international capital flows, and also of barriers to technology transfer, and
- deregulation of internal markets for goods, services and financial flows.

Links between Information Technology and Deregulation

These two driving forces have not been entirely independent factors, but have had mutually reinforcing effects over the period since the early 1970s. Exploration of these links is beyond the scope of this paper, but they should not be neglected. Dramatic new global capabilities in computing and communications provided both the pre-conditions for, and some impetus to, deregulation of global markets, while global competition and technology flows have contributed to the rapid declines in both goods and services prices. These links are particularly evident, for example, in financial markets, where the new technological capabilities have facilitated the development of new financial products and of global capital flows on an unprecedented basis, and perhaps beyond the capacities of many countries to supervise effectively.

1.2 The Defining Characteristics

Knowledge Intensity

One defining feature of the global knowledge economy is the growing incorporation of knowledge into economic activities involving both goods and services. Knowledge becomes incorporated in productive activities in many different ways, ranging from learning by doing by operators on the shop floor to formal processes of knowledge generation and application, of training and of investment in advanced equipment. The economic value of a typical knowledge intensive good – an advanced aircraft, a drug, a computer or a 'smart' card – goes far beyond the value of the materials of which it is composed, in virtue of the knowledge embodied in the product. Similarly, services such as medical diagnosis and treatment, education and training and business consulting rely heavily on embodied knowledge. The process of the increasing knowledge intensity of economic activity involves both the increasing knowledge intensity of individual goods and services (e.g. the increasing sophistication of computers or of the process of planning and booking a holiday) and the growing importance of those goods and services which already rely heavily on embodied knowledge.

While this trend to the increasing use of knowledge is evident in many aspects of modern economies, it is important to try to quantify it. Firstly, we can follow the work of the OECD by using the division of manufacturing industries into four levels of science and technology intensity which they have developed (OECD 1994, Annex 2). In this classification, 22 industries (defined according to the International Standard Industrial Classification) are classified into the four levels by their ranking in terms of average R&D/production ratios for the major OECD countries as a whole, as discussed above. Table 1 provides a classification of world manufactured exports over the period 1985 to 1995 into these four categories, and hence provides evidence of the shift in the composition of world trade in manufactured goods towards knowledge intensive products.

Table 1. World Manufacturing Exports, by S&T Intensity: 1985-1995

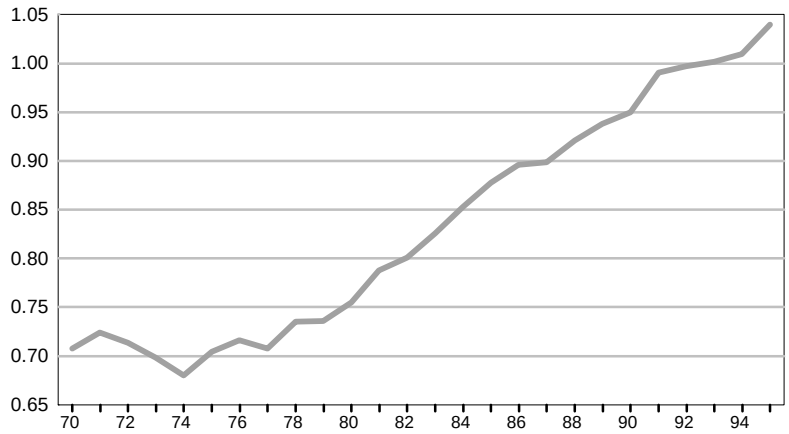
	US$ billion			*Average annual growth Rate (%)*		
Technology Level	**1985**	**1990**	**1995**	**1985-1990**	**1990-1995**	**1985-1995**
High	183.2	421.3	738.7	18.1	11.9	15.0
Medium high	406.0	794.5	1116.1	14.4	7.0	10.6
Medium low	395.5	724.1	900.3	12.9	4.5	8.6
Low	424.2	822.6	1087.7	14.2	5.7	9.9
Total Manufactures[1]	**1414.6**	**2773.1**	**3857.6**	**14.4**	**6.8**	**10.6**
Total manufactures, excluding high tech	1231.4	2351.8	3118.9	13.8	5.8	9.7
High tech share of total	12.9%	15.2%	19.1%			

Note: 1. Includes minor items not covered by technology classification.
Source: Based on UN Trade Statistics, from IEDB database; OECD technology level definitions, defined in terms of average R&D intensities in each industry for 13 OECD countries.

The dominant trend in the table is the very rapid growth in world high technology exports over the period 1985 to 1995, relative to all other categories, and especially over the period 1990 to 1995. The high technology category covers aerospace, computers, electronics (including communications equipment) and pharmaceuticals. World exports of high technology products grew by 15.0% per annum between 1985 and 1995, by comparison with 9.7% for all other goods, to reach US$738.7 billion in 1995. Over the period they rose from 12.9% to 19.1% of all manufactured exports. For the five years to 1995, the rate of growth of high tech exports (11.9% per annum) was more than double that of the medium low and low tech sectors (4.5% and 5.7% respectively). If the sectoral growth rates achieved over the 1990-1995 period were continued for the next decade, high tech exports would clearly be the dominant element in world trade, amounting to nearly 30% of total manufactured exports by 2005, and to 70% of the sum of medium low and low tech exports by that time.

For the manufacturing sector it is possible to go beyond these partial indicators to create a single indicator of the knowledge intensity of trade flows in goods (or of value added or employment). To take account of the information available about each country's trade at the detailed industry level, we define an *index of knowledge composition* for country *i*'s exports by weighting industry *j*'s share of total manufacturing by the average OECD R&D/production ratio for industry *j* for the period 1987-1989, and dividing by the average R&D weight. Thus country *i*'s exports (imports, value added, employment etc.) in industry *j* are weighted by the average 'knowledge intensity' of that industry in the major OECD countries.

Chart 1. Index – Knowledge Composition, Manufactured Exports, World



Source: Estimates of the author, based on UN trade statistics.

Chart 1 shows the resulting index of the knowledge composition of exports for the world economy as a whole, over the period 1970-1995. It provides the single most graphic indicator of the rising knowledge intensity of global trade

flows in goods. The knowledge intensity of trade remained largely unchanged between 1970 and 1977, albeit with some possibly cyclical variation in 1974 after the first 'oil shock'. The index value over this period averaged close to 0.70, indicating that world trade was concentrated in the less knowledge intensive industries. But since 1977 it has increased steadily and persistently, from an index value of 0.71 in 1977 to 1.04 in 1995, rising by about 50% over this period. Thus by 1995 world manufacturing trade was on balance somewhat more concentrated in higher intensity rather than lower intensity industries. There is every reason to believe that further increases in knowledge intensity will be a persisting feature of world trade over forthcoming decades.

Equally, there is good reason to expect that increasing knowledge intensity is as much a feature of the service sectors of modern economies as of the goods sectors, even though the available data are much more limited for these sectors.

Globalisation

The second aspect of the new knowledge based economy is equally important: the rapid globalisation of economic activities. The extraordinary pace of globalisation over the last decade or so has reflected the intertwined effects of both policy change and developments in information technology, with the computing and communications revolution providing the basic infrastructure necessary for rapid globalisation to occur.

The process of globalisation has not involved by any means only trade in goods. Indeed, following Hatzichronoglou (1996) we can distinguish at least five matters involved in globalisation: foreign direct investment, capital transfers other than direct investment, trade flows of goods and of services, and technology transfers. These aspects of globalisation are of course inter-related. For example, the links between direct investment, technology transfers and the various trade flows will often be particularly close. Investment by a firm in a plant in another country may well involve technology transfers and exports of capital goods and services to assist in establishment of the plant, while the operation of the plant may require continued imports of intermediate goods and services from the investing countries and may generate exports of finished goods to that country and to other countries. Equally, there will be close links between the various dimensions of capital flows, with rising foreign investment often being associated with increasing international bank lending and securities financing, and more generally with pressures to move to more open financial systems. Indeed, Hatzichronoglou (1996) argues that growing inter-relationships between trade, finance and technology flows is itself a significant feature of the process of globalisation. He also stresses the existence of global competition in all major markets between competitors from all major countries; the increasingly multinational origin of the inputs to production of both goods and services; the growing intra-industry and indeed intra-product nature of world trade and the interdependent role of the various elements of globalisation noted above, especially the role of foreign direct investment.

While there have been other periods of rapid integration of the world economy, the pace and extent of the current globalisation is without precedent,

primarily because of the power of the computing and communications infrastructure which underlies it. So rapid and ubiquitous is this process that it is not possible to understand it fully at the present time. Nor is it possible to reach a clear view of either the costs or the benefits of such massive globalisation, nor to define with surety appropriate national responses to its progress.

2. Some Key Features of the Knowledge Economy

In this section I review five of the many features of the emerging knowledge economy, concentrating on those aspects of the new economy that may have special relevance for China's situation. My aim is to illustrate the way in which a wide range of factors, often discussed in other contexts, are indeed linked to broader global trends, rather than to be exhaustive in the coverage of the features of the new economy.

2.1 The Growing Importance of Knowledge

The growing importance of knowledge in modern economies is evident in many aspects of public and private behaviour in advanced economies. For example:

- investment in knowledge (defined by the OECD as spending on education, software and R&D) now exceeds 10% of GDP for the OECD countries as a whole, and is a good deal high for some advanced economies (OECD 1999);
- investment in information and communications technologies (IT hardware, software and services, and telecommunications) now accounts for more than 6% of GDP in OECD countries, and about 8% in some of these countries (OECD 1999), and
- after slowing in the early 1990s, real business sector R&D has accelerated in a number of countries, most notably USA, since 1994.

Only one of many implications of the rising knowledge intensity of economic activity can be touched on here, by way of illustration. This concerns the proper recognition of the role of knowledge and related intangibles in private sector decision making, and in the regulation of that decision making, particularly the inadequacy of current accounting systems in valuing intangible assets and hence in measuring corporate net worth.

It is now widely recognised, for example by agencies such as the US Securities and Exchange Commission and the OECD, that conventional accounting statements are becoming increasingly misleading as statements of corporate profitability and net worth. Knowledge – embodied for example in individuals, technologies, systems and R&D programs – has become vitally important to the value and performance of a company. These factors, and their expected impact on future profitability, are often much more important than current profit or the value of tangible assets in determining the value of a company. The market value of a company such as Microsoft bears little relationship to either its reported profit or the value of its tangible assets. On the Swedish stock market, the total book value of Swedish companies was greater than their market capitalisation over the period 1975-1982; by 1994 market

capitalisation was double book value (Johanson, Loof and Grojer 1997). In another study of 300 firms over the period 1973 to 1992, Baruch Lev found that the ratio of market equity to book equity values rose from 0.811 in 1973 to 1.692 in 1992 (Lev 1996, cited in Mavrinac and Siesfeld 1998). Lev argued that this trend represented not only a revolutionary change in the process of economic value creation but also a sharp decline in the value relevance of traditional financial measures. For the median corporation in the study, 40% of the market valuation was missing from its balance sheet.

Thus the lack of agreed methods for valuing levels of, and changes in, intangible assets has become a major deficiency in current accounting systems. This deficiency undoubtedly has serious economic effects, for example in capital markets and especially in relation to the flow of venture capital, and inadequacies in the valuation of knowledge are often seen as critical factors hindering response to global change (OECD 1996). The US Securities and Exchange Commission is currently considering proposals for improved valuation of intangible assets (US SEC 1997).

2.2 Changing Competitiveness and Industry Composition

It is widely understood that the advent of the knowledge economy has been associated with sharp changes in the structure of economic activity in the developed countries, and that these changes have substantial implications for firms and industries, and for individuals, communities and nations. One dimension of these changes – the changing industry composition of economic activity – is briefly reviewed here, while the changing nature of the activities undertaken within particular industries, and specifically the increasing integration of manufacturing and service industries, is considered below.

In terms of the industry composition of GDP, this ongoing trend can best be summarised in terms of three clusters of industries (Sheehan and Tikhomirova 1998). These are the primary and secondary industries or the goods producing industries (*the goods industries*); the traditional service industries, notably wholesale and retail trade, and transport and storage, largely related to the movement, storage or marketing of goods (*the goods related service industries*), and the emerging services industries, primarily the knowledge based service industries such as education, health and business and consulting services, and the person based service industries such as recreation, entertainment and community services (*the person and knowledge based service industries*).

A diverse combination of factors – from greater productivity arising from technological change in the goods industries, a shift of demand in high income countries from goods to services in spite of declining relative prices for goods and intense global competition, including from newly industrialising economies – is leading to a decline in the share of GDP arising from goods production in all developed countries. This decline is being largely offset by the share of GDP arising from the person and knowledge based service industries, which is rising rapidly in virtually all developed countries, while the share of traditional services in GDP is flat or declining in most countries. In the USA, for example, person based service industries accounted for just on 40% of GDP by 1994, whereas the

goods industries accounted for only 29% of GDP. Similar trends are apparent in other developed countries, but are less advanced in Japan.

2.3 Convergence of Goods and Services Industries, and the New Manufacturing

This shift from the goods industries to the knowledge and person based industries in terms of the composition of GDP or employment is a fundamental feature of the knowledge economy, but it should not be misinterpreted. It is not as if one group of industries are replacing another, much as the motor vehicle replaced the horse-drawn carriage. While there is some increased demand for services as final products, activities related to the creation, production and distribution of goods still lie at the heart of advanced economies. But those activities are becoming increasingly knowledge and service intensive, so that there is growing convergence between what are traditionally regarded as goods industries (such as agriculture, manufacturing and mining) and service industries.

For example, firms engaged in manufacturing rely heavily on services, both from within the firm and outside it, and sell both goods and services. Many service sector firms are totally focused on providing services to manufacturing firms, or to firms producing other types of goods. *Indeed, an integrated manufacturing-services sector – integrating the vast range of services now required to develop, produce, market and distribute industrial goods and services on a global basis – is the most dynamic sector of many economies.*

Thus economic activity is certainly becoming more service intensive – drawing more heavily on service rather than production activities – but this is occurring across virtually all industries. Focusing on industries, defined in terms of their typical activities (e.g. a firm is in manufacturing if its main activity is production of certain types of goods), can lead us to overlook the changing nature of activities within industries, the growing links between industries and the continued role of processes for the creation, production and distribution of goods in driving many service activities. *The key focus for policy should be on clusters of production and service activities, which are jointly competitive on a world scale.*

It is possible to provide here only some limited evidence for these assertions. Extensive case study evidence is available from a number of recent studies and reports, such as Quinn (1992), US Department of Commerce (1998), UK Department of Trade and Industry (1998) and Deloitte Consulting (1998). At the aggregate level, however, economic analysis suffers from an inability to test hypotheses by experiment in real economies. But a most remarkable natural experiment has taken place in Hong Kong over the past decade, which provides a dramatic illustration of these manufacturing-services linkages. Since the mid 1980s Hong Kong manufacturing firms have shifted production activities to mainland China on a massive scale. It is estimated that in 1995 Hong Kong firms employed about five million persons in China, some five times total manufacturing employment in Hong Kong in 1984. According to standard figures, the share of manufacturing in GDP fell from 24% in the early 1980s to 9% in the mid 1990s and over the same period manufacturing employment fell by nearly 60% (Berger and Lester 1997; Enright, Scott and Dodwell 1997).

Whereas the traditional framework leads to a view of industries in isolation, what we now see is product systems in which manufacturing and services are combined in the creation, production and distribution of goods and services. There are many ways to approach these integrated goods producing and related services systems. They can be seen as clusters, sectoral innovation systems, complex product systems, service-enhanced or new manufacturing systems. But in whatever guise, the key feature is the integration of a range of industries into increasingly tightly coupled systems which affect the creation, production and distribution of goods and services. The advantage of using terms such as 'new manufacturing' to describe these trends is that they highlight the critical role of services and the product system linkages between industries, while also bring out the centrality of manufacturing.

2.4 Low Inflation and Variable Unemployment

In many countries over the past few years, governments and monetary authorities have congratulated themselves on the achievement of low rates of inflation. But this self-congratulation has ignored one central fact, namely that one prime characteristic of the global knowledge economy is that it is a low inflation economy. That is, there are strong anti-inflationary pressures in the global knowledge economy, which emerge from many sources, and which lie behind the low rates of inflation currently being experienced in almost all developed countries. Four particular forces can be identified, each of which relates to the combination of technological change and the emergence of global markets. These are as follows:

- Continued rapid technological change in the computing and communications industries means falling prices for many goods and services produced by these industries, such as computers, electronic products and telecommunications services.
- Intense competitive pressure and technological change in the goods industries generally is also putting pressure on prices, from commodities to finished goods. This is accentuated by the continuing entry of low wage countries such as China and India, as well as countries in Latin America, into global competition in many goods industries.
- Both the extension of information technology and of global competition to many service industries is reducing prices here also (e.g. air travel, delivery services, financial services). These factors, together with deregulation and the introduction of market mechanisms into many domestic service industries, are also leading to restructuring and to price competition in many industries which previously operated on a price-setting basis.
- The rapid shift in employment from highly unionised production industries to much less unionised service industries has reduced the capacity of unions to maintain or increase the real wages of employees. This is a factor independent of any legislative change to the industrial relations system, and simply reflects the dramatic shift in the occupational structure of employment together with the historic concentration of union coverage in production activities.

For these and other reasons, inflationary pressures in the economy have been reduced for a given rate of growth. Thus the achievement of low rates of inflation in most developed countries owes less to superior management of monetary and fiscal policy in individual countries than to these global forces.

Evidence of this global change is to be seen in the widespread nature of low inflation in the developed countries at the present time, by comparison with the highly divergent unemployment experience of these countries (Table 2). Whereas unemployment rates in November 1998 for the 21 OECD countries covered in Table 2 (those for which standardised unemployment rates are available) range from 2.1% for Luxembourg to 18.2% for Spain, with half of the sample over 7.5%, inflation rates over the year to August 1997 were much more concentrated and uniformly low. With the exception of the UK and Portugal, all countries had rates of inflation of less than 3%, with the inflation rate for two-thirds being less than 2% and for one-third less than 1%. Nor is there any evidence of a correlation across countries between high unemployment and low inflation. Indeed, using arithmetic averages, the average inflation rate (1.3%) in the six lowest unemployment countries is very similar to that (1.2%) in the six highest unemployment countries. This is consistent with long run global forces, such as those above, driving low inflation, rather than reductions in any one country being a result of unemployment or of policy initiatives in that country alone.

Table 2. Unemployment and Inflation in Selected OECD Countries, 1997

Country	*Unemployment Rate November 1998*[1]	*Annual inflation Rate Year to November 1998*[1]
	(per cent)	(per cent)
Luxemburg	2.1	0.4
Norway	3.2	2.3
Switzerland	3.4	-0.1
Netherlands	3.6	1.7
Denmark	4.2	1.7
USA	4.4	1.6
Portugal	4.4	3.1
Austria	4.4	0.8
Japan	4.5	0.8
UK	6.2	3.0
Australia	7.6	1.3
Sweden	7.6	-1.0
NZ	7.7	1.7
Canada	8.0	1.2
Belgium	8.5	0.6
Ireland	8.5	2.1
Germany	9.4	0.7
Finland	10.6	0.9
France	11.8	0.3
Italy	12.3	1.5
Spain	18.2	1.4

Note: 1. Or latest available month.
Source: OECD Online Statistics. Data refer to all OECD countries for which standardised unemployment rates are available.

It thus seems clear that there are powerful forces at work in the global knowledge economy making for low inflation. This trend, of itself, need not raise fears about deflation, either in the sense of an extended period of falling prices or of long periods of seriously depressed economic activity. There are no signs in the developed countries of any trend to significant declines in price levels, nor of the contractionary forces which have historically been associated with falling price levels. Indeed, with the return of low inflation the capacity for expansionary policies to stimulate more rapid growth without re-igniting inflation has been correspondingly increased. Care needs to be taken in implementing such policies, however, for the forces working towards lower inflation do not impact evenly throughout the economy, and inflationary phenomena such as real estate or financial asset 'bubbles' can develop even though overall rates of inflation are low. China's recent experience with falling prices needs to be seen in this context, and I return to this matter below.

2.5 Rising Inequality, Within and Between Nations

Another important fact is that the world appears to be seeing growing inequality arising from economic trends, both within and between countries. Only a few examples of this apparent trend can be given here. In the US, for example, the real earnings of the bottom 10% of employed males fell by one quarter between 1973 and 1994, while those of the top 10% rose by about 15%. The effect for female wages is similar, but with a higher rate of growth of mean real wages. The other country for which there has been a major increase in wage inequality is the UK. The main difference between the UK and the US lies not in the extent of the increase in earnings inequality but in the fact that over the period since the 1970s overall real wages have risen significantly in the UK but have risen slowly or fallen (depending on the measure used) in the US.

In describing changes in the wage distribution in other developed countries, Gottschalk notes two other groups. One, including Canada, Australia, New Zealand and Israel, experienced substantial increases in wage inequality, but less so than USA and UK. Another, including the Nordic countries, the Netherlands, France, Italy and Japan, experienced small but positive increases in wage inequality. Only Germany seems to have avoided any increase in inequality at all, although this may be beginning to change (Gottschalk 1997).

Over the last decade or so, many poorer countries have fallen further behind the richer countries in real living standards rather than catching up. There is a very real fear among developing countries that the knowledge economy will further strengthen the position of those who already possess the knowledge, namely the rich countries. Some understanding of these trends can be gained from Table 3, which summarises the results of an analysis of relative income movements of a group of 108 developing countries between 1965 and 1995 (IMF 1997, following Chari, Kehoe and McGratten 1996). The country coverage of the Table 3 includes the countries of East Asia but excludes the transition economies of Eastern Europe. In constructing this table, five income bands each covering 20% of developed country per capita GDP for that year, are defined for 1965 and 1995, and individual developing countries are allocated to them as appropriate.

Table 3. Developing Countries: Increased Polarisation in Cross-Country Relative Incomes

	Position in 1965 income distribution (quintiles)					
	Lowest	*Second*	*Third*	*Fourth*	*Highest*	*Total*
	(number of countries)					
Countries whose 1995 quintile position relative to their 1965 position was:	**52**	**34**	**15**	**2**	**5**	**108**
	Position in 1995 income distribution (quintiles) (number of countries)					
Lower	34	10	2	..	..	46
Unchanged	50	6	1	..		57
Higher	..	1	1	1	2	5
Total	**84**	**17**	**4**	**1**	**2**	**108**

Source: IMF, *World Economic Outlook*, May 1997.

This analysis shows quite clearly the polarising dynamics of recent decades. Of the 108 countries studied, 52 were in the lowest quintile and 34 were in the second lowest quintile in 1965. By 1995, 84 were in the lowest quintile and 17 were in the second lowest quintile. That is, the proportion of developing countries which were in the lowest quintile of developed country income rose from 48% in 1965 to 78% in 1995. Forty-six countries moved downward into a lower income quintile, of which 13 countries fell by two or more quintile bands, while only 5 countries moved into a higher quintile. Thus upward movements were rare, and developing countries were almost evenly divided between those whose quintile position declined and those for which it remained unchanged.

3. Some Potential Implications for Developing Countries

It is beyond the scope of the present paper to explore in any depth the possible implications of these massive global changes for the position of developed countries in general. I wish to make just two points, before commenting on the special position of China in the emerging economy.

The first concerns the potential parallel between current trends and those arising from the original Industrial Revolution. That fundamental change in the world economy was itself a knowledge revolution, as new scientific and engineering principles were applied to industrial activity. But, in terms of the distribution of the new economic activity, the lesson of the Industrial Revolution is quite clear – the fruits of development went to those (initially in UK) who generated the economic applications of knowledge and then to those (in Europe and later in USA) who could readily access and expand on this knowledge. As a result, the pattern of economic development from 1750 to 1950 has heavily favoured (with the striking exception of Japan) the countries of the West. For example, on Bairoch's estimates (Bairoch 1993), the level of real GDP per capita was about the same in 1750 in what are now the developed countries and the

developing countries. But over the two centuries nearly all of growth in per capita GDP took place in the developed countries, so that by 1950 their per capita GDP levels were about seven times those of the developing countries. Similar trends are evident in the work of Maddison (e.g. Maddison 1998, cited in Hu Angang 1999).

There must be a real danger that this pattern will be repeated in the 21st century, with renewed expansion in the countries which either have driven or have immediate access to the technologies at the heart of the new economy. Signs of this are apparent in the resurgence in the USA over the past decade, including the flow of human and financial capital into the USA, as well as in the trends related to increasing divergence between countries discussed in Section 2.5 above. While it is too early to be sure, there are disturbing signs that a large number of nations may fall further behind in the global knowledge economy.

Secondly, it is important to note that the economics of the knowledge economy are poorly understood. Knowledge is fundamentally different from other goods – for example, it is non-rival and to some degree non-excludable; it has fixed costs in its production and gives rise to increasing returns, and the development of knowledge is inherently uncertain. The prevalence of knowledge in economic affairs plays havoc with traditional neoclassical economic models, and renders the analysis and policy prescriptions arising from such models of uncertain validity. Consequently, policy makers, including those in China, are faced with decisions of great import without a firm knowledge foundation on which to base those decisions.

The position of China in the emerging knowledge economy is quite special. While it must face the pressures common to all developing countries, it has some particular advantages but also some very specific challenges. Perhaps more so than any other developing country, China has a long and sophisticated intellectual tradition, having given the world many of the ideas which were important in the Industrial Revolution. This tradition is reflected in the current strength of the national education system and the priority given by parents to their child's education. When this tradition is allied to the scale of the potential Chinese market, it is clear that the long term prospects for developing advanced industries, perhaps with foreign partners but with a substantial Chinese knowledge content, are brighter in China than in most other developed countries.

Further, there appears to be a greater awareness of the momentous changes taking place in the world economy, and of the need for systematic responses by individuals, firms and governments, in China than in most other countries outside the USA. This awareness – reflected for example in the *Decision on Encouraging Technological Innovation, Developing High-Tech Industry and Realising Commercialisation of New Technologies* taken on 20 August 1999 by the CPC Central Committee and the State Council – will be important in China's response to this global issue.

Nevertheless, in common with other transition economies, China must transform its economic structure to one more consonant with market forces while at the same time responding to the pressures of the global knowledge economy. Indeed each element of China's contemporary challenge – plan to market

transition, adjustment from the industrial era to the knowledge based economy and catch-up relative to the developed countries – is daunting in its own right. The three together create a task of truly historic dimensions.

4. Some Challenges for China

In seeking to place this historic task in its broader context, I comment below on six aspects of the challenge facing China in responding to the emergence of the global knowledge economy.

4.1 Developing and Applying Knowledge Capabilities

In spite of its long tradition of respect for and emphasis on knowledge, China's industrial activity is still based much more heavily on the advantages of low cost labour than on the application of advanced knowledge. While the advantages of low labour costs will remain, a central challenge is to develop an industrial structure which makes much more effective use of both foreign knowledge and of knowledge developed within China.

While R&D expenditure is not the ideal measure of a broadly based process of innovation, consideration of relative R&D intensity gives some indication of the magnitude of this task. Table 4 shows the levels of R&D intensity for the 22 industries used in OECD analyses, for China and the OECD 12. For manufacturing as a whole, R&D intensity in the OECD 12 was about seven times that in China in 1995, with an OECD 12 rate of 7.8% as against an estimated rate for China of 1.15%. This is, of course, not unexpected, given that it is well known that developed countries have much higher rates of R&D than most developing countries. This difference has two components: developed countries have higher R&D intensity in most of the 22 industries, and their industrial value added is also more concentrated in high tech areas than developed countries. If the OECD 12 had their actual industry specific R&D intensities but the same pattern of value added as China, their overall R&D intensity for manufacturing in 1995 would have been 6%. Thus the pattern of value added explains about one quarter of the difference in overall R&D intensity; about three quarters is due to lower industry specific R&D intensity rates in China.

A notable feature of these data are the relatively high R&D intensity in China in two areas, aerospace and shipbuilding, both presumably driven by the effects of earlier military activities. R&D intensity in aerospace, at 10%, is very much higher than for any other Chinese industry, while shipbuilding is the only industry for which the R&D intensity in China exceeds that in the OECD 12. Equally striking is the relatively low level of R&D intensity in China in most other high tech and medium high tech industries.

Table 4. R&D Intensity by Industry, China and OECD 12

	R&D Intensity		*Relative R&D*
	China 95	*OECD 95*	*Intensity – China*
	(%)	**(%)**	**(OECD adjusted level for each industry = 100)**
1. Aeronautic facilities	10.04	44.79	118.0
2. Computer manufacturing	1.53	29.94	26.8
4. Pharmaceuticals	2.87	28.06	53.8
5. Instruments	2.68	21.50	65.6
3. Electronics	1.55	20.40	39.9
6. Automobile manufacturing	1.77	15.10	61.8
8. Electric machinery	1.63	10.86	79.2
7. Chemicals	1.22	9.52	67.5
10. Other transport equipment	0.70	8.25	45.0
9. Machinery	2.22	7.65	152.7
16. Non-ferrous metal	0.81	3.73	114.1
15. Rubber and plastics	1.77	3.64	255.5
12. Petroleum refining etc.	0.86	3.57	126.8
13. Stone, clay and glass	0.91	2.53	190.4
17. Ferrous metals	0.67	2.52	140.5
11. Ship-building	2.01	1.85	571.1
14. Other manufacturing	0.13	1.75	39.2
18. Fabricated metals	0.96	1.56	325.2
19. Food, drink and tobacco	0.34	1.32	134.7
20. Paper and printing	0.77	1.16	348.1
21. Textile and clothing	0.54	0.95	296.4
22. Wood and furniture	0.37	0.64	305.2
Total	**1.15**	**7.84**	**100**

Source: For China, estimates of the authors based on the Chinese Industrial Census, 1995; for the OECD, based on the STAN Database, OECD Secretariat, 1999.

To compare the structure of R&D intensity levels by industry in China and the OECD 12, we correct for both the individual level and value added weight effects. If Chinese manufacturing had the same pattern of R&D intensity across industries as in the OECD 12, then R&D intensity levels in any industry would be the same in both regions after adjustment for these two effects. Thus we estimate the overall level of R&D in the OECD 12 using Chinese value added weights (6.04%), multiply the Chinese R&D intensity figure in each industry by the ratio of this overall level to the overall level for China (6.04/1.15) and express the ratio of the resulting figure to the OECD 12 figure for each industry as an in based on 100. Thus if each industry had an index value of 100 this would mean that the structure of R&D intensity in China is the same as in the OECD 12. Industries below 100 have an R&D intensity level in China below the implied OECD 12 structure, while industries above 100 have a higher relative level in China. In other words, after correcting for its lower weighted average level, China undertakes relatively more R&D in industries above 100 and relatively less in industries below 100.

The results of this exercise are summarised in the right hand column of Table 4. Two related facts are very clear. One is the low level of R&D in Chinese

high and medium high tech industries (except aerospace), even after correcting for the differences in average levels between the two regions. The second is the relative concentration in Chinese R&D in the medium low and low tech industries. With the exception of the catch-all 'other manufacturing' the relative R&D intensity of all of these industries in China is well above the OECD benchmark, with the index level averaging about 250 for these industries. This concentration of industrial R&D in China in lower tech industries, and the relatively low level of R&D in high tech industries, many of which are growing very rapidly, is a central feature of the structure of Chinese industrial R&D. It is certainly worthy of further study.

There has been extensive discussion in China for some time about the means by which to achieve increased innovation and technological development in the Chinese economy. Reflecting this discussion, the CPC Central Committee and the State Council adopted on 20 August 1999 the framework of a comprehensive policy in this regard. Key elements of the policy include:

- systematic encouragement of state owned enterprises (SOEs) to increase technological innovation in response to market forces;
- a concerted program to transform applied scientific research and design institutes into enterprises, with preferential policies for those which are so transformed;
- further development of high tech and new tech industrial development zones, supported by favourable treatment from the Central Government;
- support for private science and technology intensive enterprises;
- support for the development of science and technology intermediaries (innovation and technology consultancy services enterprises, information and management services, databanks and networks etc.);
- preferential financial and taxation policies to support innovation, including preferential tax policies for high tech and new tech products, and some tax concessions relating to spending on R&D, income from technology transfer and the export and import of technology intensive products;
- financial support for innovation in small and medium size enterprises, including a technological innovation fund and loan guarantee arrangements for such enterprises, and steps to strengthen capital markets in relevant areas, especially venture capital markets, and
- steps to improve the management of scientific and technical personnel and to strengthen the management and protection of property rights.

These decisions remain at the level of broad policy, and their effectiveness will largely depend on their expression in detailed policy measures over the next 6-12 months and the implementation of those detailed measures. But this framework provides a comprehensive basis for such detailed policy development.

4.2 Value Added, Trade and the WTO

A central feature of China's policy at the present time is to gain access to the WTO prior to the launch of the new round of bilateral trade negotiations. To achieve this objective, China made substantial and unexpected commitments to

liberalisation across a wide range of industries in the negotiations prior to the visit of Premier Zhu Rongji to the US in April 1999. These commitments appear to be driven above all by a desire to use WTO accession to drive market based reform within China and to revive the level of foreign direct investment into China (Yong Wang 1999). As such, it is a central element of China's response to the global knowledge economy. But such a strategy is not, of course, without its risks.

The twin characteristics of the global knowledge economy – openness and rising knowledge intensity – are clearly apparent in trade, as we have seen above. Trade is growing most rapidly in more knowledge intensive industries, and this trend seems likely to continue. But, as one might expect, China's current exports are heavily biased towards less knowledge intensive activities, both in terms of concentration in low tech industries and in terms of low knowledge intensity activities (such as assembly) in industries which are high tech on a global basis. Thus low tech industries provided nearly one half of China's manufacturing exports in 1997 and all of China's trade surplus in that year (see Table 5). Indeed, exports of textiles, clothing and footwear alone provided nearly 30% of China's manufactured exports in that year, and the surplus in this industry alone was greater than China's overall trade surplus.

It is to be anticipated that a developing country's exports will be concentrated on low tech industries, and on lower knowledge intensity within other industries. But this raises a number of issues in the current environment. Firstly, market growth is lower in low tech than in high tech industries, as the global pattern of demand shifts to knowledge intensive goods and services. This is reflected in lower rates of growth in world trade for less knowledge intensive products. Secondly, as an increasing number of less developed countries enter the global trading system, competition in world markets for low tech products is continuing to increase, putting pressure on prices for such products.

Thirdly, the process of manufacturing itself, and of the associated product chains, is becoming increasingly globalised and knowledge intensive. One implication of this is that the multinational companies which control access to developed country markets, in products ranging from sports shoes to pharmaceuticals, can source manufacturing capacity on a competitive global basis, and can minimise the share of value added going to the manufacturing process. The case of clothing and footwear companies (such as Nike), which have integrated global purchasing and production systems linked closely to short term retail trends, has been much discussed. Another example is the pharmaceutical industry, where R&D now accounts for almost one third of the lifetime cost of creating, producing and marketing a new drug (Danzon 1997).

In considering China's likely accession to the WTO, it is important to give due weight to these emerging realities. While the primary goals of Chinese policy appear to be to drive internal reform and to attract renewed FDI, these goals will need to be achieved in the context of successful initiatives to develop knowledge intensive activities within China if the risks of WTO accession are to be avoided. The risks – increased imports of value added products and further concentration of Chinese production and exports at the low tech, low value added end – remain very real.

Table 5. R&D Intensity by Industry, China and OECD 12

	R&D Intensity		*Relative R&D Intensity – China*
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	(%)	**(%)**	
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3. Electronics	1.55	20.40	39.9
6. Automobile manufacturing	1.77	15.10	61.8
8. Electric machinery	1.63	10.86	79.2
7. Chemicals	1.22	9.52	67.5
10. Other transport equipment	0.70	8.25	45.0
9. Machinery	2.22	7.65	152.7
16. Non-ferrous metal	0.81	3.73	114.1
15. Rubber and plastics	1.77	3.64	255.5
12. Petroleum refining etc.	0.86	3.57	126.8
13. Stone, clay and glass	0.91	2.53	190.4
17. Ferrous metals	0.67	2.52	140.5
11. Ship-building	2.01	1.85	571.1
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18. Fabricated metals	0.96	1.56	325.2
19. Food, drink and tobacco	0.34	1.32	134.7
20. Paper and printing	0.77	1.16	348.1
21. Textile and clothing	0.54	0.95	296.4
22. Wood and furniture	0.37	0.64	305.2
	1.15	**7.84**	**100**

Source: For China, estimates of the authors based on the Chinese Industrial Census, 1995; for the OECD, based on the *STAN Database*, OECD Secretariat, Paris, 1999.

4.3 Competitive Firms – SOE Reform in the New Environment

At the heart of China's response to the global knowledge economy is the process of reform of the SOEs. This process of reform faces in full the three challenges noted above: enterprises must move from a plan based, public ownership system to a market system, and do so while attempting to catch up with foreign firms which are themselves undergoing fundamental change. While this triple challenge can appear very daunting, the knowledge economy also offers some prospects of leap-frogging to advanced practices. This is particularly so in relation to use of information technology and the Internet.

The attempt to leap-frog to advanced practices seems to be concentrated on the policy of 'managing the large and letting go of the small'. This is the official policy to support intensively some 300 or so large SOEs with the intent of making them large international companies, while loosening state control and ownership over smaller ones. There are clearly successes and failures in this regard, but it is important to note that companies in all countries face a crisis of adjustment to the new economy. This adjustment can indeed be acutely difficult for a relatively

successful, established company which faces wholesale re-engineering of what until recently had been successful practices, procedures and systems. At the national level, the difficulties faced by Japan in responding to the pressures of the global knowledge economy is a case in point.

4.4 Deflation, Unemployment and Savings

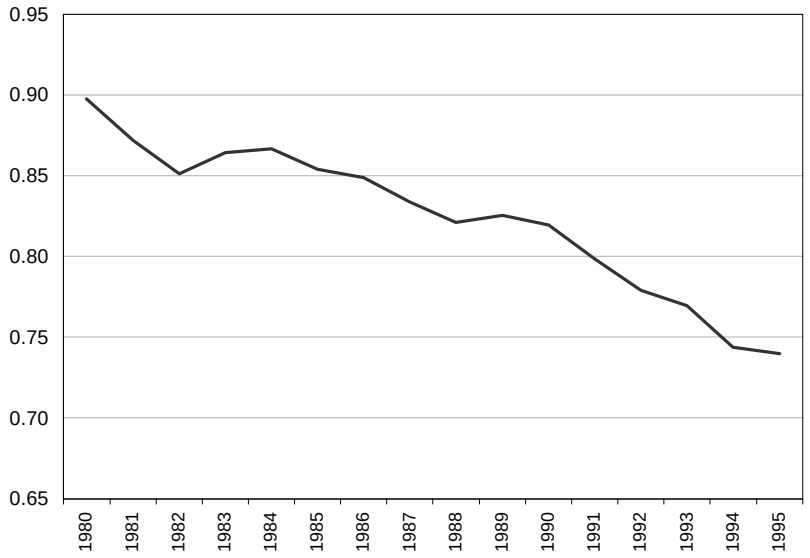
Recent notable features of the development of China's macro economy have been a falling price level, rising levels of unemployment and increased uncertainty among consumers, giving rise to high levels of consumer saving. As a result, the level of economic activity has been supported by high levels of public sector stimulus, primarily through investment in capital works, but at the cost of further substantial increases in the Central Government budget deficit.

While many specifically Chinese factors are undoubtedly central to these trends, it is worth noting the extent to which similar trends are apparent in many other countries in recent years. Many OECD countries have experienced high unemployment and considerable national uncertainty in the 1990s, as they have sought their optimal response to the new economy. And, as pointed out in Section 2.4 above, virtually all OECD countries have seen very low inflation in recent years. This is true both of countries, such as USA, for which full employment prevails and for countries such as Spain, where the unemployment rate is of the order of 18%. Thus the experience of China, where retail prices have been fallen at the rate of less than 2% per annum for the past eighteen months, is not so far removed from the international norm as is often supposed. Special factors in China, such as excess capacity in certain areas and the move from administered prices, are obviously important, but there is no need to fear a deflationary spiral as a result of these price declines.

4.5 Inequality

The growing divergence within nations evident in many countries in recent years, has also been evident in China. Although China's economy grew at exceptionally high rates between 1980 and 1995, its provincial economies have grown further apart in recent years. Dispersion in per capita income or output is commonly used for testing the existence of convergence or divergence between different economies. A group of economies is said to be converging (diverging) if standard deviation in per capita incomes is found to be decreasing (increasing) over time. On the basis of this test, the economies of 28 provinces of China (excluding Hainan and Tibet) appear to be diverging, particularly from around the mid 1980s when the coastal provinces surged ahead, benefiting from the policies of the open economy (Grewal and Sun 1999). Indeed, the provincial economies along the East Coast of China have converged among themselves, while the inland provinces have also converged into a distinct group of their own, in spite of initial divergence during the second half of the 1980s (Chart 2). Thus, while China's economy is experiencing divergence when all provinces are considered together, the pattern also shows multi-peaked convergence as the provinces are experiencing convergence within smaller groupings.

Chart 2. Convergence in China's Coastal Provinces (standard deviation of GDP per capita)



Source: Grewal and Sun (1999).

Table 6 illustrates this point in terms of indicators of human development rather than by per capita GDP statistics. While the indicators for the best province in China are comparable to those of the high-income countries, those in the lowest province are comparable with those of low income authorities. There are also signs of increased divergence within some provinces (Wang Shaoguang and Hu Angang 1999).

My point is simply that, in terms of rising inequality, China shares this problem with most of the developing nations. There are growing signs that growth in an open, global knowledge intensive economy will inherently generate strong pressures to increasingly inequality. This is a major challenge for policy makers everywhere, and not only in China.

4.6 Growth and Human Welfare

Most discussions of the growth of nations use national accounting methods and measures, which were themselves developed during the industrial era to measure change in national and regional economies over time. But the objective of economic growth has always been increased welfare for the individuals served by the economy, rather than a continuing increase in the output of goods and services as an end in itself. In recent decades it has been often noted that increases in per capita GDP do not necessarily correlate with increased human welfare, and in some areas (e.g. environmentally) there may even be an inverse correlation.

Table 6. Selected Human Development Indicators: China and the World

	China			World		
	Average	*Worst Province*	*Best Province*	*Low Income Economies*	*Medium Income Economies*	*High Income Economies*
Urbanisation (%)	27.5	13.3	70.1	27	60	78
Illiteracy Rates (%)	13.3	40.0	6.4	49	17	< 5
Mean Schooling (yrs)	6.1	2.2	8.7	1.6	5.3	11.1
Life Expectancy (yrs)	68.8	59.1	75.2	56	68	77
Infant Mortality (per '000 live births)	30.6	94.6	8.7	89	39	7

Source: Wang Shaoguang and Hu Angang (1999), based on World Bank, *World Development Report 1995* and other sources. China data are for 1994; other data are for 1993.

The experience of China also illustrates this point, for China has achieved improvements in many aspects of human welfare well ahead of its GDP performance, and indeed some of these gains were achieved in the pre-reform period. As is evident from Table 6, in spite of still being a low income country China has lower illiteracy and infant mortality rates, and higher schooling and life expectancy levels, than the medium income countries as a whole. As noted above, levels in the best Chinese province are comparable with those in the high-income countries.

The point of this is that rethinking the relationship between GDP figures and human welfare will be an important aspect of responding to the knowledge economy. Not only may the GDP figures become increasingly misleading in this regard, but new technologies (such as communications, telemedicine and online learning) may offer direct increases in human welfare without any large, intermediate growth in the output of goods and services.

4. Conclusion

China faces an historic and daunting task in moving through the transition from plan to market and seeking to catch up with the developed countries while the global economy grapples with the rise of the knowledge economy. But many issues which China faces are shared by developed and developing countries alike, and China has some particular advantages as it addresses these challenges. Coming to grips with the global economy is not optional for any country – how effectively China is in addressing these issues will be an important determinant of its prosperity in the first half of the 21st century.

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