Growth through Innovation
An Industrial Strategy for Shanghai

Synopsis

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Chapter 1
Introduction and Overview

In broad terms, the sources of economic growth are well understood but relatively few countries have succeeded in effectively harnessing this knowledge for policy purposes so as to sustain high rates of growth over an extended period of time (Commission on Growth and Development 2008; Yusuf 2009).[1] Among the ones that have done so, China stands out. Its GDP growth rate averaging almost 10 percent between 1978 and 2007 is unmatched. Even more remarkable is the performance of China's two leading industrial regions: the Yangtze River (Changjiang) Delta area and the Pearl River Delta.[2] Both these regions have averaged growth rates well above 11 percent since 1985. Shanghai, the focus of this study, is the urban axis of the Yangtze River Delta's thriving economy.[3] Its future performance and that of a handful of other urban regions will determine China's economic fortunes in the coming decades.

Can Shanghai sustain the momentum it has achieved with the help of investment in infrastructure, real estate and industry over the medium term? Are growth rates in the 8 -10 percent range feasible given the stage of urban development it is at and the likelihood that foreign trade might be a less reliable source of future growth? Would an accelerated expansion of the services sector be a desirable step and could the export of services to other countries and to the rest of China partially offset a decline in commodity trade? Could a systematic effort to deepen Shanghai's innovation capacity significantly improve its growth prospects? And if so, what measures and under what circumstances are likely to yield growth promoting outcomes? These are some of the questions which are uppermost in the minds of policymakers in the Shanghai Municipality and in the central

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[1] Easterly and others (1993) showed that for most countries, periods of fast or slow growth have tended to be temporary with countries reverting to a global mean rate after a brief period. The correlation in rates of growth between successive periods is close to zero.

[2] The Pearl River Delta covers an area of over 40,000 sq km and has a population of 41 million (Yusuf 2007). Two-thirds of PRD's GDP comes from just four cities: Guangzhou, Shenzhen, Foshan, and Dongguan (World Bank 2009).

[3] See Yao and Ning (2008) and Hu (2007) for a recent analysis of the industrial dynamic in Yangtze River Delta.

government as they come to terms with a maturing urban industrial economy and the knowledge that cost efficiency will be only one factor contributing to Shanghai's competiveness and dynamism.[4] Success at innovating appeals to all parties because it promises to introduce new products and services, the profitability of which increases with globalization, ways of enhancing productivity, and means of increasing consumer welfare by widening choices and providing better value. Moreover, national market integration and globalization have both increased the returns to innovation. If innovation could be systematized and effectively harnessed by manufacturers and services providers alike, then it would complement and appreciably extend the gains from investment and from progressive improvements in the quality of the urban workforce.

An innovative urban economy is a highly attractive objective and international experience offers some clues as to how it might be achieved. But the current state of knowledge offers only a number of conditions which collectively can contribute to making an economy innovative. There is no short cut: ideas conducive to innovation of all kinds are likely to flourish in skill intensive urban environments furnished with certain kinds of institutions and amenities and which support certain types of economic activities (Glaeser 2009). There are no tested recipes for creating such an environment, however, research is providing some guidance. The biggest challenge is to embed a culture of innovation which nourishes existing growth industries while providing the seeds for new activities which can emerge as the leading sectors of the future.

To sustain adequate rates of growth over the next decade and more and to make a transition to an economy which derives impetus from innovation, Shanghai will need a strategy which builds on its strengths, and through these, develops tradable activities with the greatest potential for innovation capable of generating attractive returns. Identifying Shanghai's advantage in this regard, examining the innovation potential of candidate activities, and indicating how Shanghai can realize their potential, is the purpose of this study.

Shanghai's strengths derive from its size and industrial diversity which are a source of scale and urbanization economies; the competitiveness of several manufacturing subsectors; the emergence of business services; its expanding

[4] Some of the increase, of course, would derive from an appreciation of the exchange rate.

technological capabilities being nurtured by a deepening pool of human capital, by increasing R&D, by FDI in high-tech activities, and by the openness of the city to the rest of the world; and from a growing middle class which is likely to feed a nascent demand for innovation.

With a population approaching 19 million, Shanghai has ample scope for exploiting the productivity enhancing benefits of scale and agglomeration economies.[5] Although some research suggests that the optimal economic size of a Chinese city is reached when population is in the region of 5 million (Au and Henderson 2006), other findings indicate that well managed cities can continue growing in size without encountering decreasing returns. In fact, Overman and Venables (2005) observe that for a city, being too small is more of a disadvantage than being too large. Shanghai is also a remarkably industrialized city. The share of manufacturing in GDP is twice that of Beijing and it is four times greater than Tokyo and six times that of New York. Even forty years ago, manufacturing industries generated no more than a quarter of Tokyo's GDP and a fifth of the GDP of New York. Shanghai's manufacturing sector moreover, is highly diversified. Of the top six manufacturing subsectors, four comprise equipment of various kinds: general, communications, electronics and transportation. If to these are added special purpose equipment and instruments and office equipment, together these account for 55 percent of industrial GDP. Metallurgical and chemical industries together contribute 25 percent of the output with industries producing textiles, food, furniture, paper, plastic and wood products making up the rest. The strong export orientation of the leading industries is a good indicator of their competitiveness. With this product mix and industrial diversity, Shanghai can reap the benefits of urbanization economies and also the advantages accruing from a strong focus on industries producing complex capital goods, high technology components and key industrial materials. These industries have multiple linkages with other sectors, and have a history of high productivity growth and of R&D intensity. A comparison of the scale and composition of Shanghai's industrial activities with those of Tokyo suggests that it is better positioned to maintain a strong

[5] This is especially so because the population density is also high, and agglomeration economies, especially the induced accumulation of human capital, are particularly beneficial at earlier stages of development (Brülhart and Sbergami 2009). In addition, Shanghai is advantaged by its location at close to the mid point of China's coastline (Lu 2004).

industrial lead well into the future by complementing its technological capabilities with the capacity to innovate, even as wages and land costs rise and certain kinds of labor intensive industries migrate to other parts of China and to other countries. Moreover, the crisis of 2008-9 and the industrial restructuring it has triggered in China and throughout the world economy, increases the opportunities for radical innovations by dynamic firms (Bers and others 2009),[6] and for an acceleration in labor productivity. Between 1995 and 2003, industrial reform which catalyzed the restructuring of industrial enterprises and a reallocation of resources, contributed over 40 percent of the annual 20 percent increase in labor productivity. There remains scope for further reallocation and "creative destruction"[7] in Shanghai and a closing of the 'efficiency gap' between Chinese firms and their overseas competitors which could deliver a continuing productivity bonus over the course of a decade.[8]

Shanghai is currently pursuing a strategy which is attempting to raise the salience of finance and business services in GDP.[9] Shanghai is also seeking to increase the share of life sciences, advanced materials, and nano-tech based activities in manufacturing. The importance given to services and the effort to make Shanghai into a financial and logistics hub is similar to the approach adopted in the past by other global cities and has well established precedents.

This study argues, however, that a high growth strategy which puts technology upgrading and innovation at the center might warrant a different approach from the one currently favored. It derives from the experience of global cities such as New York and London and the empirical research on industrial performance and on innovation. This has yielded four significant findings: First, monosectoral services based economies grow slowly because they benefit less from increases in productivity and from innovation.

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[6] Two examples of firms which have made remarkable strides in cost innovation are the battery maker BYD which has drastically reduced the prices of lithium ion cells; and Zhongxing Medical which has scaled down the costs of direct digital radiography (Williamson and Zeng 2009). BYD is now eyeing the electric car market based on their strength in battery technology. It is currently employing 5,000 battery enginners and 5,000 automotive engineers ("China Vies" 2009).

[7] This creative destruction will lead to the disappearance of weaker companies and of the considerable excess capacity in several industries (See Foster and Kaplan 2001).

[8] J. Zheng, Bigsten and Hu (2009). See for instance the comparison by Crafts and Toniolo (2008) of productivity differences between the U.S. and European countries.

[9] The services sector was given priority by the Shanghai authorities starting with the Shanghai's 8th Five Year Plan (1985-1990).

Second, manufacturing industries producing complex capital goods, electronic equipment, and sophisticated components are more R&D intensive, generate many more innovations, are more export oriented, have a solid track record of rising productivity, and having achieved competitiveness, are in a better position to sustain it because the entry barriers to these industries tend to be higher. By giving rise to dense backward and forward linkages these industries can serve as the nuclei of urban clusters and maximize employment generation. Third, industrial cities create many more jobs for a middle class and tend to have a more equal distribution of income than cities which are dominated by services. Fourth, and finally, cities with a world class tertiary education and research infrastructure linked to industry, are more resilient in the face of shocks, more innovative, and better able to reinvent themselves (Glaeser 2005;2009).

These findings and others motivate the proposal for a strategy which has four elements:

- Shanghai should aim for a balanced economic structure with manufacturing activities continuing to account for a quarter or more of GDP. While the growth of business services is a welcome development, Shanghai's objective should be to maintain the presence of key manufacturing sectors in the periphery of the core metro area, and to promote their competitiveness. The focus should be on complex capital goods and associated components whose productivity, profitability, and competitiveness are more durable. The city should encourage the life sciences, new materials, and electronics while recognizing that these are subject to long gestation lags and might not generate significant profits or employment and contribute modestly to growth. A balanced approach is more likely to lead to sustainable growth with equity and sustain a diverse urban population. It would call for a rationalizing and recalibrating of incentive policies for industry affecting land use, cost of inputs, and tax obligations so as to avoid a narrowing of the incentives for industry relative to services or other activities.

- An innovative economy will be a function of what kind of industry flourishes in the city and the strategy and dynamism of the leading firms (many of which are currently SOEs) – because innovation is industry specific and large firms conduct the bulk of the research. There is little correlation between innovations and spending on R&D by firms, hence incentives for R&D are subject to diminishing returns. An innovative economy will also depend on the quality of the leading universities and how they contribute to the intellectual culture of the city. Aside from aiming to attract the best talent, universities must view teaching and basic research as their primary missions. This is how they can most effectively serve the knowledge economy and enhance the demand for innovation. Downstream applied research which could have commercial applications should be – as it is in the advanced countries – a secondary and for the majority of universities, a relatively minor objective.
- Education and medical services can be the basis of two important research-cum-industrial high-tech clusters. As the experience of Boston and San Francisco has shown, tertiary education and health services, if they are world class, can be immensely profitable sectors which generate demand for other business services, can become leading exporters, give rise to significant idea spillovers and induce the entry of new firms.
- Shanghai's innovativeness will depend in part on its openness to ideas, and people, and on its livability, which attracts and retains highly skilled and mobile knowledge workers. It will also be influenced by the city emerging as an intellectual leader among the global centers with its own distinctive vision and strategic initiatives. The current real estate driven development is leading to sprawl, automobility, the multiplication of residential towers with limited recreational amenities, and to gated communities, all of which threatens the cultural, aesthetic and environmental attributes of the city, not to mention its social capital. Other world cities have gone down this road are now having to reinvent themselves and to redefine livability and cultural capital, emphasize

compactness and dynamic mixed use neighborhoods, put a premium on amenities, and to minimize their environmental footprints.

The financial crisis and the global slowdown that started in 2008, have brought the world economy to a crucial juncture. There is need to interpret afresh for the purposes of policymaking, the past trends, stylized facts and lessons from the experience of the developed world, as well as the direction, pace and characteristics of urban development in China. This is a time for global economic consolidation and a rethinking of strategy for Shanghai (and China). Views - and past findings - regarding the roles of industry and services and policies to "rebalance" the economy could usefully be reconsidered. In the years ahead, the opportunities for China might be different and greater if it exercises strategic foresight in fully harnessing its economic potential and advantages. The major economies of the world are in for an industrial shake-out. Many firms will close their doors and industrial capacity will be redistributed throughout the world. This outcome – which will be painful - represents a great opportunity for Shanghai to strengthen its economic base. No other major industrializing country has the nascent urban centers, the savings, the low indebtedness, the accumulated industrial capabilities, the elastic supply of human capital and the momentum which China (and Shanghai) does to discover growth opportunities in these challenging times.

A new development strategy should include three additional objectives. First, because Shanghai's current and future comparative advantage lies in complex capital goods and high tech components among others, it needs to ensure that these sectors survive and emerge stronger and better positioned to compete and to expand their shares of the global market.[10] This requires that they have access to the resources to last out the downturn, sustain capability enhancing investments and add to their technological capacities. Certain capital goods sectors are likely to benefit from the investment in physical infrastructure which has strong policy support in China and the world. Second, this might be a time to very selectively acquire production, research, and intellectual

[10] The mid-term evaluation of the 11th Five Year Plan of China (covering the time period 2006-2010) reveals that while the growth of high-tech industry has been impressive, it falls short of expectations. The target was for high-tech industry to account for 10 percent of the value-added. However, by 2006 its share was 5 percent and a doubling in four years is unlikely (World Bank 2008b).

property related assets from foreign companies which are going out of business, as well as critical tacit knowledge and brand names. Third, this is also the time to move faster with the transition out of those industrial subsectors in which Shanghai's comparative advantage is vanishing and to channel the resources from these sectors to others with better prospects, as well as to redouble the efforts to retrain and equip the human assets released by these subsectors so that they can be absorbed elsewhere in the economy, once recovery begins. Such a transfer of resources will provide a welcome boost to productivity and reduce the overhang of excess capacity in light industries.

The next chapter presents the strategy suitable for Shanghai to sustain its growth and the reasoning behind selecting the key components of the strategy.

Chapter 2
Making Shanghai's Industries Innovative

I. Urban Strategy and Policy Directions

China's central and municipal authorities are actively promoting the development of technological and innovation capabilities which will help urban centers to upgrade existing industries and to extend their comparative advantage to new industries with higher profitability and better growth prospects.[1] Shanghai is at the epicenter of these efforts. Starting in the mid 1990s, Shanghai launched a program to develop six pillar industries. These being: information, finance, trade, automobiles, complete sets of equipment, and real estate. More recently it has turned its attention to building business services with an emphasis on finance so as to eventually make Shanghai a world city akin to New York and London.[2] In pursuance of these strategic initiatives, Shanghai is also actively addressing the factors that affect technological adoption, deepening, and innovation. By strengthening the individual components of a 'municipal innovation system' and its linkages, Shanghai seeks to accelerate industrial change in directions that will be advantageous for growth and employment.

Space and data limitations make it impossible to evaluate the effectiveness of existing fiscal and financial incentives given to pillar industries and to enhance Shanghai's innovation capacity. However, a listing of the major incentives in Table 2.5 suggests that they are comprehensive, and comparable to incentives provided for high tech industrial development in the OECD countries. Given the uncertainties regarding the effectiveness of these instruments, adding to the list of incentives or making current incentives more generous, may not be desirable. Moreover, the feedback from interviews conducted for this study indicates that neither industry nor research entities are pressing for additional fiscal or financial incentives.

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[1] Technology policy will require the coordinated action of national, provincial and local governments. The near term objectives need not be system wide innovation but innovation in specific industries and fields and in specific geographic locations.

[2] New York and London are the most competitive cities in the world. Shanghai ranks 41st and Beijing 66th ("Urban Competitiveness" 2008).

What we propose here is a partial reorientation of Shanghai's development strategy based on the findings and views presented in earlier chapters and factoring in Shanghai's industrial assets and capabilities. The intention is, paraphrasing Paul Romer (1993), to introduce better recipes and not just to engage in more cooking. This strategy would:

- Emphasize a balanced development of manufacturing and services to maintain the share of manufacturing in municipal output in the 25-30 percent range over the longer term.
- Prioritize activities with reference to longer term profitability, local linkages and value added, and scope for incremental innovation and export prospects.
- Encourage process innovation (over the medium term) by leading firms in the principal industries over radical product innovation in new high tech areas. On this, the large firms must take the lead,
- Promote tertiary education and healthcare, and cultivate strong linkages between these services industry and other industries,
- Focus on the quality of workers and entrepreneurs so as to prepare them to contribute more actively to innovation.
- Create a culturally rich, aesthetically pleasing, and efficient urban environment so as to attract and retains high value adding economic activities and an increasingly affluent and educated workforce.

Balanced development

For the purposes of growth that is fuelled by productivity and innovation, Shanghai needs to pursue a two pronged approach. One prong would rely on fiscal, land use, skill deepening, and innovation policies to sustain those industries which by virtue of accumulated tacit knowledge, product customization and differentiation, multiple linkages, research intensity, potential for innovation and high entry barriers, have sound long term profitability, although as in 2009, they may go through cyclical downturns. Several of these industries are likely to be ones producing complex capital goods,

components and processed materials. Others at the research intensive end of the spectrum, might trace their technological lineage to the life and the nano sciences or to IT sector or be engaged in developing advanced materials and their competitive strength will depend upon their ties with research centers. What matters more is not only an industry's research intensity but its profitability and the capacity to sustain profitability through a variety of measures, among which innovation in a variety of areas could play a prominent role (Porter 2008). Industries can be research intensive but may struggle to generate a pipeline of products and to achieve profitability as for instance biotechnology, in which case it is far from obvious that they deserve priority over less technologically glamorous industries that are reliably profitable. The drugs introduced by the biopharmaceutical firms (or firms producing advanced materials) take 10 to 15 year to reach the market, cost, development costs as much as drugs introduced by pharmaceutical companies – that is, $800 million to $1 billion – and biotechnology has made it no easier to discover new and effective drugs. What discoveries (which have spawned new sub-disciplines), and new techniques have uncovered are new layers of complexity requiring inter-disciplinary effort but without any short-cuts. Small doses of venture capital while sufficient for chip design, web based technologies and software, are no more than drops in the bucket for biopharma firms. The U.S. experience cautions against putting too much store by high tech industries. Since 2000, employment in the computer and electronics subsectors has stagnated and the web based and media industries have generated little new employment. Other high tech stars such as biotechnology have yielded new products but breakthrough discoveries have been rare. Nanotechnology has considerable promise but again the commercial successes of nanotech research have been modest and slow to materialize even though U.S. researchers and companies are in the forefront ("Can America Invent" 2008; Pilkington and others 2009).

A balanced portfolio of manufacturing industries for Shanghai would assign the highest weights to the machinery, electronic components and processing industries (assuming that the pollution these cause can be contained through regulation coupled with technological advances). It would assign lower weights initially to the research intensive life and nano sciences which have abundant potential but are slow to generate highly profitable products commanding global markets. Supporting these industries

makes good strategic sense and safeguards future options. Nevertheless, a realistic appraisal of their contribution to the local economy is needed to ensure that they do not divert an excessive amount of capital and research talent from the backbone sectors.

China and Shanghai, have demonstrated a strong and growing comparative advantage in manufactures (see Table 2.1). China has comparative advantage in more than one third of commodities that it exports.[3] By building upon this comparative advantage, following the past example of Germany, Japan, and Korea, China can deepen and extend this advantage into higher value added and knowledge intensive products, thereby increasing its export shares in the more profitable segments of the international market for manufactures. Figure 2.1 shows the product space for China. "Product spaces", pioneered by Hausmann and Klinger (2006), assumes that each commodity produced gives rise to different opportunities for future diversification. That is, some products offer easier and multiple diversification paths to other related products while others do not. In general, primary and resource-based products do not lead to many opportunities for diversification. By contrast, manufacturing goods such as electronics generate skills and assets that are similar to those required for the production of other manufacturing commodities, and hence are classified as high value products. The x-axis is the inverse of the density (i.e. closer to the origin indicates higher density) and the y-axis measures the difference between PRODY and EXPY (i.e. a positive number means "upgrading" in a sense of exporting more sophisticated commodities relative to the overall export basket). The commodities that are in the area of high density are mostly higher valued commodities such as engineering and high technology goods among others (see Table 2.2).[4]

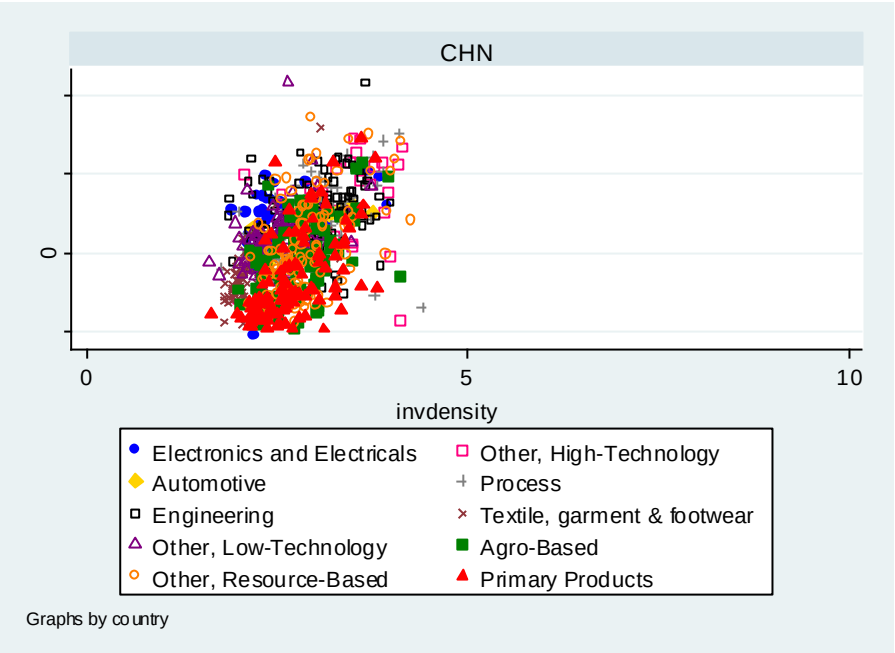
[3] In comparison, Malaysia has comparative advantage in 16 percent of the products that it exports.
[4] The discussion in this section focuses on the "upscale" goods i.e. PRODY-EXPY are both positive.

Table 2.1: Exports of China and the Share of Commodities in which China Has A Comparative Advantage

	1995	2000	2006/7
Number of commodities exported by China	766	763	763
Number of commodities that China has comparative advantage	274	279	278
	(35.8%)	(36.6%)	(36.4%)

Note: There were about 780 products exported by at least one country each year.
Source: Authors' calculations

Figure 2.1: Product Space for China, 2000-2004



Source: Authors' calculations

Table 2.2: Selected "upscale" commodities with highest density in China, 2000-2004.

Product Name	Product	Density	Tech	PRODY - EXPY
Other sound recorders and reproduce	7638	0.537294	mt3	4765.33
Television receivers, monochrome	7612	0.524965	ht1	5388.19
Optical instruments and apparatus	8710	0.483351	ht2	10039.76
Peripheral units, incl.control & ada	7525	0.478158	ht1	5142.37
Microphones, loudspeakers, amplifiers	7642	0.472566	ht1	1301.51
Printed circuits and parts thereof	7722	0.468498	mt3	2855.42

Source: Authors' calculations

With the global downturn in economic activity which began in 2008, firms in the industrialized countries are abandoning certain types of manufacturing activity – as is the

case with many *mittelstand* in Germany.[5] This is opening up lucrative niches in the global market place.[6] Chinese firms can occupy these niches. Furthermore, many firms are in dire straits, which represents an opportunity for Chinese firms to acquire needed technology (codified and tacit), intellectual property, brand names, and market access.[7] The government can facilitate this process by improving access to financing however, the ultimate outcomes will depend upon the initiatives of the firms themselves, the receptivity to such takeovers in the OECD countries and the capacity of Chinese firms to absorb technology – and in some cases foreign firms. Chinese firms which will spearhead this process are more likely to succeed with manufactures and services associated with manufactures, than with services, because they already have a head start and have an export product mix comparable to advanced countries (see Table 2.3).[8] And among Chinese cities, Shanghai with its well developed industrial capabilities can emerge as a leading global producer and exporter of the technology intensive, high end manufactures. This is not to deny the contributions that services and the export of services can make to Shanghai's economy. They can be vital complements.[9] However, even impersonal services are inherently less export intensive,[10] and East Asian and international experience suggests that acquiring an international brand name in services and a sizable global market share, is harder because of entry barriers and takes longer.

Manufacturing employs 32.5 percent of Shanghai's workforce. This is a high percentage and many of these jobs are for skilled, middle aged workers who are relatively well paid. The availability of employment on such a scale, buttresses Shanghai's prosperity but there is more to it than that. Capital and skill intensive manufacturing activities also affect the income distribution in the urban area helping to provide the

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[5] In 2003, Chinese firms acquired 278 small and medium sized German firms (Zeng and Williamson 2007).

[6] The US is the leader in only five product categories: computer hardware, software, biotech, aerospace, and entertainment. ("America's Decline" 2008).

[7] Samsung was unable to develop or acquire the necessary semiconductor technology until Micron Technology was in a financial distress and willing to make this available (Nabeshima 2004).

[8] Even though China exports a similar bundle of goods, there may be substantial quality differences within each commodity. For instance, average unit values of Japanese exports are 2.9 times of China's, suggesting that Japanese exports are of higher quality (Fontagne, Gaulier and Zignago 2008).

[9] As a matter of fact, as incomes rise, so does the share of the services industry. Because of its larger share, the growth, especially that of productivity, in services would be desirable. However, it is unlikely that reliance on services sector alone would enable a city (or a country) to achieve growth rates in 6 to 8 percent range.

[10] Export of services to other parts of China is likely to become a growing business for firms in Shanghai.

crucial middle layer of income earners which are the vanguard of China's consuming class and whose growth is also a way of checking income inequality. Manufacturing is an urban balance wheel, maintaining growth with equity and the urban economic diversity which is at the root of urbanization economies.

Table 2.3: Export Similarity with OECD

	1972	1981	1991	2001
Asia	0.16	0.20	0.26	0.27
China	0.09	0.28	0.55	0.75
Latin America	0.22	0.22	0.31	0.34

Note: Asia excludes China. The export similarity is calculated as the overlap of export commodities to the United States from OECD and China (and other regions), with 0 being no overlap and 1 being complete overlap.
Source: Schott (2006)

I-O data for China shows that capital and knowledge intensive manufacturing activities give rise to a multiplicity of backward and forward linkages supporting a vast number of suppliers of products and services. From the I-O tables we can see that transport equipment manufacturing to take one example, is linked to and sustains a wide spectrum of activities, several of which contribute to innovation and technological progress. The cumulative contribution of the activities associated with transport equipment subsector to growth for example, is highly significant. Manufacturing is also strongly linked to the logistics/transport sector that is a key industry in Shanghai.[11] Manufacturing and logistics are mutually reinforcing and together comprise the principal growth pole of Shanghai's economy. In 2006, out of 100 million TEUs of containers handled in China, 21 million were by Shanghai's ports ("A Failure to Keep" 2007). With one of the busiest ports in China, and a new deep seaport, the opportunities are there for the domestic logistic firms to develop intermodal capabilities and become world class players.[12,13]

[11] Shipbuilding is now a booming industry in the Yangtze River Delta with sound long-term prospects.
[12] Unlike some other industries, the logistic industry is still rather fragmented. The top 10 logistics firms accounted for less than 40 percent of the global share in 2006 ("Where Winners" 2007). This provides some opportunities for a new firm to enter the global market since MNCs are now looking for logistics firms that can operate globally. One such firm, Shanghai International Port Group has acquired terminals in Belgium as a first step to becoming a global container operator ("A Very Solid Foundation" 2007). A

The supplier networks which are at the heart of the transport, engineering, and electronics industries are a significant source of value-added and of technological advances. Very likely the survival of suppliers many of which are small and medium sized firms that co-create components and modules with the final assemblers and provide just-in-time services, will determine the future of these industries in Shanghai. Safeguarding the health of the supply chain has always been a consideration, but in a downturn, it takes on added significance because smaller firms servicing narrow markets, are less resilient in the face of demand shocks. With market demand shrinking and credit becoming harder to obtain, specialized component suppliers struggle to survive, and the weaker ones will close their doors.[14] Assisting the majority to weather the recession and also strengthening the foundations of the parts manufacturing industry calls for three types of measures: credit programs catering to firms which are critical nodes in the supply chain and ones with substantial technological capabilities; encouraging consolidation of small firms with overlapping product lines into more viable units;[15] and the provision of industrial extension, financial and labor training services to small firms so as to bolster their productivity and widen revenue margins.

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strong logistics sector can in addition, stimulate financial and insurance transactions as was the case in London and New York.

[13] The logistics sector is an important source of earnings and employment in cities such as Miami and Los Angeles. For instance, the Miami International Airport directly and indirectly has created nearly a quarter of a million jobs for the Miami-Dade county area and its annual economic impact via tourism, international banking, and trade in 2006 was estimated at $19 billion. The ports of Long Beach and Los Angeles directly employ 280,000 workers and indirectly support the employment of another 900,000 in the Southern California region ("California's Wipeout Economy" 2009).

[14] In 2008, about 300,000 factories ceased their operations, often abandoned by the owners, leaving creditors and workers unpaid ("As Factories Fail" 2009).

[15] In December 2008, the Chinese government has relaxed the financing rule to allow firms to borrow from banks for the merger and acquisition of firms in the same line of business (in the past, the funding must come from retained earnings, issuing of more stocks or bonds). This has led to some of the cash-rich state-owned enterprises to acquire weaker rivals whether they are state-owned, privately held, or located abroad, especially in strategic industries such as steel and automotives. For instance, Baosteel acquired Ningbo Steel and Baotou Steel through a loan ("China: Pace of Mergers" 2009). The Chinese government is also planning reduce the number of automotive makers from 14 to 10 by 2011 through mergers ("Beijing Drives" 2009). Even though at the same time, the Chinese government is restricting M&A activities, especially those by foreign firms through the anti-monopoly law which became effective on August 1, 2008 ("Deals on Hold?" 2008). Although the Ministry of Commerce approved the InBev's acquisition of Anheuser-Busch, it imposed restrictions on InBev from further increasing their shares in Tsingtao Brewery and Zhujiang Brewery and prohibited from buying shares of two other Chinese breweries ("InBev Ruling" 2008). The Ministry of Commerce prevented Coca-Cola to acquire Huiyuan Juice, a leading juice maker in China ("Beijing Scuppers" 2009).

Rethinking the Role of Finance and Business Services

Although the share of services is bound to increase because of trends in demand and in relative prices, it is desirable that over the foreseeable future services should complement and not massively displace industry. The experience of Japan and Germany suggests that even though the services have greatly enlarged their share of GDP, the prosperity of these countries and their positions in the world of trade continues to rest on their advanced manufacturing industries.[16] It is the high productivity of these industries which supports myriad services activities (whose value added is far lower and which have failed over almost two decades to catch-up with equivalent activities in the U.S.), and it also enables Germany and Japan to maintain favorable trade balances. By comparison, it is the relative decline of manufacturing which is partly to blame for the trade deficit the United States confronts and which it will need to narrow. Furthermore, balancing the portfolio of producer services with manufacturing industries minimizes the damage inflicted by shocks affecting particular activities, and can with appropriate coordination, give rise to many more growth promoting linkages.

The international experience with the development of major clusters of financial and business services is mixed at best. From a national perspective, financial development is definitely a plus. Financial development which increases the institutional stake and leverage of insurance companies, pension funds, and others in publicly listed corporate entities could in a competitive global environment, encourage innovation and improve corporate governance (Aghion, Van Reenen and Zingales 2009).[17] It is also associated with stronger economic performance. Whether finance and business services can be an effective growth engine for mega cities is less obvious. Only New York and London can be classified as major world class finance-cum-services centers. They are trailed by Tokyo and on a lesser scale by Hong Kong and Singapore. Cities such as Paris, Frankfurt, Zurich and Sao Paolo do not make the cut. The scale, diversity and export of services from these secondary regional centers are much more limited. Finance and business services are the drivers of growth in New York, London and to some

[16] This reliance is also the cause of much economic grief because of the global recession in 2009.

[17] However, examining the growth experience of Japan, Korea, and Taiwan (China), Liu and Hsu (2006) find financial development under globalization did not have positive effect in all aspects. Especially, capital outflow from these economies had a negative impact on their growth.

degree, in Tokyo but in each case, these have generated only quite modest rates of growth for the city as a whole and much of the income gains have been reaped by a small segment of the workforce. Higher growth in other cities with a services orientation depends upon the push provided by alternative sources of growth such as manufacturing and logistics.

Research on the effects of financial deepening suggests that short term financial objectives can crowd out longer term real investment through two different channels. The first channel is the crowding out of real investment by an increase in the investment in financial assets (Crotty 2005). Many non-financial firms have invested in financial assets and financial subsidiaries in recent years, to the point that they hold as many financial assets as physical assets and significant amount of profits are derived from these financial assets (Orhangazi 2008).[18] Short-term focus is the second channel. Increasing numbers of managers have adopted the "portfolio view of the firm" with emphasis on the deployment of firm's assets for the sake of short-run returns.[19] This change in the view stems from several institutional development relating to corporate governance such as the increasing use of stock options as a part of the compensation package; more emphasis on the shareholder value[20] rather than the long-term viability of firms; and the impatience of investors. These two channels together have made firms focus on meeting "the short term objectives of financial markets rather than in the long term growth of the firm" (Orhangazi 2008, p.870). Management emphasizes the distribution of revenues so as to raise the company's stock prices and thereby enlarge the value of stock options (p.869).[21] When "financial markets undervalue long term investments, then managers will undervalue them too as their activities are judged and rewarded by the performance of the company's assets" (Orhangazi 2008, p.871).[22]

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[18] As early as in 1965, Tobin (1965) recognized that financial and real investments by firms can be substitutes. This is especially so when the returns from financial investments are higher than that from real investments.

[19] This changed the corporate strategy from "retain and reinvest" to "downsize and distribute" (Lazonick and O'Sullivan 2000).

[20] See, for instance, Grossman and Hart (1999) on the origin of the shareholder value.

[21] Buying back stocks is one of the often used strategies to increase share prices. This again diminishes the resources available for real investment (Grullon and Michaely 2002; Lazonick and O'Sullivan 2000).

[22] Jack Welch, the former CEO of GE made headlines in March 2009 when he claimed that "shareholder value is the dumbest idea in the world! It is not a strategy; it needs to be an outcome."

The financial crisis which started in 2008, has suspended a question over the value added by financial innovations – and the longer term contribution of finance to urban development. It has underlined once again, the difficulties in regulating increasingly sophisticated activities and the powerful vested interests they create, so as to avoid serious financial shocks which have painful consequences for the real sector. It is also raising questions as to the longer term stability of an economy overly dependent on consumption as the main driver of growth, especially when such consumption is substantially facilitated by financial innovation and financial depth which makes consumer credit more widely available at attractive rates and has the unfortunate side effects of burdening consumers with debt and giving rise to real estate and other asset bubbles.

Cities such as New York and London, but also some of the regional financial centers, are discovering the risks of excessive reliance on financial and affiliated business services. Moreover, the longer term shape and pace of financial development is less clear given the seriousness of the 2008-9 crisis and the doubts it has cast on the economic gains to be derived from current financial instruments, practices and forms of organization as well as the concerns it has aroused regarding the political power accumulated by the financial sector.

Undoubtedly finance and business services will retain a major role in urban economies, but for a city at Shanghai's level of development and with Shanghai's growth aspirations, it may be desirable to reconsider the importance attached to the financial sector and associated business services in future growth strategy.

From the perspective of rapid and sustainable growth, it might be desirable to groom a suite of tradable producer services, selecting those that directly or indirectly support a range of manufacturing-related activities. Aside from finance, tertiary education, healthcare and engineering services, may be well suited for Shanghai's strategic objectives.

Inducing Innovation: Demand Pull and Supply Push

Innovation capability arises from a matrix of elements with no clear rules for their combining. Increased spending on research is only one ingredient, an important one

doubtless but far from being enough. The quality and experience of researchers and the availability of state of the art facilities noted earlier, is a second element. The deliberate creation of spaces – science parks and incubators – so as to nurture activities which could quicken the technological change is a third. Institutions protecting intellectual property rights and incentive mechanisms for firms and researchers to innovate through monetary and other rewards are a fourth.[23] Regulations and standards which induce firms to develop and introduce new technologies is a fifth factor. For example, environmental regulations supported by publicly financed R&D have promoted innovation in a number of fields and the diffusion of technology.[24] A culture of enquiry, one which assigns a special significance to individuals who innovate, is a fourth factor. And sixth is an urban environment which is conducive to the pursuit, exchange and refining of new ideas and where commercialization of innovations is actively promoted. Shanghai's policymakers are working on all these registers, however tangible evidence of innovativeness is materializing slowly as experienced researchers, intermediaries and VCs aggregate into critical masses and an innovation culture jells within an enabling urban environment. Typically there is a strong desire to hurry the process along.

Governments' Efforts to Encourage Innovation

One avenue to an innovative manufacturing sector actively pursued in Shanghai, leads to science parks. Shanghai has a number of parks which offer tax and financial benefits, incubators providing space services and seed money, extension services, multiple special funds for different categories of firms, bonuses and prizes for inventors, subsidies for patenting and scholarships and grants for researchers, not to mention tax holidays and depreciation allowances for R&D spending and high tech firms. The question not being asked insistently enough is whether these are producing the desired results, which of the incentives are most effective and deserve to be expanded; and which

[23] In this regard, China may want to consider centralizing the appeal process to a single specialized IP court to facilitate the further development of IP market. The experience in the United States have shown that the establishment of such an IP court has led to reduction in the duration for settlements and judgments at the lower courts. The establishment of a single appeals court has clarified the scope and the extent of IP protection, proving much more certainty to the outcome of the trials relative to the case where judgments can range widely depending on the jurisdiction of the court (Galasso and Schankerman 2008).

[24] See Popp, Newell and Jaffe (2009) for a comprehensive survey of the findings on environmental regulation and its technological spillovers.

wound down.[25] Absent such a disentangling and assessment of the incentive regime in Shanghai, it is difficult to determine whether existing measures are yielding good returns and to indicate how these might be augmented, especially given the prevailing economic circumstances. Casual empiricism would suggest that the incentives to induce innovation are expensive and thus far the returns have been meager. For example:

- In principle, science parks can lead to productivity gains from idea spillovers through agglomeration and reduce the wasteful duplication of research and induce older firms to sustain their patenting efforts. Successful parks also promote networking and co-creation of innovations by linked firms.[26] A study of new technology based firms in Hsinchu Science Industrial Park showed that the elasticity of R&D with respect to outputs was greater for firms in the park than in firms located outside.[27] The study also found that park based firms invested more efficiently in R&D (Yang, Motohashi and Chen 2009). How successful the parks in Shanghai are with respect to specific metrics of networking, productivity and innovative performance, requires detailed research supported by abundant data. What emerges from the interviews conducted is that science parks periodically change their objectives and are focused more on attracting firms and maximizing exports than on technological advancement. Furthermore, the links between firms in Zhangjiang Park and universities are relatively weak in part because most universities are some distance away in Puxi and only the Shanghai Chinese

[25] Tax exemption credits and rebates as a means of stimulating R&D spending have been most extensively analyzed in the U.S. The results tend to be mixed, although on balance, tax credits show some results. A study of nine OECD countries found that a dollar's tax expenditure increased private spending on research by one dollar over the longer term, suggesting that tax incentives as distinct from direct public spending on R&D are superior, if the private sector is more efficient at allocating resources for research and/or private research produces more spillovers (Hall 2001; Yusuf, Wang and Nabeshima 2009). In sum, the limited empirical evidence on the role of tax policy does not make a strong case for such incentives (Bloom, Griffith and Van Reenen 2002; Klemm 2009; Yusuf, Wang and Nabeshima 2009).

[26] See Gerlach, Rønde and Stahl (2009); Squicciarini (2008); and Martin, Mayer and Mayneris (2008) who note that in France, productivity gains follow a U shape and decline as concentration raises congestion costs.

[27] Yang, Motohashi and Chen (2009, p.81) maintain that output elasticity is a more appropriate measure than patent elasticity, because the ultimate objective of firms is to increase profits and they will do this by suitably allocating their R&D spending to promote process and product innovations.

Medicine University is adjacent to the park. Inter-firm collaboration is also quite limited with Chinese owned firms being more skeptical than foreign invested ones and firms run by individuals with overseas training or experience. Chinese owned firms preferred to do most of their R&D in-house for fear of loss of intellectual property. Competitive pressures appear to be overriding the advantages of collaboration.

- The quality of innovation being supported by incubators is difficult to judge and without a thorough evaluation of the graduates from incubators, it is impossible to say which of these programs is working and why.
- Developing networked clusters of firms in industrial parks is one way of building innovation capabilities and creating a base of suppliers which draw large MNCs, and partner with foreign firms in building competitive strength[28]. Such networked clusters have yet to emerge in the leading parks and neither our interviews nor the published research suggest that they have begun to germinate. A related concern is that few experienced engineers and technicians are leaving MNCs to start their own firms.

The increased funding for R&D and the inducements of patent and write papers in scientific journals has produced a surge in output. But the worth of this output, in particular the longer term commercial value of the findings, is uncertain: Too many researchers might be engaged in inconsequential research. Quantity may be trumping quality.

Given how short a time has elapsed since the surge in research commenced in the late 1990s, it may be another decade before the research capital which is accumulating begins to yield a harvest of innovations. In the meantime, Chinese firms might most usefully upgrade their technological game increasing their familiarity with best practice and how to push it a notch higher. For this purpose, the creation of a "Vision Group" by the municipality to screen and synthesize the new knowledge on how the leading Chinese

[28] Such clusters of specialized engineering firms were responsible for the emergence of Detroit as the center of auto manufacturing in the United States in the early twentieth century, other clusters account for the reputation of the textile, ceramic and furniture based industrial districts in Italy, and of the electronic clusters in Silicon Valley and Hsinchu Park. Clusters are advantageous also because they provide the fertile soil for the emergence of new firms (Quigley 2008).

and foreign MNCs operating in China are pursuing innovation, could be desirable step at this juncture and arguably more effective than additional monetary incentives for R&D because it could help bridge knowledge gaps. The Group could help identify and systematize the constellation of factors which are contributing to firm level productivity and innovation in the Yangtze Basin area and make these findings widely known so that other firms can benchmark themselves. An important contribution of such a vision group would be to tailor the lessons for specific categories of firms in the Shanghai area taking into account their characteristics and the conditions they face. A "Manufacturing Vision Group" was formed in the U.S. in 1988 and its investigation of new projects in several innovative companies brought to light a wealth of relevant clues on how some companies create the conditions for serial innovation (Bowen and others 1994).

Successful Innovative Firms

We think that the municipal authorities and the national government are providing leadership, incentives and resources, however, accelerating the development of the innovation system will depend increasingly upon the business sector. Innovation must be pulled by demand and the search for profitable opportunities even as it is pushed by increased spending on inputs if it is to be successful in the marketplace. Demand from the business sector and from consumers is essential to realizing innovations that must meet the market test. It is difficult for governments using public sector entities and 'push' mechanisms alone to bring into existence an innovation system that delivers results. In most respects, the business sector is the part of the urban economy that is already primed to innovate. It has the organization, the exposure to new technologies, and the experience with absorbing, assimilating and adapting technologies. It has the strongest incentives to innovate, to carefully select from among options, and it benefits immediately from successful innovation. Moreover, many firms are already engaged in R&D and have the infrastructure and teams in place. Firms conducting some R&D are more likely to establish research linkages with universities. Their support for government initiatives to improve the quality of tertiary education, to strengthen the research capabilities of universities and to develop a local research culture can be invaluable.

Process innovation by firms provides the preconditions for the building of an innovation system, because these can be more readily integrated into the operations of a firm and the returns accrue quickly. Once process innovation which is generally incremental, gathers momentum and its utility is widely perceived, R&D gains stronger adherence both within and beyond the firm and becomes better integrated into its operations. Hence, encouraging firms to pursue process and product innovations so as to make it a mainstream activity and generate the demand for R&D, is a key task for government policy. International experience underscores this. Policies that seek to augment the supply of research in universities and public research institutions with the help of public financing may raise the supply of scientific findings but they will produce few tangible economic results. Businesses must be convinced of the utility of innovating and convinced of the value of routinizing innovation.

One striking finding from the research on firms in that there seems to be only a weak relationship between the level of R&D spending and the metrics used to measure the success of firms. Increasing R&D can raise the number of patents but patents do not readily translate into desired business outcomes such as profitability and market share, for example. In fact, excessive spending can be dysfunctional if it throws up barriers to innovation by making scientists into constituents who become wedded to the status quo (Jaruzelski, Dehoff and Bordia 2005). The most successful innovative companies are ones who can extract the maximum innovation from a moderate R&D budget. These companies share a number of characteristics:

- An innovation culture deliberately cultivated and constantly reinforced by top management and an innovation strategy fully aligned with corporate strategy.
- The innovation strategy is a comprehensive one keyed to long run competitiveness and the avoidance of frequent restructuring and changes of direction[29]. It embraces not only products but also process innovation, innovations in marketing, associated services and the business model of the firm itself. A study of innovative firms by Hargadon and Sutton (2000, p.158)

[29] The Hay Group finds that companies with consistent and stable strategies which can avoid paroxysm of restructurings, have a better chance of forging and sustaining a reputation for performance ("The World's Most Admired Companies" 2009).

found that serial innovators had perfected a "knowledge brokering cycle made up of four intertwined work practices: capturing good ideas, keeping ideas alive, imagining new uses for old ideas and putting promising concepts to the test." Some research suggests that the highest stock market returns and growth of revenues were achieved by firms with the most innovative business models and not the ones with the innovative products (Hagel, Brown and Davison 2008; "The Biggest Bang" 2008).

- Successful innovators adopted an open and collaborative approach to innovation, recognizing that they could not excel in more than a few areas of research and need to canvas ideas from a variety of sources.[30]
- The focus of the research efforts and the quality of leadership is critical to success, as is the closeness of interaction between the research wing of the firm and the production and marketing departments.
- Successful innovators tended to have a flatter and nimbler managerial structure and effective procedures for vetting research proposals, tracking progress and screening out failures (Lynch 2007). These companies also have well articulated procedures for developing and commercializing products.
- In industrializing countries, the successful innovators leverage their knowledge of the local market to innovate by customizing products and innovate also in the distribution of products.

One of the issues to be confronted by Shanghai – and China – is that most applied research and innovation is done by large companies. They are responsible for most of the incremental process and product innovation and it is through their own efforts and the

[30] Open innovation systems which emphasize tools such as alliances, licensing, consortia, and innovation exchanges, and joint ventures assume that innovation is a cumulative process which requires melding a number of different and intersecting technologies. Tetra Pak found that it had to draw upon the expertise of a number of other companies before it could develop a paperboard container which could be sterilized, was lightweight, rectangular and easy to hold and pour. Similarly, Cargill only managed to perfect a new family of corn based plastics when it teamed up with Dow Chemical (Rigby and Zook 2002). During the Second World War, the large scale production of penicillin became a reality after America's agricultural scientists and technicians, who knew a lot about culturing moulds, became involved.

marketing of innovations by others that radical advances achieve commercial success.[31] Large firms often do not give rise to breakthrough innovations – for reasons delineated by Christensen and Raynor (2003) – however, their development and marketing inputs frequently determine the success of disruptive innovations.[32] Some research by Zucker and Darby (2007) also shows that notwithstanding the drawbacks of industrial concentration and oligopolistic producers, consumers derive larger welfare gains from the innovativeness of large oligopolistic firms. Most of the bigger firms in Shanghai are wholly or partially state owned and they dominate both traditional and high tech subsectors. Hence in the medium term and perhaps over the longer run as well, SOEs need to take the lead in innovating which has not been their strength thus far (Muller and Sternberg 2008, pp. 236-7). In fact, for the urban innovation system to find its stride there is no substitute for the initiative and leadership that large firms with transnational strategies can provide. Government incentives and purchasing policies can encourage innovation,[33] universities and research institutes can assist, and incubators and science parks can nurture new ideas, but SOEs which seek to compete and earn profits on the basis of innovation, must provide a good part of the impetus – the demand for innovation and some of them need to become the innovation hothouses of China. Many more SOEs must be induced to become as dynamic and competitive as China's corporate icons such as Huawei, ZTE, SAIC, CIMC, Wangxiang and others.[34] A further round of ownership and governance reforms will need to be complemented by changes in management and organization, a trimming of the dead weight of diffuse (and sometimes geographically dispersed) unprofitable activities that distract management, and an aligning of incentives

[31] Baumol (2004) notes that technical progress requires both breakthrough ideas and a protracted follow-up process of cumulative incremental improvement of those breakthroughs with the combined incremental contribution of this second phase often exceeding that of the first (p.4) …….. In today's economy, many rival firms use innovation as their main battle weapon with which they protect themselves from competitors …. The result is precisely analogous to an arms race (p.10)".

[32] The spread of electricity and the internal combustion engine was expedited by takeovers which consolidated production in a few large firms which could reap scale advantages and sustain technological advance.

[33] For instance, Shanghai has the first maglev trains operated commercially in the world. Future railroad development could be based on this technology (especially for a newer high speed train system) and being the leader, firms in Shanghai can accumulate tacit knowledge concerning this technology and evolve to become global players.

[34] There is some evidence suggesting that older SOEs are taking a more active interest in upgrading their production capabilities and in innovation (Girma, Gong and Görg 2009).

in support of profitable innovation. It scarcely bears repeating that the productivity and innovativeness of SOEs will be directly influenced by the quality of management and how this is monitored by boards of directors.[35] Time and again, research findings show that the productivity of firms, their capacity to innovate and the returns on innovation, and their harnessing of IT to enhance competitiveness is correlated with management (Bloom, Sadun and Van Reenen 2007). Augmenting the talent in the managerial ranks of the SOEs is inseparable from other measures to raise long-term performance.[36] Large Chinese firms will have to lead Shanghai and China to the innovative economy which is profitable and sustainable. If the global recession and a slowing of growth in China leads to an industrial shake-out and a reduction in capacity, then research suggests that well established older firms which pursue competition strategies based on innovation, are more likely to survive and prosper (Klepper and Simons 2005).

Much like international production networking, the networking of the innovation process is becoming an important source of competitiveness advantage. This process is exemplified by the example of the iPod which brought together in one imaginative and extraordinary successful package, innovations in a number of discrete technologies. The revolutionary feature of this product was the skillful yoking together of innovative energies of many firms and the use of electronics production networks to locate the manufacture of components first in Taiwan (China) and later in China (Sener and Zhao 2009).[37] This is a lesson for Chinese MNCs, also. It is becoming vital to acquire the skills to seek and integrate innovation from diverse sources. In-house innovation and in-house production capacity should be seen as only some of the assets a company can draw upon. No less significant are the assets to be harnessed from other sources. Winning innovation contests will demand that globally oriented firms look beyond their own

[35] For instance, Yusuf, Nabeshima and Perkins (2005) find that managers circulate among SOEs and reformed SOEs. Reformed SOEs with managers from former SOEs did not see their performance improve.
[36] Better management practices can also lead to more efficient use of resources (Bloom and others 2008).
[37] From the cost breakdown of video iPod, it is estimated that Apple makes a gross profit of about $80 per unit (of the retail price of $299). China was responsible for assembly of all these parts into a complete iPod. However, the value added in China was only about $4 (Dedrick, Kraemer and Linden 2008). In 2006, there were more than 41,000 workers associated with the production of iPod. Of this total, China's share was 30 percent. However, its share of total wages was 2.4 percent, because most of the workers were engaged in assembly. In contrast, the majority of workers in the US, Japan, and Korea are classified as professionals (Linden, Dedrick and Kraemer 2009).

walls, to think of the innovation possibility set in a far more expansive way and to begin planning their international networking and acquisitions accordingly.

Sustaining R&D operations by Firms

Firms can react to a recession by slashing their R&D expenditures in an effort to improve short-term results. In recessions, firms worry about two kinds of failure, "missing the boat" (missing a great opportunity) or "sinking the boat" (bankruptcy) (Dickson and Giglierano 1986). They worry more about the failure of a firm rather than the missed opportunity. However, this can prove to be shortsighted as companies which sustain their efforts to innovate improve their chances of bouncing back and increasing their market share. This was the experience of U.S. companies following the 1990-91 recession. Some important innovations have been introduced during recessions to the advantage of the producing firms, such as the transistor launched by Texas Instruments in 1954 and the iPod in 2001, following an increase in Apple's R&D spending by 42% between 1999 and 2002. This learning has induced many MNCs to protect their R&D efforts from the recession which commenced in 2008. Companies such as Intel, Microsoft, Cisco, and TI raised their R&D between 2007 and 2008. P&G is increasing its spending on new engineering and manufacturing technologies and other companies are also resisting pressures to pare back ("How P&G Plans" 2009; "Intel Tries to Invest" 2009; "R&D Spending Holds Steady" 2009). However, if slower growth persists through 2010, R&D might succumb to a sense of uncertainty and more companies will be induced to scale back (Bloom 2007). Minimizing such cutbacks among firms in Shanghai may require going beyond the fiscal measures currently extended to firms and offering targeted subsidies for one to two years to firms in the technology intensive subsectors. This would offset the uncertainty firms' face and enable them to husband valuable research capital which takes years to accumulate.

In addition, a significant expansion of the municipal government's extension and product development services to SMEs may be desirable. These can serve as means of transferring valuable technical and problem solving skills to industry; they can also be vehicles for absorbing a large number of temporarily unemployed skilled and technical workers and channeling their expertise into value adding activities. Such a program

which could be modeled on the Fraunhofer Institutes in Germany or the Advanced Technology Program introduced by the National Institute for Standards and Technology,[38] would confer three additional benefits: it would increase the skill intensity of the SME sector and encourage R&D activity in firms that rarely engage in research; it would give university graduates an opportunity to acquire practical experience and provide job opportunities (Bramwell and Wolfe 2008; Lundvall 2007); and it would partially neutralize the disincentive effects of the economic downturn for students contemplating a future in science and engineering or in R&D.

Healthcare as an Urban Growth Pole

A healthcare industry that has linkages to manufacturing industries such as pharmaceutical industry, diagnostic equipment manufacturers, and manufacturers of implants and high-tech electronic instruments and other IT services providers[39] can be a source of local employment, substantial value addition, innovation at many levels and exports of services and complex manufactures in addition to the direct social benefits it can provide to the population of the municipality. Creating a competitive healthcare industry in conjunction with tertiary education and high tech manufacturing subsectors, could create an economic powerhouse with long-run growth potential (see Figure 2.2)[40].

With an ageing population, Shanghai can anticipate strong demand for eldercare and chronic diseases in particular. This kind of demand can be used to reshape the healthcare system in Shanghai so that care providers are linked to and benefit from university based research on new drugs, traditional medicine, bioengineering,

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[38] Darby, Zucker and Wang (2003, pp.5-6), explain the advantages of the ATP as follows: "It has a goal of encouraging collaboration among firms and between firms and universities and other organizations in the U.S. innovation system. ATP encourages the formation of JVs, providing potentially higher award levels and more years of funding, and encourages JV members to establish governance structures for internal management of JVs….ATP in effect opens up boundaries where the ATP project impinges, encouraging joint governance and reasonable access by all JV members of intellectual property created within the JV…The firms not only have more financial resources through ATP funding but also have changed social relationships. These relationships provide intellectual capital and social contacts that add value through learning processes".

[39] The technological revolution that is sweeping the medical sector as a result of the confluence of biology, information, engineering and material technologies, is described in "Medicine Goes Digital" ("Medicine Goes Digital" 2009).

[40] Porter and Teisberg (2006) discuss the competition strategies for healthcare providers and program which could enlarge the benefits for users.

bioinformatics, robotics and imaging technologies to name just a few of the research fields that are helping to enhance the quality of medical care. Healthcare, much like telecommunications, is also increasingly a capital intensive service which relies upon an array of diagnostic and imaging devices,[41] implants, instrumentation and IT equipment. Many of these are high value, knowledge intensive manufactures that are growth areas for Shanghai's electronics, new materials, precision engineering, pharmaceutical and biotechnology industries.[42] Because each of these fields attracts new starts, they look to venture capitalists for early stage and mezzanine financing.

With the help of suitable incentives, healthcare can become the core of a flourishing cluster comprised of university hospitals, high-tech manufacturing firms, research centers and providers of risk capital as well as other services. Experience from the United States suggests that this may not happen spontaneously but may require incentives from the government coupled with coordination among a variety producers, standard setting and certification, and regulation. The point to be emphasized here is that the gains for the city in terms of growth and employment can be greatly magnified if the linkages from healthcare to manufacturing and university based research can be realized within the geographical confines of the city. Medical – manufacturing – research clusters have great promise and can become prolific exporters of state of the art medical services as well as complex high tech and profitable products.

Quality of Education and Tertiary Education as a Leading Sector

Premier Wen Jiabao has observed that China must "cultivate large numbers of innovative talents [through] a free environment to enable [students] to develop creative thinking and critical thinking …… To raise a question or to discover a problem is more important than solving a problem" (cited in interview by Xin and Stone 2008). The competitiveness of Shanghai's industry and services, the capacity to innovate, and the pace of diversification into new activities will be a function most directly of the quality of education. Those individuals with more education or better quality have a higher

[41] There are a number of areas in which improvements can be made. One promising area is a miniaturization of the MRI. Researchers so far has been able to miniaturize nuclear magnetic resonance (NMR) device, which is quite similar to MRI (Blumich 2008).
[42] Although biotechnology faces an uncertain future (Pisano 2006).

probability of starting a technology intensive business, hire skilled workers, and to engage in innovation.[43] Workers with a solid grounding in the sciences and in engineering, with good analytic problem solving and team working capabilities, require less remedial training once they join a firm and can more fruitfully contribute to incremental process innovations which are frequently the life blood of competitiveness. Interviews with firms in Shanghai suggest that one of the major hurdles they face relates to the workforce.[44] University graduates enter the job market with a grounding in theory but with little practical knowledge and analytical skills. Employers ascribe this to the continuing reliance on rote learning and on training to take tests; on the knowledge and pedagogical techniques of many of the teaching staff which could be seriously outdated; on the low quality of textbooks; the limited attention given to practical training; and the obsolescence of lab and testing equipment that is available to the students. All these factors combine to constrain the productivity, the innovativeness and the entrepreneurial capacity of the workforce which is Shanghai's single most important asset.

Among the suggestions for improving the performance of universities coming from Europe are performance criteria that include both the quality of graduates and graduation rates, diversified and shorter diploma courses which give students more choice and the option of deciding when to stop, and greater autonomy for universities (Boarini and Martins 2008). The emphasis of tertiary education policies supporting innovation ought not to be limited to enhancing STEM skills but should seek to produce graduates who are versatile "with unique skills and a penchant for sustaining their excellence through career long self-education" (Flanagan 2006, p.5).[45] In a world where technology is continually evolving, such an attribute would be enduring value.

The importance of creating and fully utilizing the research potential of Chinese universities cannot be minimized. This calls for attention to the design of institutions and a focus on the quality of teaching and research so as to build a tradition of scientific

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[43] Entrepreneurial performance is associated with the quality of formal schooling (Berry and Glaeser 2005; Glaeser 2007; van der Sluis, van Praag and Vijverberg 2008).

[44] Lack of industry experience, a "big picture mindset" creativity and to "think outside the box" were some of the weaknesses noted. Firms also did not cite the education and training as the distinguishing feature of graduates form the best schools. Nor did they comment on the readiness to work long hours (Wadhwa and others 2007; and interviews).

[45] See also World Bank (2008a) on the thinking with regard to tertiary education policies and Salmi (2009) on the ingredients of world class universities.

excellence. This can entail autonomy in hiring staff, in determining salaries, and incentive mechanisms, and in budget management. It can depend upon the capacity to compete for first rate talent from across the nation and all over the world. And it is strongly influenced by visionary leadership by key university administrators. A comparison between American and European universities reveals starkly how these factors influence the quality of university faculty and the value of the research conducted.

By identifying the top 250 most highly cited researchers in each of 21 scientific disciplines, Bauwens, Mion and Thisse (2008) were able to show that American universities accounted for two thirds of the total during 1981-1999 and European universities for only 22 percent (see Table 2.4). Two other findings are also notable. First, the United States has a significant edge over European universities in every field except pharmacology. Second, the top 25 institutions with the most highly cited researchers (HCR) accounted for 30 percent of the total HCR and all but three were in the United States. Clearly American universities are contributing to inventiveness and they are able to do so because they have built up durable tradition based on the excellence of both teaching and of research and other institutional differences.[46] For instance, Aghion (2009) observes "that both Anglo‐American and Scandinavian countries (plus Switzerland) perform relatively well, whereas continental countries (particularly France, Italy, and Spain) perform relatively poorly. Interestingly, unlike their Anglo‐American counterparts, Swiss or Swedish universities are mostly public, charge low tuitions, and are not very selective when accepting applicants at the undergraduate level. However, good performance always relies on high budgets per student combined with budget and hiring autonomy ... The main findings are that (i) higher autonomy is more growth‐enhancing or patent‐enhancing in states that are closer to the technological frontier, and (ii) autonomy and spending are complementary in generating higher growth or higher patenting in the state"(Aghion 2009, p.23).

[46] This does not mean that these researchers are all Americans. The data is based on the addresses of the institutions with where researchers are affiliated.

Table 2.4: Number of Highly Cited Researchers, 1980-1999

Discipline	US	EU17	EU17 without UK
Agricultural Sciences	113	84	64
Biology and Biochemistry	138	40	29
Chemistry	143	72	51
Clinical Medicine	161	36	17
Computer Science	226	45	35
Ecology-Environment	192	73	48
Economics-Business	263	24	11
Engineering	138	32	24
Geosciences	219	70	43
Immunology	201	81	66
Materials Sciences	159	50	33
Mathematics	221	75	53
Microbiology	159	71	49
Molecular Biology and Genetics	197	63	47
Neuroscience	182	73	39
Pharmacology	93	121	73
Physics	148	74	59
Plant and Animal Science	147	100	59
Psychology-Psychiatry	228	23	5
Social Sciences, General	295	11	3
Space Sciences	206	74	45
Total	3,829	1,292	853

Source: Bauwens, Mion and Thisse 2008

Incentives and encouragement to university faculty to conduct applied research with the potential of yielding commercial outcomes needs to be carefully calibrated so as not to divert attention and resources from the core mission of the leading research universities. First and foremost, Chinese universities many of which have expanded enrollment, need to ensure the quality of their teaching and research by building up the caliber and experience of their faculties.[47] Equipping students with up-to-date theoretical knowledge, and soft skills which employers' value, must be the principal objective of the university. Strengthening the capacity to conduct basic research so as to generate new knowledge – which the private sector does little of – is a second major objective requiring investment in graduate and post doctoral programs; faculty with the requisite skills to lead and manage significant research projects; a well-equipped laboratory infrastructure; and leadership at the apex of the university as well as at the level of

[47] Salmi (2009) describes the attributes of world class universities. See also Altbach (2003) and Levin, Jeong and Ou (2006).

departments. The evolution of the field of biotechnology vividly illustrates the contributions of fundamental research in several seemingly unrelated fields conducted over a period of many years. Biotechnology owes its current eminence to breakthroughs in theoretical biology, in imaging techniques arising from advances in high energy physics and in computing technologies. Many of these advances were the results of university based research financed by the U.S. government through the National Science Foundation (NSF) and the National Institute of Health (NIH). According to Lawlor (2003, p.30), "It is the long term nurturing of the broad basic science base that has produced the U.S. competitive edge in biotechnology [with the help] of a non-centralized government funded but largely university performed basic research."

Applied research and its commercialization through licensing, consulting, and start-ups can be a third objective however, it should not detract from the first two. In fact, the success of university entrepreneurship depends upon the university's reputation in providing quality education in important research fields. Very few universities in the United States – perhaps no more than five – derive a significant income from licensing of research findings and royalties. Most do not even manage to cover the operating expenses of their technology licensing offices from the commercialization of research. The equity stakes universities acquire in start ups are modest and have frequently proven to be worthless (Lerner 2005).[48] Start-ups in fields directly linked to basic and upstream applied research in universities such as biopharmaceuticals and nanotechnology, can be a benefit but the risks are high and the payoff uncertain (Feldman 2003),[49] Moreover, as indicated by Miner and others (2001), "Efforts [by the university] to stimulate new ventures may generate short-term prosperity but may ultimately harm the university incentives that lead productive faculty who previously generated steams of inventions, to leave the university to create new firms. Overtime, this process could ultimately destroy the university's underlying capacity to generate new knowledge and could leave the university with faculty members least likely to produce sustained inventions" (p140-41). Even Shanghai's premier research universities must first augment their core functions of

[48] University venture funds in the U.S. have a poor track record and few have reached maturity (Lerner 2005).

[49] Chinese universities are also discovering the downside of start-ups and distancing themselves from direct ownership and responsibilities (Zhou 2008).

providing world class training and of conducting world class research before embarking upon technological entrepreneurship. The first two are vital for the longer term success and technological evolution of Shanghai's economy and to the crafting an intellectual climate conducive to innovation. Technological entrepreneurship can become a minor source of revenue for a few research universities and a conduit for knowledge transfer from the leading institutions, but only after they have built up strong research programs. Although universities in Shanghai are engaging in research in photonics, nanotechnology, new materials and biotechnology, it may be some years before they can contribute significantly to advances in knowledge. A global recession which is forcing leading universities around the world to retrench some of their research endeavors and look for partners, presents an opportunity to launch two or three broad ranging blue sky research projects comprised of cross-national teams with researchers in Shanghai co-directing the activities and playing a significant role. The research should be of long-term consequence with spillovers for other areas and the subject matter could be drawn from the physical or social sciences. The advantages of such research at this point, is first to engage a sizable number of researchers in a challenging, high-level collaborative endeavor with potentially a large payoff. Second through collaboration, it will build much needed experience and analytical skills among young researchers in Shanghai which will help to raise the quality of teaching and research in universities. By staying focused and building up their research capital and teaching capabilities, some universities will raise the skill level of the Shanghai urban region and be better able to service the needs of industry and begin building fruitful linkages with industry.

By strengthening tertiary education, and promoting university research, Shanghai would greatly enlarge the benefits to local industry. It could moreover, make this sector attractive as a services provider for foreign students some of whom would supplement the local talent pool, and for foreign companies wanting to enter into research partnerships or to outsource their research. Through a variety of channels, the education sector can boost Shanghai's growth and build resilience against shocks affecting individual industries.

An Innovative City

Most innovation takes place in a few large cities and a lot hangs on what kind of people live in the city and visit the city, how they interact, float and exchange ideas, and perceive opportunities for fulfilling their ambitions. Large cities have the edge over smaller ones in terms of employment opportunities and avenues for pursuing entrepreneurial options. Those open cities which attract many visitors and migrants from within the country and abroad, are doubly advantaged by the influx and circulation of diverse ideas and talent. As Glaeser (2009, p.50) notes, "attracting and retaining skilled people is a critical task for local governments." And the experience of the United States suggests that consumer amenities are the most effective way of building the skilled workforce which is invaluable under any set of circumstances but most especially when industrial change is in the offing. Phillips (2008, p.731) presciently observes that "Most cities are the longest running examples of large open source projects. Cities were open source long before Linux." And cities that are designed with an eye to the quality of the socio-cultural environment, amenities, and physical aesthetics are triply advantaged because talented and discriminating knowledge workers gravitate to the city and some may choose to live there. Cities can also instill the culture of inquiry and interest in sciences by actively promoting science-oriented conferences, fairs, and exhibitions.

Shanghai has the advantages of size and in China it is a city that attracts many visitors. It is also a city in the throes of change and this is where great care is needed in order to create a socio-cultural environment and an urban aesthetic that will buttress the productive innovation system the city wants.[50] Perhaps this is the most difficult attribute of a city to capture.[51]

Insufficient attention to forward looking urban planning is leading in one major city after another to single function zones, emphasis on auto-mobility, urban sprawl (and dormitory suburbs), elevated expressways, hundreds of residential tower blocks devoid of recreational amenities, shopping malls, gated communities and segregation by income

[50] A continuing adjustment of the hukou system might be needed to ensure the flow of high quality human capital from elsewhere in China, and from abroad. See C. C. Fan (2008) for current issues surrounding hukou system. Shanghai's fourth reform of the hukou system announced in February 2009, took another step towards easing the constraints on obtaining a resident status.

[51] See for instance Florida (2005; 2008).

groups, with the poor concentrated in squalid decaying ghettos often (but not always) on the periphery of the city. This is the very antithesis of the dynamic global city of tomorrow which is compact so as to facilitate the use of public transport and encourage a healthier, walking lifestyle, industrially balanced, well-connected nationally and with international urban nodes, energy frugal, with numerous mixed use neighborhoods (which maximize use of land and infrastructure and can induce an environment that minimizes criminal activity) and with the cultural and recreational amenities which enhance the quality of life[52] even as incomes rise and make urban life in Sennett's words "a source of mutual strength rather than a source of mutual estrangement and 'civic bitterness'". Leading global cities have only some of these attributes. They are struggling to undo the damage done by past decisions because these attributes will determine whether a skilled labor force can be retained and a cycle generating a succession of knowledge intensive industries made integral to the urban dynamic.

In its haste to modernize, Shanghai might lose sight of these objectives, but it needs remembering that 'urban deserts' do not breed innovation.[53] And cities that are resistant to in-migration quickly lose dynamism and entrepreneurial vigor which can result in an irreversible decline of growth.

Many cities are aspiring to be "creative," few will succeed. If Shanghai is to be among the leaders then Shanghainese must emerge as trendsetters in China and in the world demanding innovation from companies and providing a crucible for the testing and selection of concepts and products. Shanghai will need to become the preferred habitat for a cosmopolitan creative class because the city can offer choices and it is rich in opportunities.

The transition to a creative central place in the global economy demands action at three levels: the visual; the intellectual; and the strategic. Physically Shanghai needs to strike a happy balance between local distinctiveness and enduring and vital global chic.

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[52] Surveys of life satisfactions in China identify unemployment and pollution as two main sources of unhappiness among its urban residents (Appleton and Song 2008). The housing prices across cities in China are influenced by pollution. Housing prices in cities with less air pollution are higher than those with more severe air pollution (S. Zheng, Kahn and Liu 2009).

[53] Since 1993, Shanghai has experienced a massive construction wave so much so that the municipal government has needed to print a new map of the city every three months (Lu 2004).

This can be achieved through inspired efforts to build dynamic neighborhoods fused together by a well planned transport infrastructure.

Intellectual leadership will derive from the excellence of universities and think tanks and how their physical presence in the heart of the city feeds and enhances the sophistication of urban culture. In cities such as New York, Philadelphia, and London, the location and the quality of the universities has added immeasurably to the richness of the discourse. This does require an avoidance of a narrow focus on technology development on the part of the key universities and a broader expansive engagement with the sciences as well as the arts. The convening of seminars, workshops, and science festivals catering to a general audience would further the process of engagement between the creative class and the general urban population, thereby enabling the culture of creativity to strike deeper roots[54]. Writing on the celebration of science in New York, Lawrence Krauss (2008) observes that "what are these science festivals have done is to let people indulge the natural inner fascination with the world around us in a context that is neither intimidating nor culturally remote as university lecture hall too often seems" (p. 643).

The visual characteristics of the city and its intellectual vigor need to be topped by audacious strategic initiatives which put Shanghai on the map and able to begin influencing global networks at the level of technology and ideas and not only through the scale of its construction activities.

The global cities of today are all reinventing themselves or rethinking their development strategies so as to sustain or enhance their economic prospects and to attract the skilled workforce needed for new industries. Many global cities have become monosectoral service-based economies without any emerging leading subsectors. To survive, these cities will need to reverse decades of shortsighted decision-making, zoning, land development, and transport policies and to prepare for a harsher economic environment made more challenging by an ageing workforce, rising energy and resource

[54] Shenzhen began hosting an International High-Tech Achievements Fair starting in the autumn of 1999, while Beijing convenes an International High-Tech Industries week in May each year (P. Fan and Watanabe 2006, p.314).

costs and by climate change.[55] These cities are not the models for future global cities but they do offer lessons on desirable industrial structures and capabilities which are described above.

II. Policy Messages for Shanghai

Our findings in this study lead us to five policy messages, relevant to formulate medium- to long-term growth strategy for Shanghai. These are:

- Maintain and upgrade the manufacturing base in key areas;
- Augment the research capital of the city by focusing universities on teaching and basic research which is knowledge deepening;
- Develop services industries such as education and health which have spillovers for manufacturing;
- Attend to the livability of the city so that it attracts and holds knowledge workers;
- and Carefully evaluate current incentive policies so as to maximize the benefits.

In addition to longer-term objectives, Shanghai's development strategy needs to address near term objectives. First, industries which will be the drivers of future growth should have support needed to weather the recession which commenced in 2008 and the incentives to consolidate and improve competitiveness by accumulating knowledge capital. In this context, Chinese firms might step up their efforts to acquire equipment, tacit knowledge, and IP from technologically advanced foreign firms which are going out of business.

Second, the economic downturn is a time to accelerate the exit from declining labor intensive industries and to reallocate the land and human resources to other uses with a higher pay-off. In particular, this will require retraining workers made redundant

[55] Coastal cities will need to prepare for rising sea levels by minimizing land subsidence associated with the pumping of groundwater, by building dikes and pumping facilities, and using natural passive defenses such as wetlands and mangrove forests (Day and others 2007; UN-HABITAT 2008).

by sunset industries. The freeing and transfer of resources will stimulate productivity aside from reducing the excess capacity in a number of light manufacturing industries.

How Shanghai can apply the elements of strategies suggested above depends on the assessments of current policies in place in Shanghai and elsewhere. Unfortunately our knowledge on these matters is limited to an assortment of anecdotes and is lacking in a reliable expectation of their effectiveness if applied in other places in a different time. To move forward, we need to deepen our understanding of the effectiveness of policy instruments that are in place in Shanghai so as to improve upon them.

Table 2.5: Fiscal Incentives for Innovation Offered in China

Fiscal Incentives for R&D and Related Activities	▪ Provision of import tariff exemptions: o To facilitate firms' technological renovation and product upgrading in existing state-owned enterprises. In addition, targeted industries such as those in the electronics sector were exempted from tariffs and import-related VAT on equipment during the 9th and 10th five-year periods. o To promote technical transfer and commercialization. Foreign individuals, firms, R&D centers engaged in activities of consulting, and technical services related to technology transfer and technological development are exempted from corporate tax on their incomes.
Fiscal Incentives Given to Various Technology Development Zones	▪ Establishing economic zones, new and high-tech industrial zones (HTIZs), and economic and technological development zones is one of the key measures the Chinese government has adopted in facilitating acquisition of new and advanced technologies, promoting technological innovation, promoting the commercialization of S&T results, and enhancing China's industrial competitiveness. From the early 1980s, China began establishing special economic zones and, since the 1990s, high-tech industrial development zones. ▪ In 1991 China approved 21 national HTIZs, and by 2005 the total number countrywide had risen to 150, of which 53 are at the national level. These HTIZs have nursed 39,000 high-tech firms employing 4.5 million people. The total turnover of firms reached 2.7 trillion yuan in 2004, an increase of 31 percent over the previous year. The per capita profit was 33,000 yuan; per capita tax yield was 29,000 yuan, and the per capita foreign earnings were 157,320 yuan (US$19,000) ▪ In the national HTIZs a series of investor-friendly policies and measures have been introduced. These measures include tax reduction and exemption policies.
Fiscal Incentives Related to Income Tax	The Chinese government offers various tax holiday schemes to different types of firms. ▪ Foreign-invested enterprises can enjoy the preferential treatment of income tax exemption in the first two years after making profits and an income tax reduction (by half) in the following three years. ▪ Foreign-invested high-tech enterprises can enjoy income tax exemption in the first two years after making profits and an income tax reduction (by half) in the following six years. ▪ Sino-foreign joint ventures can enjoy income tax exemption in the first two years after making profits. ▪ Other firms are eligible for income tax exemption in the first two years when starting productive operation. ▪ Domestic firms in HTIZs are eligible for preferential treatment but with limits in terms of types of business activities (income earned from technology transfer or activities related to technology transfer, such as technical consulting service and training). A ceiling is imposed on how much they can benefit from income tax exemption (less than 300, 000 yuan). ▪ Income tax rate is set at 15 percent in these zones, which is much lower compared with the normal rate for those located outside the zones. Firms whose export share is above 70 percent of their annual production can enjoy further income tax reduction (10 percent). *Turnover tax* ▪ Foreign enterprises and foreign-invested enterprises are also exempted from the business tax on technology transfer.

	Tariff and import duties ▪ Tariff and import-stage VAT exemptions have been granted to foreign funded enterprises for their importation of equipment and technologies that are listed in the Catalogue of Encouragement *Accelerated depreciation* ▪ New and high-tech firms are granted accelerated depreciation for equipment and instruments (since 1991; see China's State Council Document [1991] No. 12).
Scholarships for Students Studying in Science and Engineering Fields in China and Abroad	The Chinese government has created an Overseas Study Fund to sponsor Chinese students and scholars to pursue their studies or training overseas. In 2004, the fund sponsored 3,630 people for advanced studies or research programs overseas. In line with China's development priorities, the fund identified seven disciplines or academic fields as its sponsorship priorities for 2004: ▪ Telecommunications and information technology ▪ High- and new technology in agricultural science ▪ Life science and population health ▪ Material science and new materials ▪ Energy and environment ▪ Engineering science ▪ Applied social science and subjects related to WTO issue
Incentives Given to Attract Overseas Chinese Back	▪ The *Chunhui* program has sponsored 8,000 Chinese scholars with PhDs obtained overseas to come back to carry out short-term work. The Yangtze River Fellowship program awarded 537 overseas Chinese scholars professional appointments in Chinese universities for curriculum building and teaching and for joint academic research.
Fiscal Incentives Given to Attract the Establishment of R&D Centers by MNCs	▪ The fiscal incentives offered include the following: ▪ Exemption from import duties and import-related VAT for imports of equipment, devices, and spare parts for R&D purposes (1997). ▪ Tariff and import-related VAT exemption for acquiring imported new and advanced technologies. Foreign-funded R&D centers receive the same fiscal benefits as foreign-funded high-tech firms and enjoy the same fiscal preferential treatments (November 2004). ▪ Exemption from corporate tax for revenue earned through the delivery of consulting or other technical services related to technology transfer, and technical development activities (1999; no. 273). ▪ Reduction in income tax payment for those R&D centers whose expenditures on R&D increased more than 10 percent annually.

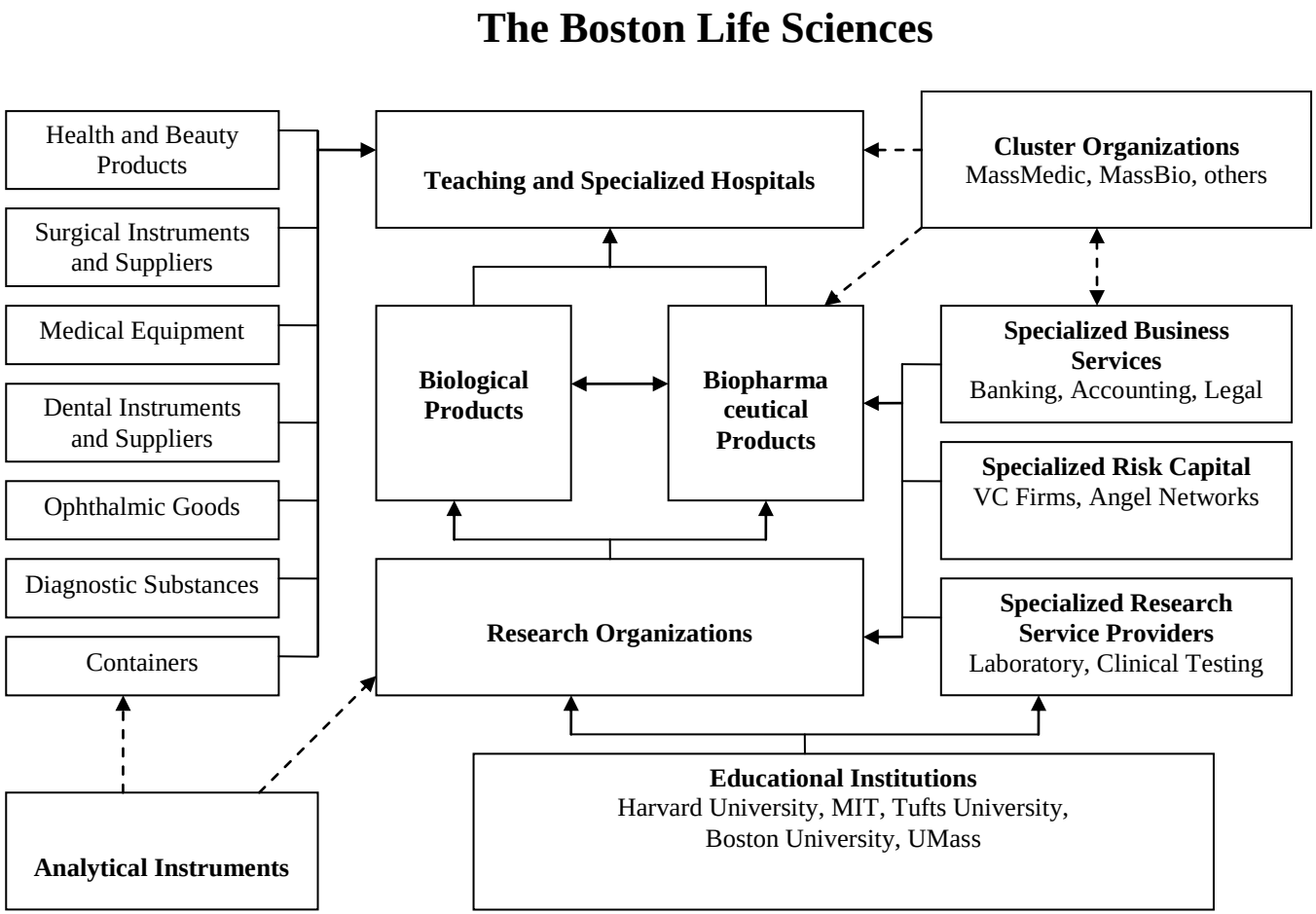
Source: Yusuf, Wang and Nabeshima 2009

Table 2.6: Technology Licensing Offices in Tokyo

Name	Universities	Approved by METI, MEXT	# of license	Spin-offs	
Todai TLO	University of Tokyo	1998	948	-	
Nihon University Business, Research and Intellectual Property Center	Nihon University	1998	249	-	
Waseda University Research Collaboration and Promotion Center	Waseda University	1999	245	101	as of March, 2007
Keio University Intellectual Property Center	Keio University	1999	260	-	
Tokyo Denki University TLO	Tokyo Denki University	2000	17	-	
Technology Advanced Metropolitan Area - TLO	16 universities (mainly in Tokyo area)	2000	128	-	
Meiji University The Intellectual Property Headquarters for the Promotion of Social Collaboration	Meiji University	2001	21	-	
The Foundation for the Promotion of Industrial Science	University of Tokyo	2001	108		
Tokyo University of Agriculture and Technology TLO	Tokyo University of Agriculture and Technology	2001	61		
Campus Create	University of Electro-Communications	2003	23		
Nippon Medical School TLO	Nippon Medical School, Nippon veterinary and Life Science University	2003	17	-	
Ridai Scitec	Tokyo University of Science, Tokyo University of Science at Yamaguchi, Tokyo University of Science at Suwa	2003	27	9	
Office of Industry Liaison, Tokyo Institute of Technology	Tokyo Institute of Technology	2007	206	47	(includes all spin-offs in the past)
Tokyo Medical and Dental University TLO	Tokyo Medical and Dental University	2008	0	-	
Japan Industrial Technology Association	Advanced Industrial Science and Technology	2001	-	-	Located in Tsukuba but has Tokyo office
Japan Health Sciences Foundation	various research institutes under the Ministry of Health. Labor and Welfare	2003	-	-	
Agriculture, Forestry and Fisheries Technical Information Society	various research institutes under the Ministry of Agriculture, Forestry and Fisheries	2003	-	-	
Support Center for Advanced Telecommunications Technology Research	National Institute of Information and Communications Technology	2004	-	-	

Note: The list includes those approved and certified TLOs located in Tokyo. There are 48 approved TLOs and 4 certified TLOs nationally as of April, 2008.
Source: Japan Patent and Trademark Office

Figure 2.2: Components of The Boston Life Sciences Cluster



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