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China's transition to the new economy
An Institutional Approach

1. Introduction

In order to cope with the dynamism of the New Economy, a new framework for government and public policy is necessary to allow a country to adapt to the fundamental shifts in economic and social realities that its emergence brings about. Not only private sector innovation and entrepreneurial drive but also strategic and concerted public policies are essential to overcome the difficulties involved and thereby achieve the New Economy's full promise.

In the past two decades, China has undergone intensive transformation in terms of industrialisation and urbanisation; at the same time, it has experienced transition from 'the plan' to 'the market' and from isolation to gradual integration into the world economy. Starting as a low-income 'non-core innovator' country, China has encountered the challenges of developing an 'old' manufacturing economy, mass-production and the New Economy *simultaneously* in a uniquely short period. We argue that the 'catch-up' strategy relying on technological diffusion has its inherent limits for China and that China's government has taken an active approach to the challenges, fostering new and high technology industries to provide breakthroughs in sustaining economic growth subsequent to the initial industrialisation period. As the driving force of the New Economy, the role of government in the development of high-tech sectors in China is the focus of this paper.

Instead of following the somewhat tired dichotomy of 'the free market versus government intervention' and the deterministic approach of the neo-classical property rights school to interpret the transition of new high-technology industries in China, we adopt in this study an institutional approach to change. In so doing we argue that

China has coped with the dual challenges of economic development and institutional transition simultaneously within its unique 'contextual circumstances' and that gradualism and pragmatism have turned out to be the 'path dependent' solutions for China to deal most successfully with the 'churn' of transition. We argue that the 'transitology'[1] of China, from the very beginning has involved pragmatic attempts at wealth creation, welfare improvement and growing efficiency by the most appropriate available means within its extant contextual circumstances rather than by blindly following textbook models

The current situation shapes the institutions of tomorrow and, as a result, institutional change cannot be explained in abstract from past institutional arrangements. Thus we argue that, with regard to China, the institutional framework of the Mao era (1949-76), with its features of rigid party/state governance structures and the political norm of the collective good, shaped both the evolution of the new institutional framework and the nature of the market in China-in-transition under Deng Xiaoping and Jiang Zemin (1978-present).

In the first part of the paper, we present our understanding of general questions associated with the New Economy. In the second part, our analysis of the New Economy in the context of China-in-transition presents the contextual circumstances in which China has recently found itself.

In the third part, based upon an institutional approach to change, we present the process through which the high-tech sectors in China have evolved. We discuss the role of government in fostering institutional innovation, highlighting the policymaking and management of two major government projects in the post-reform era under Deng Xiaoping and Jiang Zemin: The National High Technology Research and Development Programme of China (863) and The Torch Programme. We argue that the springboard for growth of the high-tech sectors in China in this period was the science and technology and R&D capabilities that had accumulated under Mao in which the unique 'government-industry-university' partnership was originally forged. China's prior institutional framework allowed government and the universities to

[1] This concept is associated with Laszlo Csaba (SOURCE?)

engage in activities that went far beyond basic research and which became the early driving forces for product development and commercial adventures in high-tech sectors.

In the final part, we present the evolutionary process of university high-tech spin-offs that have been characterized by 'fuzzy property rights' and 'public entrepreneurship', and through these concepts, attempt an explanation of the recent 'path dependence' of the Chinese high-tech sector.

2 The New Economy: an American Phenomenon?

In recent years, the 'New Economy' has become a highly nuanced concept. The term was originally coined to describe the performance of the US economy in the 1990s: often referred to as the 'American Phenomenon' and characterized by high productivity and growth rates, yet with low levels of both unemployment and inflation[2], it represented a stark contrast to the post-war decades of the 1950s through to the 1980s when economies seemed forever dogged, in traditional 'Phillips Curve' style, by periodic bouts of *either* inflation *or* unemployment. Subsequently, the term 'New Economy' became identified with those sectors of any economy characterized by high-tech industry, driven by ICT, enjoying booming capital markets and associated with intensified globalisation (in contrast to those elements of the economy dominated by traditional industry) promising a new economic dawn without periodic boom and bust. Despite enthusiasm for the concept of the New Economy, even at the crest of the wave, however, there have always been doubts as to whether such a thing ever really existed. Those doubts[3] intensified once the ICT and dot.com share bubbles

[2] See *Business Week*, Jan 31, 2000: "With the information technology sector leading the way, the U.S. has enjoyed almost 4% growth since 1994. Unemployment has fallen from 6% to about 4%, and inflation just keeps getting lower and lower. Leaving out food and energy, consumer inflation in 1999 was only 1.9%, the smallest increase in 34 years."

[3] Doubts are held by economists who argue the performance of American economy in 1990s does not support the claim that 'new economy' generates consistent high productivity: the annual growth of non agriculture sectors from 1963 to 1966 was 7.0%, 3.5% and 3.2%, and that from 1970 to 1973 was 6.1%, 3.6% and 2.9%. By contrast, the average growth from 1996 to 1998 was 4.3%. The average increase of productivity during 1990-1996 was 1.5%, which is much lower than that during the 'golden age' (1948-1966). Gordon (1999) and Trghet (1998) argue that contribution of globalisation and information technology innovation to growth of American economy has been falsely amplified and

burst at the start of the new millennium and the economies of the USA and Europe joined Japan in suffering the cold winds of cyclical downturn.

Yet a number of American economists argue that reports of the New Economy's demise have been greatly exaggerated. According to their (optimistic) views, the current difficulty is merely a short-term blip within a much longer growth cycle associated with a New Economic transformation which has scarcely begun. As representative of their views, Scherer (1999, p.119) emphasizes, "there is a centuries–old tradition of gazing with wonder at recent technological achievements, surveying the difficulties that seem to thwart further improvements, and concluding that the most important inventions have been made and that it will be much more difficult in the future to achieve comparable rates of advance. Such views have always proved to be wrong in the past, and there is no reason to believe that they will be any more valid in the foreseeable future."

In the same vein, authors (Cornelius, Balnke and Paula, 2002 – PAGE NUMBER?) of "The Growth Competitive Index" indicate, "the reality is that the New Economy was neither an epochal and dizzying transformation nor a slogan generated by some dot-com companies looking to inflate their IPO prices. Rather it was and is the kind of profound transformation of all industries that happens perhaps twice in a century… we need to remember that the New Economy was never just about the Internet. Rather, it is about the transformation of all industries and the overall economy. As such, the New Economy represents a complex array of forces. These include the reorganisation of firms, more efficient and dynamic capital markets, more economic "churning" and entrepreneurial dynamism, relentless globalisation, continuing economic competition, and increasingly volatile labour markets".

Nowadays the influence of the New Economy, in terms of its intertwined fundamental tendencies of scientific and technological innovation (with the information revolution as its leading force) and globalisation, has gone beyond the territory of the United States. Other countries, regardless of their different levels of

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thus overemphasised. According to Shapiro & Varban (1999) – MISSING REFERENCES!, although the technology has been significantly improved, the economic laws and mechanisms remain as valid as development, have also embraced New Economy–driven changes. But while the American model of the New Economy represents the archetype for the ongoing science-based innovation-led changes in economies and society generally, the contours of the New Economy in other countries are not and necessarily cannot be the same as those of the world's only superpower.[4] Yet currently, according to Kolodko (2001) – PAGE NUMBER?, "the concept of the 'New Economy' and the innovative attempts at its theoretical explanation are heavily biased in favour of the American outlook on reality". As a result, there is a need to identify the wide-ranging nature and characteristics of ongoing fundamental change involved in grasping the New Economy in parts of the world beyond the boundaries of the United States.

Concepts such as the 'knowledge economy', 'information economy', 'the fourth industrial revolution' have all been variously used to describe recent economic transformations. For the purposes of this paper, however, we propose to understand the New Economy as being differentiated from the old by the following features:

(1)Knowledge as its critical factor of production,

(2) Science-based high technology as its driving force,

(3) Innovation as its spirit,

(4) Globalisation as its economic environment.

3. The New Economy in the context of China- in-transition

ever. "The New Economy is built on old virtues" says Treasury Secretary Lawrence H. Summers (SOURCE?)

[4] In terms of the openness of the economy and adoption of information technology, the economic conditions of industrialised countries such as Britain, France and Japan are similar to those of the USA. However, unemployment in Britain and France was much higher than in America in the 1990s, Japan has suffered a decade of stagnation, and none has yet achieved the typical 'new economy' standard of 'one stability three lows' - stable growth and low unemployment, low inflation and low interest rates. Yet can we argue that Britain, France and Japan have not embraced the benefits of the New Economy? If that were the case, the New Economy should be interpreted merely as an 'American phenomenon' rather than as a world-wide trend.

3.1 New Economy - Driven Industrialisation

China has achieved both remarkably fast and generally stable rates of economic growth in the past 20 years. Having seen 'Made in China' products ranging from labour intensive low value-added goods such as toys and textile goods to high-tech high value-added computing and telecommunications products flooding world markets, some western observers argue that China has successfully turned itself into a 'factory of the world'[5] with its massive manufacturing power. However, according to the latest Global Competitiveness Report (2002) – MISSING REFERENCES!, China remains classified as a low-income 'non-core innovator' country. Its authors adjust China's competitiveness by taking out the part of growth that is related to the 'catch up' phenomenon. Because the latter is temporary, its authors argue, it disappears once low-income countries have caught up with richer economies and should therefore be ignored. Thus, according to that report, China's competitiveness ranks only 38th out of 80 countries and only 63rd in terms of technology, weighting ½ to 'core innovators' and 1/3 to 'non-core innovators' in the Growth Competitiveness Index (GCI).

For China, grasping the New Economy involves profound transformation of all industries. Such a change is equivalent in scope and depth to the rise of the manufacturing economy in the 1890s and the emergence of the mass-production, corporate economy in the 1940s and 1950s in the west. It has taken western developed economies a span of two centuries to go through the various stages of transformation. However, post-reform China has encountered the challenge of developing a mass-production manufacturing economy more-or-less from scratch in a significantly shorter time span (no more than twenty years or so) *while at the same time* engaging in its transformation into a New Economy.

New growth theory identifies technological change as a key factor in economic development and technology is given a high weighting in gauging a country's

[5] Chinese scholars argue that there is still a long march ahead for China to reach before it can be truly described as the 'factory of the world'. According to their research, China contributes 7% of the outputs of manufacturing industries world-wide, by contrast, that United States and Japan contribute 22% and 14% respectively

competitiveness, requiring, first and foremost, an analysis of the extent to which that country is able to achieve technological progress. The way technology affects economic growth is dependent on the level of economic prosperity a country has already achieved.

Porter (1990) identifies three stages of economic development: factor-driven, investment-driven and innovation-driven.[6]. In his analysis, at early stages of economic development and once a country has exhausted the benefits of low-cost factors of production, a country's ability to launch its economy on a steeper growth path depends primarily on the transfer of technology from abroad. According to the Global Competitiveness Report (2002), developing countries that have experienced rapid economic growth are typically those that are successful in rapidly absorbing and disseminating the advanced technologies and capital of the more technically advanced countries - known as *technological diffusion.* This process of 'catch-up' growth has been very important for developing countries but for any country to advance further it is necessary to achieve a new competitive advantage by developing unique products and processes at the global technology frontier.

Cornelius (2002, p10) argues: "The transition through the different stages of economic development is not necessarily linear or gradual, nor does it happen automatically." As a large developing country, China has faced the challenge of balancing the needs of development of high and new technology industries with traditional industries, of capital- and technology-intensive industries with labour-intensive industries. Thus, to accomplish industrialisation *and* modernisation has been regarded by the Chinese government as a vital historical task. But unlike in 'core innovator' countries where, as the New Economy develops, increases in manufacturing productivity leads to a decline in the number of factory jobs and their

[6] Factor-Driven stage: firms produce commodities or relatively simple products designed in other, more-advanced countries. Technology is assimilated through imports, FDI and imitation.
Investment-Driven stage: efficiency in producing standard products and services becomes the dominant source of competitive advantage. Technology is accessed through licensing, joint ventures, FDI and imitations. At this stage, firms not only assimilate foreign technology but also develop the capacity to improve on it, extend capabilities more widely in the value chain.
Innovation-Driven stage: the ability to produce innovative products and services at the global technology frontier using the most advanced methods becomes the dominant source of competitive advantage.

share in total employment, in China, it has been necessary to ensure the sustainable growth of the traditional and new industries of mass production *at the same time* as promoting the New Economy given the need to absorb the vast numbers of endogenously displaced agricultural workers.

Yet in order to maintain the efficiency of the traditional industries, it is necessary to transform them with high and new technology. Manufacturers who use more high technology in their production processes export more and are more productive than manufacturers who do not. Meanwhile, it is important to accelerate the development of the high-tech industries, the modern service sector and to enlarge the proportion of the tertiary industry in the national economy. Thus the ongoing process of industrialisation of China is *intertwined* with the rise of the New Economy.

As a 'non-core innovator country', technology transfer has played a considerably more important role than innovation in China's development in the last 20 years. China has actively participated in international economic and technological cooperation and competition and has opened up to the outside world[7]. China's kinship with Taiwan, Hong Kong and Singapore, classified as 'core innovator' countries in 1990s, has provided an important channel through which China has gained access to the global technology frontier[8].

Yet while China has achieved very high rates of growth, 'catch-up' growth with reliance on *technological diffusion* has had its inherent limits and constrains the international competence of the mass manufacturing sectors.[9] As a result, the Chinese government has recently proposed a strategy for accelerated development by 'taking a new road to industrialisation'. In President Jiang Zemin's speech at the 16th Party

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[7] Jennifer Blanke, Friedrich von Kirchbach, Mondher Mimouni and Jean-Michel Pasteels – (...) (SOURCE?), economists from International Trade Centre and World Economic Forum, find that developing and transitional countries are seeing important improvements in their export performance over time. Curiously, improvements largely driven by increasing FDI flows are taking place at the higher end of the investment and technology ladder – in sectors with higher value added goods, such as IT and consumer electronics.

[8]According to Huang Yasheng (SOURCE?), 60% of FDI to China come from overseas Chinese societies in the region of Asia and the Pacific Rim.

[9] Chinese DVD manufacturers are the leading producing force of DVD, however, the 'core' technologies and patents of DVD are held by an international DVD manufacturing union of 6 multinationals from Japan and Europe – 6Cs. Chinese manufacturers only holds 6 core patents out of

Congress in November 2002, he concluded (SOURCE? PAGE NUMBER?) by arguing that China needed to "take a new road to industrialisation and implement the strategy of rejuvenating the country through science and education and that of sustainable development… We must press ahead to optimise and upgrade the industrial structure so as to bring about an industrial pattern with high and new technology industries as the leader, basic and manufacturing industries as the kingpin and the service industry developing in all areas. We must give priority to the development of the information industry and apply IT in all areas of economic and social development. We must develop high and new technology industries to provide breakthroughs in stimulating economic growth. "

In taking this 'new road to industrialisation', the Chinese government is thus reinforcing a strategy based upon a consideration of the context of China as a developing country while at the same time accommodating the challenge of the New Economy.

32, although they have claimed the most patents in non- core technology and design of DVD. Therefore, Chinese manufacturers have to pay $10 as a patent fee to 6Cs for every DVD they sell.

3.2 The *gradualism* and *pragmatism* of China's economic reform

As indicated at the Fourteenth National Party Congress in 1992, the fundamental goal of Chinese 'transition' was to establish a 'socialist market economy' through *reform*, *opening up* and *modernisation.* However, given the diversity of issues involved in the transitional process, in terms of policy strategy and theoretical base, there was no standard textbook, from within China or without, for Chinese policy makers to go by. Csaba (2002:p3) pinpoints the similar circumstances that puzzled policy makers engaged in the transition of the Soviet economy and eastern European countries: "(western) academic–and especially macroeconomic–departments had little idea, if any, about command economies in general and the social context of Central and Eastern Europe in particular". Thereafter, as Murrel (1995, PAGE NUMBER?) argues, "the lack of knowledge of the specific post-communist context tended to be 'remedied' by reliance on a direct application of textbook solutions, without much care about the institutional or historic context into which these insights were to be transposed." The policies, with uncritical reliance on 'standard, pre-cooked solutions' adopted by some transitional countries in the 1990s[10], as Csaba argues, led to a neglect of the "*contextual circumstances*", which "determine the success or failure of the application of a proven theoretical insight to policy-making." (Stiglitz 2000, pp.552-7)

China's experience, described by Naughton (SOURCE?) as 'growth out of plan', has been repeatedly contrasted with neo-liberal shock therapy. One of the characteristics of China's reform, as Fan Gang has argued, is that China has had to handle the dual challenge of 'development' and 'transition' simultaneously. Regarding the relationship between 'development' and 'transition', as Deng Xiaoping once indicated (SOURCE? PAGE NUMBER?), "development is the fundamental principle" while the ultimate purpose of 'reform' or 'transition' in China is to facilitate economic development and improve people's living standards. Yet 'transition' is not simply a linear process in which the backbone of 'the plan' is broken and replaced by the spine of 'the market'. Economic prosperity *and* social stability have been dual principles of the reform. The 'transitology' of China from the

[10] For example, voucher privatisation in Russia in 1992-4, privatisation of public utilities in Hungary in late 1995, the introduction of the private pension system in Kazakhstan in 1999

very beginning has never been concerned with transition *per se*, nor did it focus on the creation of capitalism or the search for the optimal allocation of resources through privatisation, but with a *pragmatic* search for wealth creation, welfare improvement, growing efficiency *and* social harmony.

An analysis of China's gradualism as a pragmatic 'bottom up' process correctly emphasises the importance of local conditions and initiatives rather than textbook blueprints as the key determinants of change. Lifting and relaxing the ideological constraints has encouraged local tests and trials and once they have been perceived as serving the principles of economic prosperity and social stability, the Party / State pragmatically authorizes and legalises them. As Gang Fan neatly concludes: "In short, the definition and contents of 'the socialist market economy' (in China) change over time according to the changing circumstances. Talking only about 'what is achievable and acceptable' without specifying a 'final destination' (has) its pragmatic virtues and saves a lots of political costs." (2002, p.9). In appraising the 'bottom up' process, the most important feature of China's 'gradual' or 'incremental' approach to institutional transformation so far, as Gang Fan (2002, p.6) puts it, has been "the development of the market-oriented non-state sector, not the reform of the state sector ….. the development of new sectors and associated changes to the economic structure (has) had to create and improve the conditions for the reform of the old sector".

4. The Evolution of China's High Tech Sector

4.1 Institutional Evolution

4.1.1 An Institutional Approach

"The situation of today shapes the institutions of tomorrow through a selective, coercive process, by acting upon men's habitual view of things." - Veblen (1899: 190)

Studies on Chinese transition frequently contain themes of 'government vs. market' and 'bureaucratic (political) ends vs. economical efficiency' although some scholars (WHO?) have gone beyond this framework by recognizing the unique characteristics of China's transition, by examining 'the economic role of government as a variable' and by taking a look at 'the interests and roles of government officials'. As they have indicated, "the macro question is whether the logic of efficiency and economic rationality will guide Chinese enterprise reform, rather than embedded political and institutional norms. At the micro level, the question is whether the future direction of enterprise reform will reflect strategic and operational needs rather than a desire to retain political control and placement." (Edwards, 1998, PAGE NUMBER?)

Much recent research on China's high-tech sector has followed the logic of the above framework. Francis's empirical work (1999) on the science and technology sector in Beijing concentrates on exploring new ways of combining business autonomy with a changed role for government. Gu's research (1997) follows the same outline: according to his research, highly successful enterprises in the information technology industry – the Founder Group, the Legend Group and the Stone Group - are officially categorised as collectively owned or state-owned but they have considerable strategic decision-making autonomy. This autonomy has, in effect, turned state support into a business asset rather than a liability. Science-based companies have thus evolved a new form of corporate governance, which renders their official ownership status little more than nominal. The government obliges these companies to meet certain requirements but it refrains from direct intervention in their business. This arrangement offers a model of evolution towards managerial autonomy and non-bureaucratic practices within state-controlled organisations.

Instead of following the above framework to interpret Chinese high tech sector, however, we take an institutional approach which involves interpreting the evolution of the high-tech sector as a process through which both 'economic rationality' and 'institutional (political) norms' at the macro level, and 'strategic and operational needs' and the 'desire to retain political control and placement' at the micro level are intertwined forces that dynamically shapes the path of institutional change.

Institutional transformation cannot be explained by starting from an institution-free state of nature. Institutions involve rules, constraints, practices and ideas that can sometimes, regarded as constraints, *mould* individual purposes and preferences in different ways. Menger's 'bottom up' approach first analyses the role of constraints in institutional evolution, proposing that habit formation greatly enhances the formation and stability of institutions. The process of habit formation, resulting from institutional channels and constraints, is described as '*reconstitutive downward causation'* by Hodgson & Knudsen (2001), in which institutions and constraints have a capacity to mould individual preferences. Once habits become established they become a potential basis for new intentions or beliefs. As a result, shared habits become, dialectically, the constitutive material of institutions, providing them with enhanced durability, power and normative authority. (Hodgson, 2001)

The market itself is an institution (Hodgson, 1988; Loasby 2000). "The market involves social norms and customs, instituted exchange relations, and – sometimes consciously organised – information networks that themselves have to be explained. All market and exchange relations themselves involve complex rules and cannot be institution-free" (Hodgson, 2001:114). As Viktor Vanberg (1985:75) puts it: " What we call a market is always a system of social interaction characterised by a specific *institutional framework*, that is, by *a set of rules* defining certain restrictions on the behaviour of market participants."

4.1.2 *Tiao kuai system* from Mao to Deng

Although few civil high-tech industries producing commercial products in the west existed in China at the end of the Mao era, this did not entail a lack of development of modern science and technology under Mao. On the contrary, state education and research institutions were established and developed under the '*tiao kuai*' system[11]. However, most R&D capacity was concentrated in the military and defence industries which were given top priority at that time. The then planned system was highly efficient in terms of mobilising available sources to complete key projects, notably in successfully launching 'two missiles and one satellite' in the 1960s and early 1970s. By the end of the Mao era in 1976, China had established R&D capability with teams of scientists and researchers based mainly at universities and research institutes attached to respective industrial ministries. Under the system of planning, R&D units conducted academic and research projects assigned within their '*tiao*' or '*kuai*' systems, which received the allocated funding from the central fiscal plan and then distributed it to units accordingly. All universities and research institutes were (and most still are) state-owned and research projects were conducted collectively in highly organised project units. Therefore, instead of relying on markets for the allocation of labour, technology and capital as 'a set of rules' *moulding* economic actors behaviour under market-oriented institutional arrangements, the planned '*tiao kuai'* system relied on rigid political and administrative forces which constituted the 'rules' governing participants' behaviour. The institutional arrangements and norms of 'party / state' provided the springboard from which the later reform started. At the micro level, the accepted norms and habits under the 'party / state' structure stressed the collective good and individualism was viewed as politically incorrect.

Under Deng Xiaoping's leadership from the early 1980s, ideological constraints were gradually lifted and the strategic priority was shifted from political struggle towards economic construction. At the macro level, the change started by a modification of the rigid planning system by incorporating market principles progressively. The reform of administrative institutions followed the policy of "releasing rights and sharing benefits", starting from the reform of fiscal policies allowing local government to retain local tax revenues. The economic structure was adjusted by transforming parts of the military and construction industries into civil

[11] *Tiao & Kuai* (Vertical & Horizontal): it was the administrative structure of China under the planned system. All functional ministries and line industries under the direct control of the central government through the State Council were '*Tiao*' systems which within themselves had administrative hierarchy from the central to grass roots. '*Kuai*' referred to the local authority that governed the local functional departments and industries. In this study, universities and research institutions directly controlled by the State Education Committee, Ministry of Science and Technology and other ministries are defined as '*Tiao*' units; and those governed by local authorities are classified as '*Kuai*' units.

production and stressing the importance of developing the tertiary sector previously neglected under Mao. At the micro level, the non state-owned sector was allowed to develop and State Owned Enterprises (SOEs) were allowed to generate and retain capital. People were allowed to pursue their individual interests.

Deng Xiaoping emphasised the importance of science and education for the economic development of China. Once he came into power, the first National Science and Technology Forum was held in spring 1978, later referred to as 'the spring of science and technology'. There was a need to apply the R&D strength that had accumulated under the Mao era in civil sectors to serve the long-term development objectives of the 'Four Modernisations' of China. This process was intertwined with the transition from planning to the market which started with the incorporation of competition and market principles into the system and which gradually progressed by building up market-oriented institutional infrastructures. It was a 'reconstitutive downward' process. People whose lives had been spent in military and political struggle gradually adjusted to the market economy. Meanwhile, in the science and technology sector, the institutional need was to bring together the technological strength already developed within public research institutes with the opportunity-seeking, flexible entrepreneurship that characterised the traditional Chinese model of doing business. This required an accommodation between the cultures of bureaucracy and enterprise and necessitated the establishment of an institutional norm of *entrepreneurship*. Nonetheless the formation of any new norms were constrained and 'moulded' by the prior planning system and the norm of the collective good.

4.1.3 Government's role in the Development of Science & Technology

According to the World Competitiveness Report "government plays an inevitable role in economic development. Universities, schools, infrastructure providers and other national and local institutions must not just develop and improve their capabilities, but must also become more connected to the economy and better linked with the private sector." (World Economic Forum, 2002 – MISSING REFERENCES, PAGE NUMBER?). However, the nuances of the economic role of 'government as a variable' and 'the interests and roles of government officials' have particular implications not only in different countries but also in distinct periods within the same country and should be interpreted within different 'contextual circumstances' (Stiglitz, 2000).

In the case of China's science and technology sector, at the initial stage of reform and transition in 1980s, the challenge came on two fronts, on the one hand developing science and technology *per se* to catch up with world leaders while, on the other, transforming the technological strength that had developed within public research institutes into 'productivity' and to serve the pragmatic needs of improving people's living standards.

When the reform started at the end of 1970s, the state sector was the dominant force in Chinese economy, which, in 1978, contributed 76% of GDP, with the collective sector contributing the other 24%. Throughout the 1980s, the non-state sector, Township and Village Enterprises (TVEs) in particular, flourished and increasingly contributed to economic growth in China. Thus, under the circumstances of a lack of a private sector and of market-oriented institutions, the development of the high-tech sector was initiated by public research institutions within the planned economy. Its growth was intertwined with the process of transition as market principles were gradually established and the non-state sector gradually outperformed the state sector.

As indicated in Figure 1, government funds were the principal source of finance for S&T in 1980s. With the development of the non-state sectors, funds from self-generated channels gradually increased yet from 1995 to 1999, government funds contributed on average a stable 45% of total S&T finance although the share of self-generated funds increased sharply in 1998 up to 46.20% from only 2.5% in 1997. Only in 1999 did the share of self- generated funds (48.75%) exceed that of government funds (47.8%.) for the first time. The data indicates the general picture that government has been, until very recently, the primary source of S&T development although the non-state sector has now outstripped the government sources, while sources from finance institutions, as indicated by the share of bank loans, were trivial and declined after 1995. The sources of S&T finances have diversified and government is no longer the only channel of investment in S&T as the non-state sectors have played a larger role. However, the market oriented finance channel for S&T remains weak. The role of public institutions has been vital in financing high-tech sector given the minor role that banks have played.

Figure 1: Statistics on Higher Education for Scientific and Technological Activities

China Statistical Yearbook 2000: p688 – MISSING REFERENCES!

PLEASE RE-STATE THE DATA ON S&T PERSONNEL IN THE SAME FORMAT: EITHER THE TOTAL OR IN THOUSAND (3,9 THOUSAND SCIENTISTS IN FUNDAMENTAL RESEARCH?)

Item	1995	1996	1997	1998	1999
S&T Personnel	**324,279**	**332,008**	**326,202**	**345,159**	**341,910**
Scientists & Engineers	307,985	316,354	311,622	311,417	328,991
R&D Institutions	**3,431**	**3,398**	**3,306**	**3,241**	**3,124**1
Fundamental Research	3.9	4.1	4.3	4.6	4.7
Applied Research	7.8	8.0	9.2	9.3	9.8
Sources of Funds for S&T (10,000 Yuan)	**494,756**	**565,380**	**730,763**	**849,556**	**1,029,460**
Government Funds	220,525	258,241	364,700	411,494	492,174
	44.57%	45.68%	49.90%	48.44%	47.80%
Self-raised	12,041	17,138	18,248	392,490	501,908
	2.43%	3.03%	2.50%	**46.20%**	**48.75%**
Bank Loans	11,748	8,302	7,126	-	4,509
	2.37%	1.47%	0.97%	-	0.44%
Total	49.37%	50.16%	53.37%	94.64%	96.99%

4.2 The National High Technology Research and Development Programme of China – The 863 Programme

" We must have our own 'fist' products, otherwise we will be bullied and beaten"
Deng Xiaoping 1992

In order to narrow the gap between China and high-technology frontiers, the Chinese government launched The National High Technology Research and Development Programme of China, referred to as the 863 Programme (representing March 1986, the date it was initially proposed). The policy makers of the initial programme took the China context into consideration when they made the plan. As a large low-income developing country, China was not capable of investing full-scale into new high-technologies and it was impossible (and, indeed, not necessary) for China to compete with leading developed countries in every high technology front. Therefore, the programme followed the guideline of adopting high technology according to the pragmatic demands and capacity of China, selecting seven priority areas (biotechnology, information, automation, energy, advanced materials, laser and space) covering fifteen subject topics as national key projects[12]. The programme currently covers 20 subject topics selected from eight priority areas.

4.2.1 Policymaking and management of the 863 Programme

The programme learned the lessons of developed countries' high-tech programmes but incorporated them with China's 'mass mobilisation system' nourished in the Mao era. Based on the 'hardware' of extant institutions, the policy

[12] . In 1993, telecommunication was added as a subject topic of the 863 Programme and from 1991 to 1995, there were other 4 subject topics added. In July 1996, marine was added as the eighth area of the programme

and management systems of the programme can be described as a 'high-tech programme with Chinese characteristics' in a number of aspects.

First and foremost, under state direction, the universities, colleges and research institutes were the key forces employed to conduct projects nationwide. As indicated in the latest statistics from the Ministry of Science and Technology (MOST), the host institutions of projects under the programme in 2001 were distributed in 28 provinces, municipalities and autonomous regions across the country. More than 20,000 researchers and administrative staff from over 3,000 research institutions, universities and enterprises across the country were involved[13]. Figure 2 makes clear the continuing importance of universities and research institutes to the work of the 863 programme.

Figure 2: Distribution by the nature of project undertaken (2001)

	Research institutes	Universities	Enterprises
Projects	38%	50%	12%
Expenditure	43%	43%	14%
Personnel	39%	46%	15%

(Source: The 863 Program Annual Report 2001) – MISSING REFERENCES!

Secondly the funding system involved direct appropriation of central government funds to key projects, circumventing the bureaucracy and other obstacles of the then planned fiscal and financial systems that otherwise might have slowed down the programme. Reforms led to the allocation of funding directly to the projects rather than to the 'directing units' (*zhu guan danwei)* of the universities research institutions, which belonged to different '*tiao*' and *'kuai'*, thereby putting limited sources together to pinpoint the project.

[13] The top ten regions in terms of R&D funding accounted for 85% of the national total and the top ten regions in terms of project number accounted for 84% of the national total. Beijing, the top region in terms of project numbers had a 40% share of the national total; Shanghai ranked second with 11%, Hubei third with 6%. Many of the best Chinese universities and research institutes, including 32 of those which are classified as '*bu shu yuanxiao'* (under the direct leadership and control of the Ministry of Education), or which are directly controlled by Ministries, are based in these top three regions: Beijing, Shanghai and Hubei (province capital Wuhan).

Thirdly, the management of the programme was based on an expert management system established under MOST. This involved a field expert committee (FEC) and a priority expert group (PEG), the former responsible for supervision, evaluation and consultation regarding the implementation of projects in a specific field, the latter responsible for organizing the technical direction and process control. For key projects, a general expert group (GEG) was set up to be responsible for organising the projects and ensuring their smooth implementation.

4.2.2 Success of the 863 Programme

The 863 programme can claim progress on a number of fronts. Firstly, it has narrowed the gap between China and high-tech frontiers[14]. In the biotechnology sector, new varieties of plants with high yields and tolerance have been developed. Breakthroughs have been made in developing new medicines, vaccines and gene therapy and in protein engineering. The government approved the first China-made anti-AIDS drug for clinical testing and China's human genome sequencing project was incorporated in the framework of the International Cooperation Programme. In automation technology, a breakthrough was made in the intelligent robot (IR) project and home-made robots were used in manufacturing industries; a project involving robots working at sea in depths of 6,000 metres was successfully completed, allowing China to conduct scientific research in 97 % of the oceans of the world.

Secondly, under the 863 Programme, breakthroughs in high-tech frontiers and applied technologies have provided China with strategic home-supplied technologies and products to compete with overseas multinationals, breaking their monopoly and technology constraints, specifically in the areas of the ICT sector including intelligent

[14] According to the statistics of the Ministry of Science and Technology (MOST), 1,200 projects were completed in the first ten years, covering five priority areas, 540 of which were classified as operating at 'world level', and 244 projects were granted international and national patents. Among 36 key technology projects that were selected by MOST when the programme was initiated in 1986 and were started largely from scratch, 60% were completed at 'approaching world level' by 1996, 11% were conducted at 'world level' and 25% made progress although they were evaluated as 'below world level'.

computer systems, optoelectronic device & systems integration technology, information acquisition and processing techniques[15].

Thirdly, the programme has promoted commercialisation and industrialisation of completed projects. The implementation of high technologies has reshaped traditional industries and enhanced the productivity and the competence of China's manufacturing sector. The breakthroughs in information technology, biotechnology and other high-tech sectors have provided China with opportunities for China to build up its own New Economy sector[16].

Fourthly, the 863 Programme has nurtured a new generation of leading scientists. The programme invested heavily in basic research and sponsored 70% of the papers in computing science published and presented by Chinese scientists in international journals and conferences. Within ten years, there were more than 30,000 scientists involved in the programme receiving funding providing the backbone of China's national effort in science & technology.

4.3 The Torch Programme and the Introduction of High-Tech Development Zones (HTDZs)

In August 1988, MOST launched the Torch Programme. While the 863 programme put emphasis on long-term R&D in the strategic and cutting-edge high-

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[15] More than 20 varieties of home-made servers have been introduced widely used domestically. The Dawning 2000-11 Super Server was successfully developed. The 'Hangwang-99' handwriting recognition systems and the 'Tsinghua Wentong' printed Chinese character recognition systems (OCR) held the largest shares of the domestic market while the Chinese-supporting platform of 'Sitonglifang' won a market share of more than 50%. The R&D on the 'third-generation semiconductor' was conducted at 'world level'.

[16] The Programme established bases and projects to facilitate the *application* of research outcomes and university-industry partnerships were encouraged. For example, in the Automation Technology sector, Contemporary Integrated Manufacturing System (CIMS) technology which started from scratch at the outset of the 863 Programme had within ten years established ten CIMS training centres nationwide and given CIMS training to 400,000 people including 37,000 chief engineers and company experts. The CIMS Centre at Tsinghua University and Huazhong University of Science & Technology were awarded University Lead Awards by the Society of Manufacturing Engineers (SME) in 1994 and 1999 respectively. Their achievements made China only the second country to receive the award more than once, the USA being other. CIMS technology has been applied widely in 11 industries including China's key exporting engines, including the textile, electronic and machine tool industries and provided competitive advantage for Chinese products. By 1999 a Contemporary Integrated Manufacturing System Virtual Network (CIMSNET) had been established, realizing nationwide integration and sharing of contemporary integrated manufacturing technology information and resources and promoting the dissemination and application of CIMS on a networking basis. Ten universities and five institutes in China jointly undertook the CIMSNET project.

tech sectors, the main mission of the Torch Programme was to focus on the *application* of completed R&D and on the commercialisation of market-oriented technologies that would benefit business quickly. In terms of administration and management, while all 863 Programme projects were (and still are) are monitored and directed by MOST at central government level, the Torch Programme is administered at both central and local level.

Between 1988 and 1999, the Torch Programme made significant progress with a total of 18,888 projects completed, 5,045 classified as 'nation level projects'. The scientific breakthroughs under the 863 Programme and the pragmatic application of schemes under the Torch Programme provided the essential foundation for the formation of clusters of high-tech industries[17].

In order to the gap between basic R&D and commercialised applications, the government adopted the method of fostering Science & Technology Industrial Parks. At the same time, MOST instituted a network of High Technology Development Zones (HTDZ) across China to facilitate the Torch Plan and support the commercialisation of basic R&D at local level[18].

4.3.1 Characteristics of the Torch Programme

[17] In ICT area, leading companies including Huawei Technology, ZTC, Great Dragon Technology and Giant Tang Technology formed the cluster of telecommunication equipment, and Chinese manufacturers are capable of competing with multi-national giants Northern Tel, Cisco on international markets. With 7 semi-conductor companies, China currently holds the second largest manufacturing power in producing computer chips, with America being the first[17]. The formation of new clusters upgraded the structure of China's export products from low value added as majority to currently with significant part of high tech high value added goods.

[18]The major functions of HTDZ, according to the MOST, were: 1). The building-up of high-tech industrialisation bases. 2). The establishment of 'demonstration sites' for science and business links, accelerating the *application* of research outcomes and stimulating applied technology innovations. 3). The provision of a source for enhancing the competence of traditional industries with high technology. 4). Fostering entrepreneurship. 5). Acting as a window for the 'open' policy. 6) Functioning as trial sites for in-depth reform of governance in terms of institutional innovation.

The Shenzhen High Technology Industrial Park was opened in July 1985. In May 1988, the State Council approved the establishment of the first national level High Technology Development Zone – Beijing HTDZ. Thereafter, through 1991 to 1997, the State Council permitted the establishment of 52 other national level HTDZs, are located in 29 provinces, autonomous regions and municipalities. HTDZs in China have made rapid progress throughout the1990s. By 1999, there were 17,498 high tech companies registered in 53 HTDZs, which hired 2.21m employees, the industrial turnover exceeded 600 billion Yuan, generating 85.6 billion Yuan in the form of profits & taxes.

First and foremost, the programme was (and is) *state-led*, collectively conducted through cross-ministry co-operation. In contrast to 863, the Torch Programme covers lower but wider technology areas and has been conducted by both central and local authorities but, as with 863, in addition to the establishment of new institutions, the programme initially relied upon extant institutions, including the '*tiao*' and '*kuai*' system.

High-tech companies registered in HTDZs under the Torch Programme benefited from a range of favourable policies. In terms of taxation, for the purpose of stimulating the development of applied technology and promoting its commercialisation and industrialisation, MOST and the State Bureau of Taxation consistently provided significant tax breaks[19]. With regard to financial arrangements, from 1990 MOST and the China Industrial and Commercial Bank, Construction Bank and Agricultural Bank jointly issued regulations that favoured high-tech companies in the provision of special loans for R&D and applied high tech projects. In terms of customs policy, high tech companies registered in HTDZs were allowed to set up duty free storehouse and manufacturing plants within the zone[20]. In 1991 MOST issued new regulations that simplified the application process for going abroad from high-tech company chiefs. Meanwhile, cross-ministry co-operation has played a key role in fostering the cluster of high tech industries. For example, in 1998 six ministries, including the State Planning Committee, Ministry of Education, MOST, Ministry of Electronic Industry, China Academy of Science and the Bureau of Technology

[19] At an early stage of the programme, in December 1989, MOST and the State Bureau of Taxation issued a new regulation to exempt tax duty on lab products for mass production developed by research institutes. Subsequently, in 1991, according to the then newly-issued "Law on Science and Technology Progress of P.R. of China" and State Council regulations, high-tech companies registered in HTDZs became entitled to favourable taxation policies including 1). An income tax rate for high- tech companies of 15% (compared with that of 55% on SOEs in traditional sectors), while for those high-tech companies whose export turnover contributed more than 70% of the total turnover, an income tax rate of 10%. Newly established high tech companies were exempted from income tax for the first 2 years of production. 2). Newly established high- tech joint ventures with foreign partners with a co-operation period over 10 years were exempted income tax for the first 2 years in which profits were generated. Favourable taxation policies were issued at both central level and local level and local governments to some extent competed with each other by providing more attractive policies for high tech business.

[20] In 1995, China Custom opened the first customs branch in Beijing Zhong GuanCun HTDZ to improve the efficiency and convenience of the custom service for high tech companies. High tech companies also benefit from favourable custom tax policies on their exports.

Supervision, worked together on a national strategy to foster the development of the software industry primarily in HTDZs[21].

Secondly, as with the 863 programme, the implementation of the Torch Programme has fundamentally relied on R&D strengths in the universities and research institutes. Indeed, one of the main missions of HTDZs has been to provide guidance and support for academics from university and research institutes to 'commercialise' their research outcomes[22]. Most HTDZs were established in university districts.

MOST and the Ministry of Education, the governing body of 32 top Chinese comprehensive universities, built up strategic cooperation. Under their joint direction, the 'University Science & Technology Park' (USTP) project was established in 1995 for the purpose of fostering technology innovation and cluster formation[23]. With the aim of attracting overseas Chinese scholars, 25 Business Hatches for Overseas Scholars were set up hand-in-hand with USTPs to provide business start-up opportunities for overseas Chinese, especially for those who left university for adventures abroad and obtained frontier technologies in western countries.

Thirdly the Torch Programme instituted a new management system to include HTDZ Management Committees. Unlike extant government functional departments, the committees were originally set up as NGOs, the nature of which was close to that of an agent, functioning as a connection between the academic and business worlds.

[21]To date, 22 'software Industry Bases' have been established with more than 3,700 registered companies hiring 170,000 employees. By 2000, the total turnover of software companies registered in 22 bases exceeded 65 billion Yuan.

[22] For example, the Beijing HTDZ was located at Zhong Guan Cun where Beijing University, Qinghua University, the China Academy of Science, Peoples University and other important research institutes are based. Zhong Guan Cun has been transformed from a suburb campus into a high tech zone with world leading ICT manufacturers and their associated research institutes, including Chinese groups such as Legend, Founder, Sitong, DaTang, originally spin-offs of universities in that zone, and American blue-chips such as Microsoft China and Motorola China.

[23]During the 9th Five-Year Plan, relying on 67 universities' R&D forces, 22 University Science & Technology Parks were established. There were 2,778 companies registered within the parks and attracted an investment total of 17 billion Yuan. In 2000, the total sales of the Parks was more than 25 billion Yuan, with an increase of 91.6% in twelve months. Registered companies developed 2,191 kinds of home-made new products and obtained 4,813 intellectual property rights and registered patents. 3,482 units

They became the creature of the needs of both ‘development’ and ‘transition’, facilitating the development of high-tech businesses following market principles.

The HTDZ Management Committees were a hybrid of the transition process, originating from the old system as a ‘market force’, yet incorporated into the ‘old’ system as ‘new’ blood[24]. By nature, they were ‘semi-authority, semi-entrepreneur’ institutions. Originating from their semi-entrepreneur nature, they have, indeed, pursued their own economic interests as market actors. However, they have taken the advantage of their ‘authority’ origin and benefited in terms of access to limited sources. The HTDZs, unlike old institutions, have been encouraged to function as enterprises rather than as purely bureaucratic organisations[25].

5 The *Evolution* of the Government-Industry-University Partnership in China

So far, we have examined the macro-level decision-making concerning the development of high-tech sectors in transitional China. However, appropriate macro-level conditions are necessary but not sufficient in themselves to provide opportunities to generate prosperity and create wealth. Wealth is actually created at the micro-level by enterprises[26].

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[24] Starting as a semi-official institution, poorly equipped with limited staff, the HTDZ Management Committee played the role of ‘official’ agent. With central government’s increasing emphasis on high tech sector, the fast expansion of HTDZs and the robust growth of business within HTDZs, in February 1995, 7 years after the first HTDC opened, the State Council finally approved the HTDC Management Committee, which governed 26 HTDZs at the time, with the status of ‘*shiye* (governing) unit’ equivalent to the status of the science committee at local level. With the growing importance of HTDZs in local politics and economies, the HTDZ Management Committee was granted a higher bureaucratic position, the head of the committee, very often, being deputy Mayor of the city.

[25] Acting in their semi-official function, HTDZs organised training courses for high-tech enterprises to adopt market-oriented systems, acting as both ‘organiser’ and ‘referee’ of the reform. Various training courses on modern enterprise and share systems were delivered through the HTDZ system. However, the HTDZ Management Committee turned out to be ‘player’ as well. In 1994, Zhongshan Torch HTDZ was, as the first of 53 HTDZs, transformed into a public company and floated on Shenzhen Stock Exchange in 1995.

[26] Therefore, generally, there is a need to enhance the microeconomic business environment to foster the sophistication of company strategy and operating practices. The quality of scientific research institutions and of university / industry research collaboration are among variables that establish the microeconomic conditions in which firms compete.

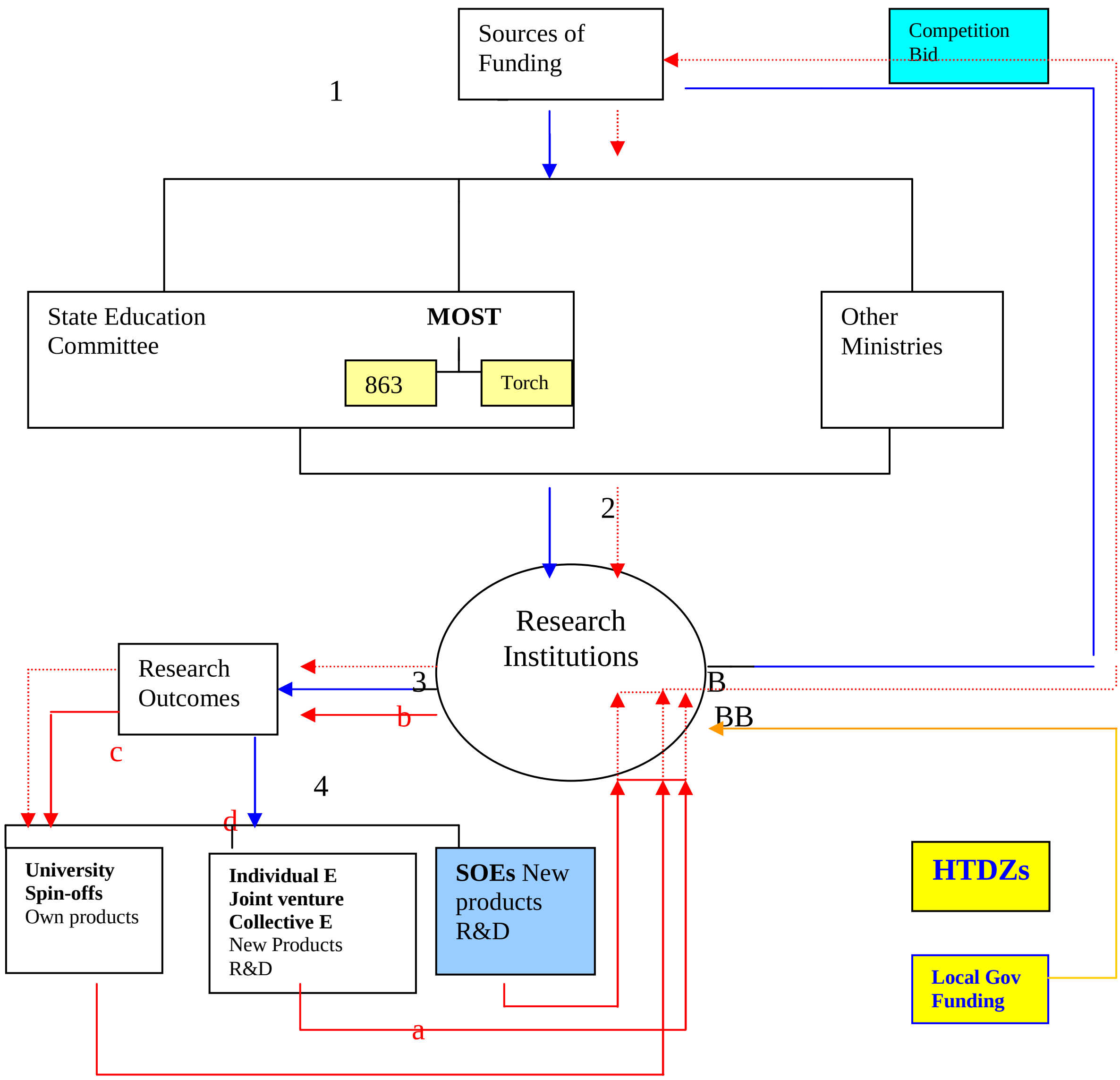
The development of the high-tech sector owes much to the reforms, but also drew heavily upon the 'accumulated capacity' of science and technology built up in the previous era, particularly at an early stage. For much of the reform period that followed the Mao regime, the norms and methods of the past prevailed in governance and administration, serving as the principal instruments by which successive reforms incorporated market principles into the extant system.

Institutional arrangements constrain individual habit and behaviour. The reforms allowed research institutes to pursue units' benefits and individual researchers' chase after wealth was no longer regarded as a vice'. The capacity to generate profit' (*chuang shou*) by turning research outcomes into commercial ventures turned out to be an assessment criterion as important as basic academic achievements for promotion, both political and academic, within the system. The interplay of these forces helped to create new positions for individuals and gave them an opportunity to play a part in the new order. As a result, the direct and indirect consequences of the reforms had the effect of creating new interests and groups, some with an explicit commitment to the reforms themselves, others seeking to find a role as the reforming measures began to erode their hitherto secure status.

Central government policies played a vital role in creating an appropriate environment to foster the transformation of S&T research outcomes into commercial ventures. The nature of the process, like the nature of the reform process generally, was that of trial and error without a uniform style. Fostering business ventures from previous state-owned and state-operated research institutes turned out to involve an interplay between transforming a 'work unit' *(danwei)* under the plan into an 'enterprise' in the market and converting technology into commercial products.

Research institutes and individuals were encouraged to co-operate with industry, firstly with SOEs and thereafter with the non-state sectors. The reforms were implemented at different rates, depending upon the initiative, energy and norms of the local officials, university leaders and scientists. It was a process which involved education and S&T officials, R&D leaders and otherwise well-connected individuals within the system using the capital and influence they had accumulated within the administrative system and S&T worlds of the previous era to pursue business ventures in the new one. The practical consequences of the reforms were less clear-cut and took time to emerge, often shaped by the personalities involved. As a result there were diverse forms of business venture, including industry-university (research institute) partnerships which varied not only for businesses developing in different regions and from different universities, but also for businesses *originating from the same university*.

Figure 3: Government-Industry-University Partnership



(MOST: Ministry of Science & Technology, SOE: State Owned Enterprises, E: Enterprises, HTDZs: High-tech Development Zones)

: Flow of G-I-U partnership at start-up stage

: Flow of I-U partnership at growth and expansion stages

: Flow of G-I-U partnership at growth and expansion stages

SOURCE??

Figure 3 shows the evolution of high-tech business sectors. The blue flow indicates the circumstance at start-up and survival stages of the enterprises: at this stage in 1980, the SOEs were major industrial partners in transforming research outcomes into products in traditional industrial sectors while universities established directly supervised spin-offs to launch products in brand new high-tech sectors. The red flow indicates the growth and expansion stages of high tech sectors. Industry–university partnerships were established with the surge of new industrial enterprise formation involving mainly non-state owned firms. Market reforms created intense competition and pressure for technological innovation. Both state and non-state enterprises increased investment into R&D with the accumulated capital and hunted for new technologies from research institutions. The broken red flow shows the process whereby the established high tech enterprises, regardless of the nature of ownership, co-operated with research institutes and jointly bid for government funding for further innovation. The yellow line indicates the goal and function of local government and local HTDZs roles in regulating the growing forces of high-tech enterprises.

In terms of the changing nature of ownership of high-tech enterprises, the development has proceeded through gradual reassignment of specific property rights[27] within the party/state administrative hierarchy (from higher government agencies to lower government agencies and from government agencies to enterprises, managers or individuals. In the past two decades, it has occurred gradually and has changed along

[27] Specifying property rights including following questions: who exercises managerial control? Who has a right to income flows? Who has the right to assign ownership to other parties? How are the above rights enforced.

different paths in different sectors and regions over time. The evolution of high-tech enterprises has intertwined with the uneven patterns of reform and change among different sectors and among different scale of enterprises[28]. As ownership has moved gradually away from traditional forms of state and collective toward a mixed economy, high-tech enterprises have been pervaded by various forms of ownership over time: reformed state and collective, various forms of private enterprise – the family firm, the elite industrial empire, and the private companies owned by government agencies and enterprises.

In Figure 3, the blue flow illustrates the power of the administrative hierarchy that specified and enforced property rights at the early stage of reform, given the lack of market institutions and non-state sectors. Stages 1 to 3 represent the procedures involved in applying for allocated funding under the planned system. The crucial change came at stage 4: the decentralisation and reformed institutional environment allowed those who had inventions the opportunity to explore new formats for the development of production technology encompassing different configurations of property rights. With the creation of market institutions and the incorporation of non-state sectors, mechanisms to specify and enforce property rights were gradually decentralised alongside the expansion of high-tech enterprises.

5.1. Characteristics of University Spin-offs

Among different types of business ventures in the high-tech sector, university spin-offs in China have had a distinctive development path. China's high-tech industries have from their inception been dominated by spin-offs (Gu, 1994, Baark, 1994). As we have argued earlier, universities and research institutions have played a vital role in the transitional development of high-tech sectors. In contrast to the model developed by Vannevar Bush[29] (SOURCE? REFERENCES? PAGE NUMBER?), which was presumed appropriate to the post-war American market economy in which

[28] Collective sector shifted toward the reformed, contracted, leased and private types of ownership earlier and more quickly than the state sector. Change from state/collective-owned towards private was employed primarily in small-scale enterprises. (Kung & Whiting, 1999)
[29] Vannevar Bush: a noted MIT electrical engineer, he proposed the model in his 1945 report to President Truman with the title "Science: The Endless Frontier".

"government should keep mission-oriented research in the hands of federal agencies and be the main founder of scientific (basic) research in universities, allowing individual scientists to decide how research funds are allocated and how research is conducted and applied", China's prior institutional framework[30] has allowed government and the universities to engage in activities that have gone far beyond basic research and which have been the early driving forces for product development and commercial adventures. Unlike western counterparts, Chinese universities have set up departments of 'industrialisation' and 'industrial-academic-research' (*chan-xue-yan*) committees to organise and develop business spin-offs. These spin-offs represent a fundamental institutional innovation which alters the organisational relationship between R&D and entrepreneurship. Figure 4 shows the evolution of university high-tech spin-offs in China in terms of property rights arrangements, management style and organisational structure.

Figure 4: Development stages of high tech spin-offs

		Period	PR	Ownership	M Style	O Structure
	Start-up	80s-92	Contract Responsibility / Contract leasing	The reformed collective firms	University DS Individual E	Unstructured
	Survival	90s e-m	Contract Responsibility / Contract leasing	Contracted public firms / leased public firms	University SS Individual E	Simple
	Growth	92 onwards	Joint Stock	Mixed ownership (Including private)	Entrepreneurial, Co-ordination	Functional, Centralised
	Expansion	92 onwards	Joint Stock Shares offered on stock exchanges	Mixed ownership (Including private)	Inception of Professional Administration	MES Dec-en

[30] The decentralisation of fiscal and managerial control has been accompanied by a decline in central government funding for public institutions on the premise that they should become increasingly self-financing. All elements of the public sector have become involved in setting up business ventures (Lin Yimin and Zhang Zhanxin, 1999 - – MISSING REFERENCES), including universities and research institutions.

	Maturity	90s m o	Joint Stock Shares offered on stock exchanges	Mixed ownership (Including private)	Professional Administration	MES, Multinational (De-cen)

(PR: Property Rights, T M: Top Management, M: Management, O: Organisational

DS: Direct Supervision, SS: Supervised Supervision, MES: Modern Enterprise System)

SOURCE??

Universities, research institutions and their governing bodies have played a crucial role in the start-up of high-tech spin-offs in terms of providing financial support. The Torch Programme identified spin-offs as the preferred strategy to commercialise technology resources. According to Gu (1994), most high-tech enterprises operating nationwide in 1993 were set up with assistance from public institutions. Universities have not only acted as organisers and liaisers but have also converted themselves into corporations. Most high-tech spin-offs were registered as 'collectives with a supervising unit' (Gu, 1994), even when the universities and other public institutions they belonged to initially engaged in the top management and remained as the ultimate controller, in terms of voting rights by shares, after they had grown into multinational publicly listed companies.

Property rights arrangements in university high-tech spin-off ventures were fuzzy at the start-up stage and continue to remain unclarified. The paradox is that university spin-offs have performed impressively through intense competition in innovation-based sectors, their growth dependent upon the sophistication of clusters, company strategies and strong operating practices, despite the inadequately developed microeconomic business environment[31] and the unclarified institutional arrangements.

For the purpose of interpreting the above paradox, we have examined the evolutionary process of university spin-offs. We have conducted a survey on 23 high-tech companies currently listed on the two Chinese stock exchanges initiated as

[31] To include the extent of bureaucratic red tape, the quality of infrastructural facilities, the condition of governance, the lack of sophistication of market institutions, constraints on the liberation of trade and quality of S&T research institutions and police protection of business.

university spin-offs. These high-tech shareholding corporations are ultimately controlled and owned by universities and state research institutions and were listed among the top 100 publicly listed high-tech companies at the end of 2001.[32] The research observes the change of ownership and control in terms of the major players involved.

Figure 5: Leading University Spin-offs

	City	**Status**	**No. PLCs**	**Industries**
Beijing University	Beijing	LC	4	ICT, CS, BT
Tsinghua University	Beijing	LC	2	ICT, BT, MT
Fudan University	Shanghai	LC	1	Mixed
Shanghai Transportation University	Shanghai	LC	2	Mixed
Tongji University	Shanghai	LC	1	BT
Zhejiang University	Hangzhou	LC	2	ICT
Nankai University	Tianjin	LC	1	MT
Tianjin University	Tianjin	LC	1	ICT
Dongbei University	Shenyang	LC	1	ICT, CS
Xian Transportation University	Xian	LC	1	ICT
Huazhong University of Sci.& Tech	Wuhan	LC	1	CIMS, MT
Wuhan Institute of Telecommunication Sci.	Wuhan	ML	1	ICT
Yunnan University	Kunmin	LL	1	BT
Chinese Academy of Science	*Various*	ML	2	ICT, BT, MT

[32] All samples are shareholding corporations listed and trade on Shanghai Stock Exchange (SHSE), Shenzhen Stock Exchange (SZSE) and Hong Kong Stock Exchange (HKSE). Data of all companies included in this research project are obtained from the China Securities Regulatory Commission (CSRC) official database and various data relevant to companies.

(LC: Leading Comprehensive University under State Education Committee, ML: Leading University under direction of the Ministry, LL: Leading University under direction of Local government;

ICT: Information Communication Technology, MT: Material Technology, BT: Biotechnology)

SOURCE??

Figure 5 identifies key sample universities in our study. Most universities in charge of publicly-listed companies are leading comprehensive universities under the direction of the State Education Committee (SEC), the rest are either directly controlled by parent industries *(zhuguan bu)* or supported by local government. Almost all sample university companies are located in the regions receiving most government funding for S&T and high tech projects and are mainly engaged in ICT, computing science and biotechnology. As Fig. 4 suggests, the top universities in Beijing and Shanghai have been allocated higher quotas for company flotations.

University PLCs were initiated as university spin-offs as a result of the commercialisation and industrialisation of research outcomes described previously in the paper. They had the following common features from start-up in the 1980s and early 1990s: (i) they started with the constraints of lack of skilled labour, technology and capital, (ii) their products relied primarily on the technology and know-how of the original founders who often were leading academics and employees of the university who remained in their life-long jobs while undertaking commercial activities outside the scope of their formal work, (iii) the founders used offices, laboratories, research students and other university resources for the development of the firm,(iv) their R&D breakthroughs were originally conducted under government programmes, and very often the research outcomes of state-funded projects and (v) the founders normally received no subsequent financial support from the university, although university directors and department heads contributed to the firm through programmes such as the Torch Programme to grant loans to launch the venture, market the products through the university's network and exempt the company from heavy tax.

At the initial stage, given the lack of legal recognition of the ownership rights of such kinds of enterprise and given that the success of the company was as yet unknown, neither the university directors nor the founders of the firm tried to specify ownership details in a formal contract. Neither were there any extant legal norms and institutions on which they could rely. Thus the definition of the nature of these high-tech spin-offs has remained a 'grey area', different from the state-owned enterprises (SOEs) but not legally distinguished from the traditional SOEs nor recognisable as 'collective enterprises'.

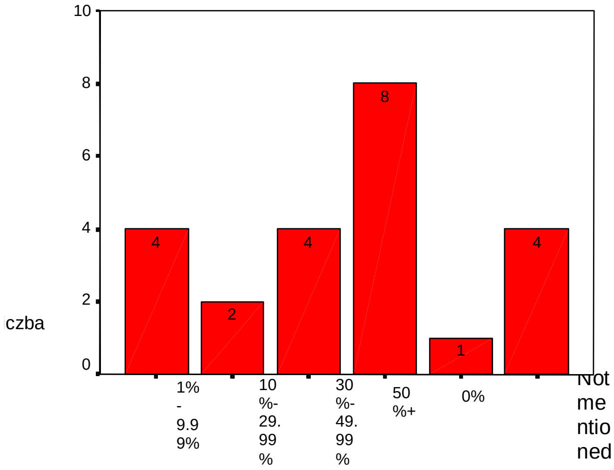
Our empirical study of university spin-offs indicates the *bargained* nature of their property rights. With regard to the right to residual income, from the time the company began making a profit, profit-sharing arrangements were bargained annually and worked out informally through discussion between the university director and the head of the company. Yet with regard to the rights of control and utilization of the company, the founder managers often exercised enormous personal power over the firm. The university exercised a limited degree of control over the appointment of the general manager, often the result of informal bargaining between the university and the appointee him/herself. Ultimately, the university retreated from the productive function, strategic decisions and employment contracts of the company, leaving the rights of control in the hands of the founder. We agree with Francis (1999) that the bargaining of property rights may have helped the spin-offs resolve problems of entrepreneurship, resource allocation, investment, soft budget constraints and other institutional and economic challenges at initial stage while the university authority remained the legitimate owner of the company, often holding the majority share in the company.

The question of fuzzy property rights has led to the difficulty of defining the nature of shares, thus leaving the rights of control and the ultimate owner of company a perennial source of dispute. Figures 6 and 7 show the size of state-owned shareholdings in university PLCs at the year of flotation and current year respectively. The absolute amount of state-owned shares has decreased and the number of companies in which the state shareholding exceeded 50% has dropped from 8 to 2. Twelve of these university PLCs currently leave the question of 'state-owned shares' undefined, compared with only 4 at flotation.

Figure 8 indicates the current largest shareholder of sample PLCs. There are five different titles of shares which are in use to describe, *de facto*, the same type of shares: Designated & State-owned Legal Person, Creator State-owned Legal Person, State-owned Legal Person, Creator State-owned, and State-owned. These terms are used to refer to shares held by governmental agencies or authorized institutions on behalf of the state. The use of different titles incorporating ‘creator’ and ‘legal person’ titles implies the possibility of designating rights of shares to ‘collective’ groups and ‘individuals’. It is not unusual for the same shares which, according to companies’ annual reports, were defined as ‘state-owned shares’ a year ago, to be classified as ‘legal person shares’ or ‘creator legal person shares’ in the next year’s report, or, to be simply left undefined. The solution to the problem, as an exogenous issue, depends on the change of macro-institutional arrangements, which involves further lifting of political and ideological constraints and the evolution of market institutions. As an endogenous issue, its resolution relies on the bargaining power and vision of individual entrepreneurs[33]. The crucial challenge at the current stage is to successfully balance the ‘selective incentives’ for individuals to maintain the ‘collective strength’ of R&D and stimulate further innovation by the reallocation of property rights.

[33] For instance, the process of defining the ultimate owner of Founder Group, which originated from Beijing University, has been going on for three years and still remains unsettled.

Figure 6: State shareholding in the 23 university PLCs researched at year of flotation

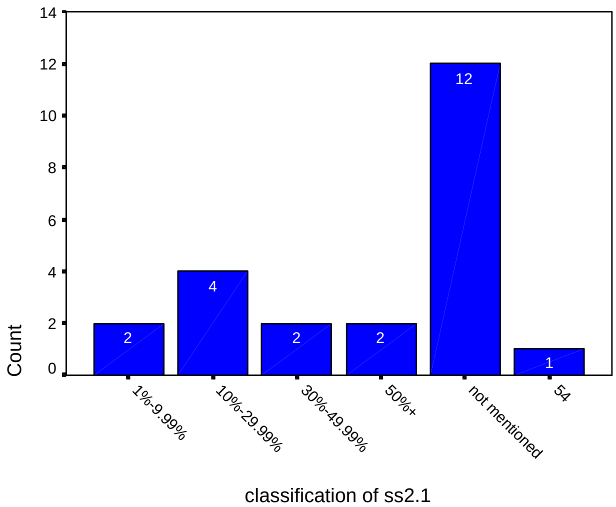


SOURCE??

COULD THESE TWO FIGURES BE PUT TOGETHER INTO ONE FIGURE, WHICH WOULD COMPARE BOTH? THE TWO FIGURES COULD ALSO A MORE INTELLIGIBLE FORMAT.

Figure 7: State shareholding in the 23 university PLCs researched currently

SOURCE??



	Share Title	Shareholder	Percentage	Nature of Share
1	Beijing University High-tech	Shenzhen Beijing University High-tech Investment Ltd	37.94	Designated & State-owned Legal Person
2	Zhong KeJian	Shenzhen KeJian Group Ltd[34]	29.01	Creator State-owned Legal Person
3	Nankai Guard	Tianjin Nankai Guard Group Ltd	47.38	State-owned Legal Person
4	Ziguang Guhan	Tsinghua Ziguang Group Ltd	21.44	State-owned
5	Tianjin University Tianjin Finance	Tianjin University	33.41	State-owned Legal Person
6	Zhejiang University HaiNa	Zhejiang University Enterprises Group Share Control Ltd	62.44	State-owned Legal Person
7	Tsinghua Ziguang	Tsinghua Ziguang Group Ltd	62.11	Creator State-owned
8	Huagong Science and Tech	Huazhong University of Science and Technology	67.95	State-owned
9	Qinniao Huaguang	Beijing University Qinniao Sci & Tech Ltd	25.41	State-owned
10	Tsing Hua TongFang	TsingHua University Enterprises Group	50.4	State-owned
11	Yunnan University Science and Technology	Yunnan University Science Industry and Trade Group	20.95	State-owned Legal Person
12	Founder Tech	Beijing University Founder Group	7.02	Transferable A Share
13	Fudan University Fuhua	Fudan University	32.74	State-owned Legal Person
14	Qinniao Tianqiao	Beijing University Qinniao Ltd	20.88	Legal Person
15	Jiaoda NanYang	Shanghai Transportation University	43.7	State-owned Legal Person
16*	China High-tech			
17	Zhejiang University WangXin	Zhejiang University Innovation Technology Co.Ltd	22.63	State-owned Legal Person
18	JiaoDa Tech	Xian Transportation University Enterprises Group	29	Transferable A Share
19	Tongji Science & Tech	Tongji University	45.16	Creator Legal Person
20	Flame Tech	Wuhan Institute of Telecommunication Sci.	70.49	State-owned Legal Person
21	Dong ruan Gufeng	Dongbei University Software Group Ltd	35.20	State-owned Legal Person & Public
22	Zhongke Yinghua	China Academy of Science Changchun Applied Chemistry Science Ltd	33.36	State-owned
23	Jiaoda Angli	Shanghai Transportation University	16.5	State-owned

SOURCE??

* Table of Shareholders of China High-tech on 2002-06-30

Shareholder	**Percentage**	**Nature of Share**
Oriental Times Investment Ltd	28.24	Legal Person
Fudan University	5.15	Legal Person
Shanghai Transportation University Investment Management Group Ltd	0.28	Transferable A Share
Tongji University	2.92	Legal Person
Beijing Telecommunication University	2.41	Legal Person
Tsinghua University	1.55	Legal Person
Beijing University	1.37	Legal Person
Shanghai Foreign Language University	1.37	Legal Person

5.2. *Public entrepreneurship* for the collective good

Schumpeter (1993[1991]) was the first to explore the entrepreneurial function and its role in social change. The very core of the 'Schumpeterian entrepreneur' rests on the importance of vision and imagination for overcoming uncertainty (Kuhnert, 2001: 14). Kwiatkowski (2002) argues that building elements of entrepreneurial society is vital for post-socialist countries to take opportunities for achieving economic growth.

As stated in Section 4.1 above, almost all directors and top managers of university spin-offs were leading academics and employees of the university who remained in their life-long jobs while undertaking commercial activities outside the scope of their formal work. When they started their businesses, there were no contracts clearly defining property rights and thus there lacked 'selective incentives' for their behaviour. There were costs, not just benefits, and risks at the initial stage of creating a business-oriented organisation from scratch when it was uncertain what the political and economic outcomes and rewards would be. According to one of the basic neo-classical assumptions, 'rational self-interested' individuals are not supposed to act to achieve common or group interests, rather there are attracted by incentives to 'free ride'. In that light, why were those leading academics in China willing to bear the high costs of creating business organisations for the collective good?

We borrow Olson's concept of 'public entrepreneurship' to describe the nature of university spin-offs as discussed above. Relying on the institutional approach involving 'a shift of perspective from the determinism of conventional physics…to the non-teleological, creative, and non-determined nature of evolutionary process' (Buchanan/Vanberg 1991:168), we gain an evolutionary perspective of the growth of university spin-offs and step towards an explanation of the phenomenon.

How did the then institutional framework mould individual behaviour toward socially beneficial decisions and thereby cause individuals to act as *public entrepreneurs*? As Krusselberg indicates: "When a decision cannot be based on incontestable facts, entrepreneurs make use of their own theories about the reality surrounding them, of their value systems, subjective interpretations of received information, and the conclusions they thus derive with regard to their future actions. In this sense decisions under uncertainty always contain a 'political element' (1969: 107, [Kuhnert's translation, 2001])".

The institutional framework directed individuals to socially beneficial decisions. Specifically, the legacy, derived from the Mao period, of pursuing the collective good prior to individual benefit had a crucial influence on their behaviour. However while people were no longer judged politically progressive or backward simply by whether they owned property or how much property they owned as they had been under Mao, they *remained judged* by their political awareness and consequently by *how* they acquired and used their property, and by *ho*w they contributed to the cause of building 'socialism with Chinese characteristics' through their work. We argue that, in this one crucial aspect, fuzzy property rights helped them cope with economical uncertainty: on the one hand, such fuzzy rights allowed the collective unit, not the individual, to bear the prospect of any business failure and on the other, such fuzzy property rights helped individuals to avoid ideological puzzles and constraints which existed during the early stages of reform. The set of institutional arrangements that allowed individuals to take different and even contradictory actions thus helped them to cope with the *ideological* uncertainty of the transition.

According to Shackle (1964:6), human beings are "liberated by the non-existence of any objective future to invent it in an image chosen by them from a range of possibilities constrained only by the orderliness of nature and the facts of their own present circumstances." Kuhnert (2001, PAGE NUMBER?) summarises: "Innovative actions must be based on a mental picture of the future. Ex ante 'opportunities' exist only in the mind of the entrepreneur (White 1990 [1976]:8 – WHICH TEXT DOES THIS REFERENCE APPLY TO?). Thus, the issue is not 'opportunities which others have not yet noticed' (Kirzner 1973:81) but rather the invention of opportunities by a certain subjective way of interpreting the information that is present in one's environment."

In the initial stages of reform, *public entrepreneurs* in China had to deal with 'uncertainty', with the 'imperfect' knowledge of the 'right' way and of the unintended consequences of actions taken to realise desired outcomes. We have identified in our survey that individual rewards for public entrepreneurs in China, particularly in terms of the range of shares for creators and incomes generated from them, varied significantly. In exchange for the investment of their time, resources, skills and capital, they expected power, honour, fame and a change of social status. Some pursued substantial control of the company and began to transform themselves into individual entrepreneurs. Such transformation was not static as it took place under the twin pressures of growth and increased competition. But in order to mobilize investments and opportunities beyond the capacity of relatively small-scale individual firms, individual entrepreneurs developed new forms of shareholding structure associated with mixed ownership and thereby regained 'public' status. And in so doing, those *individual* public entrepreneurs operated to further the *collective* good.

6 Conclusion

The 'New Economy' offers great potential for sustainable economic growth. However the full potential of the 'New Economy' cannot be achieved automatically without establishing a new framework for government and public policy. Less developed post-socialist countries have to cope with the challenges of developing the 'old economy' and fostering the 'new' simultaneously and there is thus a need for government policy to balance the process of 'development' and 'transition'.

Since science-based high technology is the driving force of the 'New Economy', this paper has examined the development of high-tech industries in China in the past two decades in which China's government has taken an active approach to taking the 'new road to industrialisation' and fostering the 'New Economy'. We argue that efforts to move quickly to the theoretically optimal condition may entail unacceptably high social and political costs. Gradualism and pragmatism as key principles of the reform process generally in China have been applied to the evolution of high-tech industries there.

Government policy has explicitly encouraged R&D and commercialisation of technological resources. Subsequence policies, including the National Science and Technology Development Program (863) and the Torch Program, have been adopted to encourage the transformation of accumulated R&D capacity into profit-making ventures. Policies have been implemented both through the extant institutional system and by incorporating new institutions, such as the High Tech Development Zones, whenever it was necessary. Government policies have encouraged the development of high-tech spin-offs from universities and other public research institutions.

We have identified the key 'path-dependent' features of China's high-tech spin-offs: fuzzy property rights and public entrepreneurship. We argue that what is optimal in theory is not necessarily achievable in the real world and that, as a result, the set of institutional arrangements that allows different and even contradictory individual actions to occur may help to cope with the uncertainty of transition. We believe this to have been the case in China in the last twenty five years as it has struggled to come to terms with the New Economy.

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