The Competitiveness of China's Leading Regions: Benchmarking their Knowledge-Based Economies

Robert Huggins
Centre for Economic Geography, Cardiff School of Planning and Geography, Cardiff University, Cardiff, CF10 3WA, UK.
E-mail: HugginsR@cardiff.ac.uk

Shougui Luo
Antai College of Economics & Management, Shanghai JiaoTong University, 535 Fahua Zhen Road, Shanghai 200052 China.
E-mail: sgluo@sjtu.edu.cn

Piers Thompson
Nottingham Business School, Nottingham Trent University, Burton Street, Nottingham, NG1 4BU, UK.
E-mail: piers.thompson@ntu.ac.uk

The Competitiveness of China's Leading Regions: Benchmarking their Knowledge-Based Economies

Abstract
China's spectacular economic growth has been spatially uneven, with much development occurring in eastern coastal areas. In particular, three metropolitan 'super-regions' have become China's most competitive knowledge-based economies, consisting of the Pearl River Delta, the Yangtze River Delta, and the Bohai Gulf Region. This paper benchmarks the competitiveness of these regions, with a view to exploring which region is best positioned to become the most dominant knowledge-based economy over time. Through the theoretical lens of dynamic comparative advantage, it is shown that each region has hugely increased its competitiveness through improvements in the capacity to absorb and diffuse knowledge. It is further shown that due to multi-dimensional advantages the Yangtze River Delta, incorporating the Shanghai metropolis, is best positioned to become the dominant hub of China's future knowledge economy. It is concluded that China's leading regions will require further economic policy adjustments in order to secure their future competitiveness.

Key words: competitiveness; benchmarking; knowledge; dynamic comparative advantage; innovation; growth; regions, China.

1. Introduction

Since reforming and opening-up to the world, the Chinese economy has developed rapidly. Gross Domestic Product (GDP) grew from US$501 billion in 1978 to US$11,273 billion in 2011 (2011 constant prices), increasing by 9.9% annually, with GDP per capita increasing 16 times. This growth, however, has been far from even, mainly occurring in particular regions that have witnessed massive urbanization. This is, in part due, to reform from a highly centralized planned economy to a market economy, and subsequent opening-up to a more globally integrated economy (Gereffi, 2009), being coupled with a range of state instigated regional development strategies (Lin, 1999; Matthews, 2001; Li, 2004; Lu and Wang, 2002; Groenewold et al., 2007; Groenewold et al., 2010). In particular, the Chinese government focused its strategies on developing the eastern coastal regions of the nation due to more advantageous physical and economic conditions (Sun, 2003; Friedmann, 2006). This has led to three metropolitan super-regions becoming China's dominant and most competitive economic spaces, consisting of: the Pearl River Delta in the south with its strong influence from Hong Kong; the Yangtze River Delta dominated by Shanghai; and the Bohai Gulf Region around Beijing.

Tan (2011) refers to the innovation-led growth in coastal cities such as Beijing, Shanghai, and Shenzhen as a process of 'Chinnovation'. However, the extent to which innovation has driven regional competitiveness in China remains somewhat contested (Huang, 2008), and an examination of the rapid growth occurring in these fast growing super-regions provides a useful opportunity to contribute to the increasingly important discourse concerning the processes by which regions within emerging economies are able to make the transition to more competitive knowledge-based environments (Scott and Garofoli, 2007; Phan et al., 2008). This paper seeks to examine differences in regional development processes across China's leading regions. In particular, it aims to explore which region is best positioned to become the most economically dominant over time, especially in terms of possessing a knowledge-based economy that may result in it achieving the status of 'China's Silicon Valley super-region'. It also aims to provide evidence on the potential limitations of growth in China's leading regions.

To achieve these aims, the paper adapts and operationalizes the model of regional competitiveness proposed by Martin and Sunley (2011), which is based on factors concerning regional dynamic comparative advantage. In order to empirically utilize the dynamic comparative advantage model in the context of the knowledge economy, the regional competitiveness benchmarking framework proposed by Huggins (2010) is also employed. This involves benchmarking each region in terms of the individual components of the framework using performance, process and policy approaches. This utilises quantitative measures to capture regional strengths and weaknesses, but also considers qualitative aspects. As models created for developed country contexts may not be appropriate for emerging economies such as China (Liu and White, 2001a; Radosevic, 2002; Hu and Mathews, 2005; Gu and Lundvall, 2006; Shie et al., 2012), the model of dynamic competitive advantage within the Chinese context is tested through further analysis within the performance benchmarking element.

The remainder of the paper is structured as follows. Section 2 considers the literature relating to the knowledge-based development and dynamic comparative advantage, and how these apply to the emerging region context. The three case study regions are briefly introduced in Section 3. More detail is provided in relation to the data and methods used within the benchmarking analysis in Section 4. Sections 5 to 8 concentrate on the four main elements of the dynamic comparative advantage model, with performance, process and policy benchmarking undertaken for each. Section 9 presents the results of the regression analysis of the components of the dynamic competitive advantage framework. Section 10 summarizes the findings of the paper and outlines the conclusions that can be drawn.

2. Knowledge-Based Dynamic Comparative Advantage in the Context of China

The concept of the knowledge-based economy has emerged from an increasing recognition of the requirement for the production, distribution and use of knowledge within modern economies (Harris, 2001; Huggins and Izushi, 2007). Alongside this, the endogenous school of regional development has proved to be of particular relevance in emerging regional environments, which has lighted the need to maximize the effectiveness of the particular and potential unique resources (Garofoli, 1992; 2002; Vázquez-Barquero, 2007). More recently, Martin and Sunley (2011) outline a model of dynamic of competitive advantage, which illustrates that it is not just the presence of resources which is important, but how they are deployed, to create outputs enabling a region or country to not only compete in the present, but to be able to adapt and continue to compete in the future. Martin and Sunley (2011) develop the notion of dynamic comparative advantage as a means of addressing what they consider to be the cluster model of regional competitiveness developed by Porter (1998). In particular, they consider that cluster analysis is not fit for purpose when analysing the 'new global competition' stemming from China and other emerging economies.

According to Martin and Sunley (2011), the dynamic comparative advantage of regions lies in the effectiveness and adaptability of the link between the resource base of regions – in terms of their underlying fundamentals and externalities – and the strategies of firms in these regions. This represents an interesting twist on the concept of regional competitiveness as it highlights that is it is co-evolutionary process, involving both elements of continuity (and path dependence) – stemming from regional resource base - and elements of change stemming from the need for firms in a region to constantly adapt to changing markets, competition, and technology.

Figure 1 presents the key constructs underlying the dynamic comparative advantage model, and in this case we have unpacked it further to concentrate on those knowledge-based factors that are likely to become more important for the future development of Chinese regions as they move away from reliance on cost and scale based advantages. Below we detail the key parameters of the model.

Figure 1 About Here

Regional knowledge resources - there are a number of routes for regions to access knowledge. These may be based around domestic industry champions, public sector research institutions, or leverage of multinational corporations (Mathews, 2001). Which is most appropriate is likely to be influenced by the knowledge resources available, as indicated by the first component of the dynamic competitive advantage framework. These regional knowledge resources can be split into those classed as regional externalities and regional fundamentals (Krugman, 2005). In the knowledge economy regional externalities are those resources drawn upon in the knowledge creation process, including tangible resources such as education establishments and the creation of human capital, encapsulated in skilled labor. Regional fundamentals relate to the social, economic, cultural and political institutions and conditions. In all three of the routes to knowledge acquisition outlined by Mathews (2001) it is important that a minimum level of education is present to allow the knowledge available to be absorbed into the system (Romer, 1993; Viotti, 2002).

To benefit from knowledge resources the development of absorptive capacity is required, defined as the ability to identify, assimilate and exploit knowledge from external sources (Cohen and Levinthal, 1990). Absorptive capacity is mediated by the wider environment in which a firm competes and operates, with firms that are part of local economic systems, such industrial clusters, more likely to be characterized by strong absorptive capacity (Van den Bosch et al., 1999; Giuliani, 2005). The ability to ensure that external knowledge adds economic value in a region depends on its absorptive capacity channels, whereby external knowledge may flow into a region through one or more of the following channels: business, academic, and social networks; established firms and organizations in the region; or through active and passive learning – diffusion (Mahroum et al., 2008). Clearly the creation of human capital through education plays an important role in increasing this absorptive capacity, and is, therefore, a key component of regional resources.

In an emerging economy context, such as China, Foreign Direct Investment (FDI) potentially plays a vital role – depending upon its nature and characteristics - in regional innovation and absorptive capacity processes, particularly its capability to create and exploit new knowledge through technological and managerial advances (Huggins et al., 2007; Fu, 2008). Knowledge enters the regional economy through technological spillovers from foreign affiliates boosting productivity (Blomstrom and Kokko, 1998; Liu, 2008; Fleisher et al., 2010; Ke, 2010), and facilitating greater innovation outputs (Fu, 2008). This means that global networks accessible through foreign affiliates allow local firms to tap into the initial ideas required to stimulate the innovation process (Liefner et al., 2006).

Fears of appropriation due to weak intellectual property rights could result in foreign firms limiting R&D activities to localization orientated R&D (Liu and White, 2001b; Fan and Hu, 2007). This lack of property right protection is a widely acknowledged problem faced throughout China, which potentially limits the incentive for firms to invest in proprietary knowledge (Gao and Fu, 1996; Gao, 2000; Liu and White, 2001a). Although there have been improvements in the intellectual property protection, there is often still a lack of appropriate implementation and enforcement (Dai and Xu. 2000; Liu and White, 2001b). In response, the government has developed a technology market to aid the transfer of technology from developers to users (Liu and White, 2001a; Awokuse and Yin, 2010). However, China still lacks the required concentration of support institutions such as vibrant venture capital, consultancy and legal industries to enable technology transfer, although these are continuing to evolve (Wu, 2007b). Further, differences in the needs of emerging economies from those served by developed country technology, also ensure that FDI tends to act as a regional resource utilized by the indigenous innovation system rather than as a pure source of technology (Fu et al., 2011). Although internationally owned, foreign affiliates provide a knowledge resource within the region although the quality and extent of access to this resource depends largely on the human capital available. Limited absorptive capacity in some regions still prevents the correct functioning of such a technology markets in the twenty-first century (Gu and Lundvall, 2006).

FDI and the human capital of the workforce are, therefore, two key regional knowledge resources that will be concentrated upon within this study, although these will need to be supported by appropriate social and cultural components. Other resources are diverse in nature. Social and cultural inputs may be captured by measures including: educational outputs such as textbooks published (Crossley and Murby, 1994), community service centres (Xu et al., 2005), health care institutions (Zhang and Kanbur, 2005; Gilson, 2005), along with physical infrastructure such as transport links captured by passenger numbers (Démurger, 2001).

Regional organisations' comparative advantage of knowledge resources - it is not just the resources available, but as captured by the second component of the framework, how these are deployed within firms that is important in generating innovative outputs. The capacity to diffuse knowledge concerns the collective ability of a region to adapt and assimilate new innovations, practices and technologies, and spread them throughout the region. Diffusion can occur through either 'active' or 'passive' emulation. The former may take place through activities such as purchases and imports of new patents, technologies or systems, while the latter mainly occurs through applied learning, reverse engineering or efforts to catch up with the competition (Coe and Helpman, 1995; Mahroum et al., 2008). This means that while knowledge may be created through a number of routes, the extent to which this can be fully exploited is influenced by the capability of regional firms in creating a comparative advantage of resources through their strategic use (Martin and Sunley, 2011).

Such activities require knowledge resources to be employed in the right manner, for example, deployment of skilled personnel within R&D positions (Ballot et al., 2001). The use of networks to secure access to both knowledge held regionally, but also that drawn from global sources, is vital as an input into new knowledge creation (Bathelt et al., 2004). In terms of deployment of the knowledge resources discussed above, studies in more peripheral regions of developed economies have found that R&D expenditure is positively associated with innovation outputs even where the underlying context may not appear suitable (Bilbao-Osorio and Rodríguez-Pose, 2004), and perhaps may have an even greater impact on innovative performance in emerging economies, such as China, than in developed economies (Wang and Kafouros, 2007). This is particularly found to be the case for private sector R&D expenditure (Guan and Liu, 2005). Although spending on R&D is important, it is also wise to consider the human capital allocated to R&D (Ballot et al., 2001; Liu and White, 2001b), as increased spending could just be increasing the rewards to an inelastic supply of skilled workers (Goolsbee, 1998).

The tradition in China of the direct control of primary innovation actors by secondary actors, such as government bodies, led to little incentive to link primary actors together (Liu and White, 2001a). Diffusion from state-owned enterprises to other firms mainly occurs through the introduction of technical workers and new industrial facilities (Liu and White, 2000; Li, 2002; Hu and Jefferson, 2002; 2004; Xue, 2004; Chang, 2008; Wu, 2010). Even with changing attitudes in recent years, the primary focus of most Chinese firms since gaining greater freedom has clearly been on developing marketing and manufacturing capabilities, rather than innovation capabilities (He et al., 2008; Li, 2009). Further, although potentially being a knowledge resource themselves foreign affiliates may draw other resources away from domestic enterprises, or lead to, domestic enterprises relying on foreign technology rather than developing their own (Lin, 2002).

Knowledge competitive and adaptive advantage of a region's organizations - the use of these knowledge resources as inputs should generate competitive advantage for firms manifested through the production of knowledge outputs, such as patents and new products, as well as ensuring access to export markets. Although it is difficult to capture many of the competitive and adaptive advantages accrued as the resource based view of the firm suggests that these need to be non-imitable, rare and valuable (Barney, 1995). In order for an advantage to be sustainable it tends to rely on the possession of tacit knowledge rather than that, which is codifiable (Hooley and Greenley, 2005; Nahapiet and Ghoshal, 1998). This means that only part of the competitive advantage can be measured through the performance benchmarking, that associated with codified knowledge, although Acs et al. (2002) suggest that patent counts are a good measure of innovative activity within a region's firms, at least in more developed countries. Until recently the rapid increase in R&D units and expenditure in China, has not been matched by the same increase in R&D outputs.

One factor potentially holding innovative output generation back is the legal system in China. This has not yet been transformed to a stage where intellectual property right protection through patenting and licensing is a feasible option for many research institutions such as universities. This is further hindered by the lack of technology intermediaries to aid the exploitation of patents and licenses (Wu, 2010). Where linkages between firms and other actors - such as research institutes and universities - have developed, these are positively associated with increased effectiveness in converting R&D inputs into utility patents, reflecting smaller incremental innovations, but not the creation of invention patent applications associated with radical innovation (Li, 2009). In general, the innovative performance of Chinese regions has become more widely distributed, as firms have taken a more dominant role in their emerging regional innovation systems (Tylecote, 2006; Li, 2009).

Associations with foreign affiliates may have the potential to yield increased innovative outputs for private enterprises as they take a greater role in regional innovative systems. However, only a small number of associations formed, those linked specifically to technological tie-ups, are linked to greater innovation (Sun and Du, 2011). More recently, growing demand in domestic markets has meant that China has sought to attract FDI through the promise of admission to domestic markets in return for access to technology and partnership with local firms (Zhou et al., 2011). However, the benefits of 'obligated embeddedness' may be reduced, as on the whole Chinese markets are less sophisticated, placing a continuing emphasis on price than quality, resulting in less pressure being exerted on domestic suppliers by foreign affiliates (Sun and Du, 2011). It seems that the regional innovation systems in China remain less effective than those in most advanced economies in converting R&D inputs into more knowledge-intensive innovations (Li, 2009), stifling the competitive and adaptive advantage of these firms.

The other evidence of competitive and adaptive advantage is manifested through the firm's ability to generate innovations in terms of new products, which may not be patented to maintain trade secrets (Cheung and Lin, 2004; Sun and Du, 2011), but show an ability of the regions' firms to adapt to new patterns of market demand (Martin and Sunley, 2011). Finally, the ability to compete internationally through exports is seen as vital for many regional and national policy makers in emerging economies (Gereffi, 2009; Venables, 2005).

Dynamic regional comparative advantage - as for overall dynamic regional comparative advantage, this is likely to be reflected in the type of employment and associated remuneration from the competitive and adaptive advantage of a region's firms in the knowledge economy. This will then feed back into a region's knowledge resources. Although measures of regional or national competitiveness have traditionally focused on productivity it is also acknowledged that the welfare of the citizens should be a key priority (Storper, 1997; Huggins, 2003; Aiginger, 2006). This means that as well as considering the success of regional enterprises it is key that this is translated into a sustainable rise in the population's standard of living, with not only average wages, but access to work as captured by the unemployment rate acting as key measures of the extent that this is achieved. Since 2003, Chinese policy has begun to shift from rewarding export focused development to the greater encouragement of domestic innovation (Zhou et al., 2011; Shie et al., 2012), which does provide incentives for regions to generate on-going and sustained dynamic competitive advantage, rather than the more temporary cost advantages associated with labor intensive activities.

Although Figure 1 summarizes the links between the different elements of an adapted dynamic regional comparative advantage model, and indicates some of those potential measures that could be used within performance benchmarking at each stage, it is recognized that this is to some extent a simplification of the overall picture. It is only possible to capture a true notion of the regions' strengths and weaknesses in the knowledge economy by considering not only the quantifiable measures associated with performance benchmarking, but also the more qualitative aspects of the structures and systems underlying these measures through process benchmarking. These have to be put in the context of the government policies currently and previously utilized, which requires a policy benchmarking approach to also be adopted. Only through a combination of all three benchmarking approaches, can the true strengths and weaknesses of the three regions' knowledge economies be identified and compared. The three regions are discussed in the next section, before the operationalization of the benchmarking activities are outlined in section 4.

3. Case Study Regions

The case study regions - consisting of the Bohai Gulf Region (BGR), Yangtze River Delta (YRD), and Pearl River Delta (PRD) - are widely acknowledged as China's most competitive and knowledge-based spatial areas of economic activity. All three regions are situated in the more prosperous eastern coastal region of China. It is possible to distinguish between the ‘broad’ city-region (Zhao and Zhang, 2007), and a ‘narrower’ spatial definition of the region for each of the regions, and in this study it is the broader city-regions that are the focus of the analysis. In the narrow sense, PRD consists of 9 cities, and extends to 14 in the broader sense - consisting of the whole of Guangdong province. The narrow sense of YRD consists of 16 cities surrounding Shanghai; and in the broader sense it consists of Jiangsu province, Zhejiang province and Shanghai. The narrow sense of BGR consists of 15 cities surrounding Beijing, and in the broader sense the Bohai Gulf region consists of Shandong province, Liaoning province, Hebei province, Beijing and Tianjin.

The three regions include 9 provinces or municipalities covering 9.5% of national surface area and 37.9% of the total Chinese population in 2008, but collectively account for 57.9% of total GDP. GDP per capita across the three regions is 1.5 times the national average, highlighting the economic significance of these regions (Table 1).

Table 1 About Here

BGR is dominated by the presence of the national capital, Beijing, along with its associated government and public sector activities. The economic development of BGR has been shaped by the presence of a large number of public institutions, and the planned nature of its economy. YRD on the other hand, dominated by the city of Shanghai, has enjoyed a longer tradition of openness than much of China. YRD consists of 80 cities, small and large, which have constituted a hierarchy structure conducive to industrial development and knowledge diffusion. YRD has a strong industrial foundation, and is the birthplace of China's modern industry, which began to take shape in Shanghai, Wuxi and Suzhou in the early 20th century. In general, YRD has an advantage in terms of attracting resources, as it possesses the best infrastructure and location, with Shanghai identified as being the most attractive investment location within China (Jefferson and Kaifeng, 2002). Similarly, PRD’s geographical proximity to Hong Kong has been an important factor in the region’s growth.

Historically, the economic context of PRD is almost the opposite of BGR. Before reform and opening-up, this region is best described by the Chinese saying *Yiqiong erbai:* poverty and blankness. Under the central planning system, Guangdong province was given very low priority in terms of resource allocation, mainly due to its relatively weak industrial foundation, and the government’s concern with its geographical proximity to Hong Kong and Taiwan (Vogel, 1989; Yang and Liao, 2010). However, over the last three decades PRD has developed an export-oriented economy, with the sum of imports and exports, as well foreign capital, the highest of all provinces in China (Lu and Wei, 2007). Although PRD has an outward orientation similar to that of YRD, this has been achieved over a much shorter period of time through considerable government intervention. This means that these three most economically developed regions of China have quite different development trajectories, which have led to their current widely varying sources of regional resource, capability and comparative advantage. The regions, therefore, provide a suitable cross-section to examine via Martin and Sunley's (2011) model of regional competitiveness in terms of past, current and future development.

4. Data and Methods

This study makes use of the dynamic comparative advantage model of Martin and Sunley (2011) as the base of the investigation into the three leading Chinese regions' strengths in the knowledge economy. In order to operationalize the framework the competitiveness benchmarking approaches outlined by Huggins (2010) are used. This consists of three forms of benchmarking: (1) *performance benchmarking* – which seeks to measure, analysis and compare the relative economic performance of regions; based on a comparison of metrics portraying the relevant characteristics of benchmarked regions; (2) *process benchmarking* – which examines the structures and systems constituting the practices and functioning of benchmarked regions; and (3) *policy benchmarking* – which seeks to compare the types of policy considered to influence the nature of the practices, and subsequently the characteristics, of benchmarked regions. The three competitiveness benchmarking exercises are conducted for each of the key components of the dynamic comparative framework, namely: regional resources; deployment of resources by regional organizations; competitive and adaptive advantage of regional organizations; and overall dynamic regional comparative advantage. This allows the differing strengths and weaknesses influencing the competitiveness of each region to be identified.

For the performance benchmarking element, we incorporate a range of relevant data to quantitatively analyze differences across the three regions, in particular using a variety of input and output measures of innovation. These measures are drawn from the National Bureau of Statistics of China yearbooks. This provides access to comparable measures at the province level, which are then aggregated for the three super regions being examined. The choice of variables utilized is restricted to some degree by the availability of this data at the appropriate level of disaggregation. However, based on the literature outlined in section 2 a number of measures are available for each component of the framework. Table 2 below outlines the variables used to capture each of the components of the dynamic regional comparative advantage framework.

Table 2 About Here

For the process and policy benchmarking, qualitative analysis of data from the extant literature and other relevant studies are utilized to highlight the nature of relationships between, and the effective use of, knowledge resources and policy development. This provides a much more qualitative examination of the competitiveness of the three regions in terms of each of the components. This allows not only the quantity, but also the quality of each of these factors to be incorporated into the assessment of the regions' strengths within the knowledge economy.

Given the qualitative nature of the process and policy benchmarking, the opportunity to test the validity of the framework is limited to the performance measures. A panel regression approach is used to consider the relationships between the components. In order to provide sufficient observations, the data utilized here is at the province level, with data used for all 31 mainland provinces. Where available the time period covered runs from 2001 to 2011, however, missing data requires a shorter period to be considered for some measures. Given the different sizes of the provincial economies all measures are scaled by regional GDP in the case of financial measures, such as expenditure on R&D, or by the population in the case of non-financial measures, such as patents granted. In order to undertake the panel regression it is necessary for the data to be stationary, so that it has no trend. To ensure that this is the case first differences of the scaled data were used, and in the case of college enrollment and patents further detrending was undertaken by regressing the series on a time series and utilizing the residuals created. Levin, Lin and Chu tests were used to confirm the lack of a common unit root process, and the Phillips-Perron Fisher chi-square test to check for individual unit root processes. All series were confirmed as stationary after differencing and detrending.

In each regression a measure from one of the components was regressed on the measures included in the preceding component, for example R&D expenditure was regressed on the regional knowledge resource measures. The independent variables were lagged one period to provide greater clarity of the direction of causality. Although the lag structure may be longer than a single year the limited period of data prevented longer lags being included.

5. Regional Resources

Performance Benchmarks

Overall, BGR has the strongest infrastructure, in terms of sheer size, for the development of human capital, with 382 of China's 1,794 (21.3%) of universities located in the region. It is also the location for many of the most prestigious universities, including 29 of the 72 universities affiliated with the Ministry of Education, as well as China's top two universities - Tsinghua University and Peking University - and 28 of China's top 100 universities (Wu, 2007a). However, across the three regions YRD displays the highest number of higher education students per 100,000 of population (1,960) (Table 3). PRD actually has a lower proportion of the population in higher education than the Chinese average (84 percent of Chinese average).

Table 3 About Here

This regional pattern of human capital formation is repeated in the terms of the educational qualifications already held within the population. The YRD proportion of the population with college or higher education is 37 percent above the Chinese national average. BGR also displays an above average proportion of the population holding these higher qualifications. In PRD, the level of college and higher education qualifications held is below the national average, although an above average proportion of the population holds senior secondary education.

In terms of technological resources, China as a later developing economy has been in the position to catch-up with technology in other economies mainly through the attraction of FDI. This has made linking to other East Asian multinational corporations and suppliers important in allowing China to take a lead position in a number of markets (Wei et al., 1999; Gereffi, 2009). Considerable regional disparities in attracting FDI exist. Although in absolute terms BGR and YRD have greater foreign investment and a greater number of foreign enterprises, when scaled by population PRD massively outperforms the national average. Between 1979 and 2009, total foreign investment in PRD was US$233.2 billion. In 2009 the region attracted US$19.5 billion of investment - 17.5% of the national total. In 2011 the region was the host for 97,084 enterprises with foreign investment (21.7% of the Chinese total). In 2001, the foreign investment attracted by PRD as a proportion of foreign investment in China reached a peak of 31.7% of the national total, although this has slipped back in recent years. This pattern is evident in Figure 2, where foreign registered investment at the year end as a percentage of regional GDP has decline sharply.

Figure 2 about here

As well as disparities in the scale of investment there are variations in the source and nature of this investment. In 2009 the proportion of FDI from Europe and North America in YRD is double that of PRD, which is more reliant on investment from other emerging Asian industrialized economies, with Southeast Asia accounting for 70.9% of foreign investment in PRD compared to only 11.3% from developed countries.

Process Benchmarks

As well as the physical resources present the institutions within a region have an important role to play as part of a region's 'fundamentals', with their impact tending to be evident through processes of knowledge creation. Given the geographic proximity required to benefit from knowledge spillovers from foreign affiliates (Jaffe, 1986; 1989; Huang et al., 2012), the concentration of FDI in PRD placed the region in a good position to grow using both foreign and domestic enterprise (He et al., 2008; Yang, 2009; Zheng, 2006; Lu and Wei, 2007). In YRD, investment is characterized by far more joint ventures and collaborative agreements between foreign investors and domestic firms - between 1978 and 2005, 57% of FDI in Shanghai was in the form of joint and cooperative ventures, compared with only 19% in PRD.

FDI from the west has tended to be significantly more advanced than other foreign investors in relation to technology and integrated management, and the diffusion effects of technology and synthesized knowledge are apparent, playing a vital role in improving the technological and industrial structure of YRD (Gan, 2003). This has resulted in YRD drawing the highest proportion of new technology from overseas, with 88.3 per cent coming from abroad. In Shanghai, this was as high as 94.1 per cent (Fu, 2008).

BGR possesses many of China's leading academic and research institutions, especially institutions with reputations allowing integration into the global scientific knowledge network. Liefner and Hennemann (2011) find high levels of international co-authorships with Beijing's academics in disciplines such as optical technology. In addition Beijing has a special central role in the national scientific knowledge network, with academics in other cities collaborating frequently with those in Beijing.

Section 2 discussed those studies outlining the general problems faced by China in adapting to new rules and regulations that provide intellectual property right protection, of the three regions YRD has superiority in terms of industrialization, urbanization and a historically rooted form of openness, facilitating better access to, and integration, within this institutional framework. Before reform and opening-up, state-owned enterprises in YRD were the largest, with industrial output for Shanghai alone accounting for 12.5% of national output in 1980. At the same time, collective enterprises in the region - at that time called 'township enterprises' – were the most advanced in China, especially in Jiangsu province, with the volume and output value of township enterprises accounting for almost half of the nationwide total (Luo and Zeng, 2001).

Policy Benchmarks

Although government intervention is high by western standards, there are varying degrees of government control across the three case study regional economies. BGR generally retains the greater centralization and is the most heavily planned regional economy, and it has remained an important receiver of national investment for many years. For example, the Liaoning province of the region was a key investment target as far back as the 1950s, receiving 1.45 billion RMB in 1950-1952, 20% of the aggregate investment for the nation during the period. In general, Beijing has remained the key city receiving investment, particularly financial, educational and R&D.

In a more contemporary sense, PRD was the pilot region for Chinese reform and economic investment, which has subsequently provided it with a range of institutional advantages that have stimulated rapid economic development (Xie and Costa, 1991; Lu and Wei, 2007). In 1978, when China first chose the path towards reform, PRD was selected as the pilot area for three of four special economic zones - Shenzhen, Zhuhai, and Shantou - are in PRD (the other Xiamen is in Fujian province), and among the 14 opened coastal port cities established in 1984, two cities - Guangzhou and Zhanjiang – in PRD were included (Wang and Bradbury, 1986). As part of its pilot status, PRD was granted a range of 'special polices and flexible measures', with the region playing the role of both a testing ground and a showcase for China's new economic policies. Measures relating to extremely preferential taxation rates were initiated, with a tax rate of only 15% imposed for overseas investors, compared to 33% for domestic enterprises (as well as a tax holiday during the first two years of business) - a policy which remains in effect - along with a plethora of land-use policies

(Lin, 2009). PRD was also the first region to allow output of foreign affiliates to be targeted at the Chinese domestic, rather than the export, market (Wang and Meng, 2004).

YRD has traditionally been one of China's most open regions, and after the Opium War Shanghai, as part of the first batch of modern Chinese cities, opened its gates and began the process of modernization, developing significant links with the capitalist production model. In YRD, local authorities have played an important role in developing industrial clusters using FDI, for instance setting-up industrial parks to house major Taiwanese original design producers and their suppliers in the notebook manufacturing industries (Greenaway et al., 2002). In recent years, government incentives and policies have played a lesser role in the decision to locate in YRD, but factors such as industrial infrastructure, land use fees, and attitudes to FDI still influence the decision of where to locate within YRD (Wei, 2010).

6. Deployment of Resources by Regional Organizations

Performance Benchmarks

The preceding component of regional knowledge resources provided an indication of the resources that were available as inputs into the knowledge creation process within the region. However, in order for these resources to be utilized effectively it is important that resources are dedicated to appropriate activities. Private enterprises have come to account for an increasing proportion of R&D expenditure and employment in China, but this has occurred at different speeds across its regions (Li, 2009). Combined with different initial government spending on R&D across Chinese regions, this has led to significant differences in the structure of R&D expenditure across the three regions. According to 2009 figures, 26.5% of the nation's R&D researchers are based in BGR, with the aggregate number of scientists and engineers accounting for 28.3% of China's total. Reliance upon the university and state sector is clear, with only 42.5 per cent of the R&D employees in the region employed in large firms, compared to a national average of over 51 per cent. Table 4 indicates that technical and scientific employment in state-owned enterprises is much more prevalent in BGR, with the number of such employees per 10,000 population approximately double that of YRD and eight to 10 times that of PRD.

Table 4 About Here

In 2009 enterprises accounted for 61.1% of total R&D expenditure in Shanghai and 89.9% in Guangdong, but only 15.1% in Beijing. Considering the R&D employment and expenditure of enterprises in 2011 there are clear differences between the regions. R&D employment and expenditure is highest in YRD, with R&D expenditure reaching US$23.4 billion in 2011. Although expenditure in BGR is similar, R&D employment is approaching 200,000 full-time equivalents lower. The performance figures, therefore, indicate that there is a much higher level of R&D activity within BGR and YRD than PRD. However, scaling employment by population and expenditure by GDP suggests that in this more privately-driven expenditure YRD and PRD perform quite similarly, with BGR lagging behind.

Process Benchmarks

It was noted in section 2 that the state tradition of direct control of innovative activities has left China's state-owned enterprises still possessing the highest quantity and best quality specialized technological human resources, with Shanghai's state-owned enterprises being China's strongest. Therefore, many technological problems arising in private enterprises and collectively-operated enterprises throughout YRD can potentially be solved by specialized talent residing in these state-owned enterprises.

As early as the 1980s, when Jiangsu and Zhejiang's township enterprises and private enterprises lacked technical talents, they invited engineers from Shanghai to help them solve technological problems largely in their spare time, a phenomenon known as the 'weekend engineer' which became more formalized in the 1990s (Rui, 2006). At a firm level, state-owned enterprises in Shanghai also have a long tradition of supplier relationships with collectively-operated and private enterprises in Jiangsu, Zhejiang and the Shanghai suburban districts, which have acted as an important diffuser of knowledge stimulating the initial growth of private enterprises located in the region's smaller and more medium-sized cities (Wei, 2010).

Although BGR has the advantage of hosting many of the top universities and government research institutes, to an extent this actually constrains diffusion. BGR has adopted a model of resource leverage placing a reliance on public sector institutions, including universities, to start the process of technology diffusion. Such is the relative glut of government research funding to universities and research institutions, most are not 'reliant' on forming industrial collaborations, which are generally weakly developed (Scherngell and Hu, 2011; Wu, 2007a; 2010). Instead, the development of spin-off companies has become the most viable option for many researchers in BGR seeking to commercialize their knowledge or technology, leading to the development of a number of science parks to house these firms and others (Zhou, 2005).

The number of universities in Shanghai is smaller than that of Beijing, but their ability to undertake technological commercialization is much stronger. An important difference is that while the main research funds for Beijing's universities are sourced from national and local government, Shanghai's universities obtain much of their funds from the private sector (Li, 2009). The more developed industrial base in YRD has heightened demand for these services and research, and universities in Shanghai have taken a strong initiative in meeting this demand, with R&D projects funded to ensure they are close to market demand. As such, two thirds of R&D expenditure in all organizations in Shanghai is directed at product or process development, with only 6 percent being allocated to basic research (Wu, 2007b).

Given the potential for FDI to have both positive and negative influences it is the relationships between foreign affiliates and domestic firms that are the parameter of key importance, rather than the presence of foreign affiliates per se. In general, YRD has enjoyed better knowledge diffusion from overseas firms to domestic firms. Both firms and universities play important roles within a city-network framework based around Shanghai (Wei et al., 2007). However, there is still evidence in YRD of a dual economy, with foreign owned firms more likely to trade with other foreign affiliates than local firms (Wei, 2010). In part, this is a result of development policy that has established greenfield technology parks where domestic firms have little or no presence (Wei, 2010).

In PRD, on the other hand, there has traditionally been poor workforce and skills development, principally due to the historic lack of an industrial base and an associated well-trained pool of workers. In the 1980s, as Hong Kong's local manufacturing costs increased, more production took place in PRD, with transport costs being relatively low due to close proximity, with most of the PRD region being only one hour's driving time from Hong Kong (Cheng et al., 2004). More recently, domestic firms have made more investments in R&D, with firms regarding cities such as Shenzhen as innovative hubs, although many foreign firms continue to regard them as little more than large-scale workshops (Zhou et al., 2011).

Policy Benchmarks

Overall, the growth model of regional development in BGR can be considered government-driven due to the knowledge-based investment emanating from central government. During the 1990s, China focused more on the development of technology and education, particularly in BGR. The decision to accelerate the development of technology was taken by the CPC Central Committee and State Council in 1995, which proposed a strategy of strengthening the nation through the development of technology and education, especially scientific and industrial upgrading. The main methods consisted of increasing R&D investment in universities and other related research institutions, as well as promoting cooperation and the development of networks between enterprises and research institutions (Liu and Jiang, 2001; Asheim and Vang, 2004; Kroll and Liefner, 2008). The Chinese Academy of Science affiliates in BGR received a significant proportion of related investments, and in recent years government R&D investment in the region has continued to grow, and on a per capita basis is ranked third across the globe.

In YRD, enterprises have played a greater role in R&D with the proportion of R&D expenditure by enterprises increasing over time. In particular, policy has encouraged this through the merger of some major research institutions with existing state enterprises (Wu, 2007b). Although already possessing one of the most skilled workforces, to further encourage this Shanghai has provided incentives for Chinese foreign trained scientists to return to YRD, as well relaxing rules on the employment of non-local scientists (Wu, 2007b).

In order to increase the level of technological transfer from foreign affiliates and move production up the value chain, in PRD the Shenzhen local government has implemented policies to encourage greater investment by high technology businesses, with policymakers playing a role in selecting the spatial and sectoral distribution of FDI (Wang and Meng, 2004; Lu and Wei, 2007). Furthermore, the Special Economic Zone (SEZ) has stopped accepting applications from *Sanlai Yibu* (overseas) firms except those representing high-technology sectors (Lüthje, 2004).

7. Competitive and Adaptive Advantage of Regional Organizations

Performance Benchmarks

In the previous section the correct positioning and combination of regional knowledge resources to undertake activities that lead to innovation was discussed. However, the success of this allocation of resources will be judged by the innovative outputs that this creates, the easiest to measure of these being patents, leading to a competitive and adaptive advantage for regional organizations (Cheung and Lin, 2004, Martin and Sunley, 2011). Although, China as a whole has been portrayed as having a poor conversion rate of R&D inputs into innovative outputs (Li, 2009), Figure 3 shows the YRD has seen a rapid increase in the number of patents granted per capita since 2008.

Insert Figure 3 about here

In absolute terms YRD generates the greatest number of innovative outputs (Table 5). However, it should be noted that a vast bulk of these are design patents, largely representing smaller incremental innovations. There is a much less difference in the number of invention patents granted, with PRD generating a similar level of invention patents per head of population as YRD. Over the last ten years the proportion of patents granted classed as invention patents, associated with more radical innovation, have increased for all three regions. However, it is here that BGR has led the other three regions.

Table 5 About Here

YRD is most productive in terms of the number of new products being generated with a matching higher level of spending on creating these goods. Although PRD lags in these terms, after controlling for its smaller economy the commercial focus of YRD and PRD compared to BGR is evident, with a larger percentage of GDP dedicated to these activities. YRD is clearly the most successful in generating sales revenue from these new products, in absolute terms and also as a percentage of GDP. Where PRD potentially lags is its ability to convert its investment in developing new products into sales, with this ratio lagging that of BGR and YRD. However, a much larger proportion of these sales come from exports in PRD, with BGR the most domestically orientated. With regard to international trade the value of all three regions' exports has increased rapidly over the last eight years. PRD's openness has ensured that it has the greatest export intensity per head, although its rate of increase is less than that of BGR and YRD. YRD exports the largest amount by value in absolute terms, and has also displayed the greatest increase in exports since 2000.

Process Benchmarks

A region's success in converting R&D inputs into innovative outputs from a process perspective will hinge to a degree on the institutions and partners that are in place to ensure the successful commercialization of research. The lack of reform of the legal system and scarcity of technology intermediaries mean that BGR, with its reliance on government funded R&D and state-owned nature of university research, faces considerable difficulties in ensuring that these institutions work effectively with the private sector (Eun et al., 2006; Wu, 2010). Studies have also found that only a minority of relationships with foreign affiliates are associated with greater innovative outputs (Sun and Du, 2011). As such BGR and YRD are likely to have seen greater gains through this process than PRD, and domestic technology clearly plays a more important role in PRD than the other regions, with 19.2 per cent of technology acquired domestically - the highest figure for the three regions (Fu, 2008). From an initial focus on 'imitated innovation', more firms in PRD are now establishing 'self-initiated innovation' that can compete with the foreign investors. For example, the capacity of self-initiated innovation among firms such as Huawei, ZTE, and TCL has improved markedly in recent years.

Policy Benchmarks

Up until the late 1990s, ownership restrictions prevented many academic entrepreneurs from starting their own businesses. This meant that the only alternative was the development of a University Owned Technology Enterprise (UOTE) (Kroll and Liefner, 2008). However, a lack of incentives meant that these UOTEs were less successful than many had hoped for (Sanders and Yang, 2003). A more market-oriented approach has been adopted since the late 1990s, with academic personnel given more freedom to start and own enterprises, leading to greater pull-entrepreneurship (Kroll and Liefner, 2008).

Linking universities to local enterprise has been seen as a policy priority with neither party used to collaborating in this fashion. To encourage such collaboration universities in both BGR, and in particular in YRD, have been encouraged to develop science parks on their campuses (Wu, 2007b). To aid technology transfer between universities and enterprise, state sponsored National Technology Transfer Centres (NTTC) have been given the role of linking to both multinational and domestic enterprises, acting as gatekeepers to imported technology (Wu, 2010).

8. Dynamic Regional Comparative Advantage

Performance Benchmarks

Clearly, all three regions have achieved very high levels of growth since 1978, although such growth and development has not been uniform, with PRD experiencing the most rapid economic development and BGR the least. Between 1978 and 2005, the compound annual GDP growth rates of BGR, PRD and YRD are 14.9%, 16.8% and 15.4% (at current prices), respectively. In 2006, YRD's GDP per capita was twice the national average, reaching US$6,422, which based on purchasing power parity equates to US$ 22,304. When comparing the two Delta regions, we find that although GDP per capita in YRD is higher in absolute terms, PRD's growth performance is higher due to its low starting base. As Table 6 indicates, official figures suggest that this growth has translated into low unemployment across the three regions, although this may partly reflect the fact that many rural migrants do not appear in official unemployment figures (Solinger, 2006). In general, rapid growth has seen GDP per capita increase quickly, with average wages following a similar pattern, although in BGR wages are relatively low compared to those in YRD and PRD.

Table 6 About Here

Process Benchmarks

The state-driven approach to development in BGR clearly has certain advantages, but there is a danger that continuing that the government's directing of innovation activities, through its funding policies, may stifle development in the long-run (Wu, 2007a; 2010). Furthermore, whilst state owned enterprises have traditionally have provided relatively high levels of remuneration (Zhao, 2002), the lower commercial orientation of knowledge-creating institutions may mean that such enterprises will struggle to compete with the private enterprise-based models in other regions (Wu, 2007b).

In the more FDI-driven model adopted in PRD there is a danger that resources will become drawn into a growth pole of internationally owned firms, resulting in little interaction with domestic enterprises (Myrdal, 1957; Fu, 2004; 2007; 2008; Aghion et al., 2005; Du et al., 2008; Kim et al., 2010; Wang and Meng, 2004). In combination with relatively poor working conditions and detrimental impacts on the general environment from rapid urbanisation (Wei, 2010), PRD's relatively lower technology base may over time struggle to attract the type of capital and labour associated with continuous economic upgrading (Zhou et al., 2011). Therefore, although currently holding a competitive advantage, facilitated by a high level of exports, PRD's firms may lack an adaptive advantage (Perkmann, 2006; Yang, 2009).

Overall, YRD can be considered to have the best economy in terms of aggregate competitiveness, but a potential downside of such competitiveness is that it could create pressures for domestic firms in terms of human capital retention (Wu, 2007b). There is some evidence that this may already be occurring with domestic market and agglomeration effects influencing the decision to locate in YRD, especially the central areas of the region in and around Shanghai (Wei, 2010).

Policy Benchmarks

As noted above, nationally the move from policies promoting an export orientation to encouragement of a more innovation based approach would be expected to start yielding greater more sustainable benefits in terms of rising living standards (Zhou et al., 2011; Shie et al., 2012). At the regional level, however, PRD is held back by earlier policies requiring foreign affiliates to export their output, which limited the type and diversity of economic activity and created a degree of inflexibility (Yang, 2009). Lower local government interference has made YRD more attractive (Yang, 2009), and the mechanisms that have facilitated the feeding back of the fruits of attracted investment into the region's knowledge resources has led to Shanghai possessing a stronger innovation environment (Wu, 2007b).

9. Relations between the components of the dynamic competitive advantage model

Although considerable differences have been found between the three regions in terms of the components of the model of dynamic competitive advantage in a knowledge economy, it is not clear to what extent that the model is appropriate for an emerging economy, such as China. To what extent do the various components of the framework link actually relate to one another? This section undertakes an exploratory analysis of the correlations between the measures constituting each component examined in the preceding sections and the measures in the next component based on the performance benchmarking measures, meaning a lack of relationship may be due to the framework being inappropriate for the Chinese context at this point in its development, or alternatively because the qualitative elements captured by the process and policy benchmarking are not be taken into consideration.

Table 7 About Here

The results indicate that some of the relationships between the components of the dynamic comparative advantage framework are stronger than others (Table 7). There is only weak evidence connecting enrolment in college and university to deployment of knowledge resources within firms to undertake innovative activities when captured by R&D expenditure, and no evidence to connect human capital creation with R&D personnel. Foreign investment shows no significant relationship with regional organizations' comparative advantage of knowledge resources, which is consistent with the concerns raised by authors such as Gu and Lundvall (2006) suggesting many regions of China lack the absorptive capacity to take advantage of any technological spillovers, and Fan and Hu's (2007) suggestion that R&D activities will be largely absent from foreign affiliates. However, where knowledge resources are deployed appropriately, R&D expenditure is associated with both greater exports and patents being granted, whilst higher employment of R&D personnel is linked to patent generation (Panel B).

Overall, China's regions appear to struggle to turn such innovative outputs into higher standards of living (Panel C). The one exception is a positive relationship between invention patents granted and the average wage. Whilst bearing in mind the limitations of only considering performance related measures it appears that the relative under-development of the knowledge economy in China means that the population at large is only currently receiving benefits in terms of rising average wages in a small number of more successful clusters even within the three leading regions considered within this study.

The results of this section and those preceding it can be used to summarize the strengths and weaknesses of the three regions in terms of each of the main components of the dynamic competitive advantage model as appropriate for the knowledge economy (Table 8).

Table 8 About Here

The analysis throughout this study indicates that whilst both BGR and PRD have strengths in some components of the dynamic competitive advantage framework system, both have been hindered in achieving their maximum potential. In the case of BGR the high level of state involvement has hindered the commercial exploitation of the strong knowledge resources present. PRD, on the other hand, faced with a low level of knowledge resources initially, has adopted policies, which have led to a development path, which did not initially rely upon or encourage the appropriate deployment of knowledge resources. Although recently efforts have been made to exploit those knowledge resources now present, it is not possible to change the nature of development immediately. YRD has largely benefited from a combination of stronger knowledge resources and a more commercial deployment of these resources, which as shown in this section is likely to be reflected in greater innovative outputs. However, there is still a weaker element in terms of the knowledge competitive and adaptive advantage of organizations created with less emphasis on those innovative outputs that will raise living standards.

10. Conclusion

Through the theoretical lens of dynamic comparative advantage, this paper has benchmarked the competitiveness of China's leading three 'super-regions' with a view to determining which region, at this stage in its development, is likely to become the most dominant knowledge-based economic force. It has been shown that each region has hugely increased its competitiveness through dynamic improvements in the capacity to absorb and diffuse economically beneficial knowledge. In particular, the number of innovative outputs created has increased as the deployment of knowledge resources has increased. However, the importance of benchmarking competitiveness both in terms of processes and policy as well as the more widely used performance approach is clear given the lack of connection found between most of the components of the dynamic competitive advantage framework. Similarly, simply increasing knowledge inputs such as the human capital encapsulated within the labour force and availability of new technology and working procedures through foreign investment is unlikely to be successful.

In overall terms, the competitiveness benchmarking exercise suggests that YRD, incorporating the Shanghai metropolis, is best positioned to become the dominant hub of the knowledge economy in China. YRD’s advantages are multi-dimensional, with the region possessing the most advanced infrastructure, and generally being the most attractive location for investment. Coupled with a relatively highly skilled workforce, this has led to the region becoming the premier knowledge-based location for both indigenous and overseas investment.

YRD, especially Shanghai, has advantages in terms of its embedded industrialization and urbanization, which pre-dates the period of reform. Since reform, however, the region has rapidly evolved its economic structure, such that it is clearly the most innovative and technology-driven region in China, possessing relatively well developed regional knowledge diffusion and absorption channels. It has the most evolved economic and technological base, allowing it to absorb advanced technology from developed nations, and establish cooperation between local enterprises and foreign capital, which reinforces the development of the region. In essence, the more pronounced shift toward a capitalist and market oriented economy in YRD has led to it becoming the leading region based on aggregate competitiveness. Although government intervention has been relatively light touch in the region, where is has occurred it has met with a significant degree of success, such as policies to stimulate industrial clusters anchored by FDI.

Although YRD has developed a dynamic regional comparative advantage at this point in time, some further policy adjustments will be required. For instance, while appropriate policies are being used to attract foreign knowledge assets to the region, these policies are not necessarily appropriate to maximize the diffusion of knowledge, and access to these resources, throughout the region (Huang, 2008). This means that although possessing a comparative advantage of resources, which generates an adaptive advantage for its firms, this advantage has not yet matched the region’s potential.

The growth models across all three regions are clearly linked to their pre-existing regional resources and institutions, and although PRD is lagging in terms of knowledge resources, it is making advances through the efficient use of available knowledge resources. However, its lack of resources suggests that it will struggle to overhaul YRD as the most likely candidate to become the dominant knowledge centre in future years. Although lacking the knowledge resources of the other two regions, it is a very market-oriented region, with the market playing a critical role in resource allocation. A lack of absorptive capacity has prevented PRD from maximizing the potential of the knowledge resource that is its huge foreign investment, but the market-driven approach has enabled some firms within the region to generate an adaptive advantage. Combined with an appropriate shift in policy to promote the knowledge economy, there is evidence that the economy is beginning to elevate itself above what has sometimes been seen as an insurmountable lock-in to low cost, low value added production.

Although BGR possesses resource advantages in terms of regional externalities, it is currently limited by the prevailing institutional structure. At the outset of reform, the region would have appeared to be best positioned in terms of the resources available for the use within the knowledge economy, but it has not moved as swiftly towards a market-oriented system as the two Deltas, mainly due to historical factors and the continuing momentum of a planned economy approach. In BGR resources have proved less appropriate when processes are examined, and policy places a rigid hold on these resources. This has meant that the resource advantage has not generally led to a comparative advantage of knowledge resources for enterprises operating within the region. This ultimately appears to place the enterprises within BGR at an adaptive disadvantage, which could limit the potential of the region to become the dominant hub of the Chinese knowledge economy, even though its knowledge institutions are well resourced and internationally linked.

The continuance of marked differences in their knowledge bases means that while all three regions will more than likely continue to grow, they will do so through different ways. A convergence in growth models will be more than partly dependent on the extent to which central and regional policymakers seek to, and are able to effectively, transfer policy lessons from across and within regions, such as policies aimed at increased marketization in BGR, or policies focused on indigenous innovation in PRD (Zhao and Tong, 2001; Wei and Ye, 2009). A key policy issue for the regions, and China as a whole, is the future relationship between FDI and GDP. The strength of this relationship is by no means certain, and will depend in part on the type of FDI undertaken, especially whether it is oriented toward exports or import substitution (Li and Liu, 2005; Fleisher et al., 2010; Lu, 2010).

Wider economic conditions in China will clearly play a role in this respect, and while economic reforms have helped provide a more liberalized trade regime, encouraging export oriented FDI, the emergence of skills shortages suggest that education and workforce could be an Achilles heel in the future (Zhang, 2001; Zhou et al., 2011). At a regional level, some findings suggest that FDI located outside the key coastal regions tends to crowd out domestic investment (Wen, 2007; Ran et al., 2007), which has led to policy moves away from the development of new special economic zones - and their associated tax benefits - to allow domestic firms to compete on a more level playing field (Fleisher et al., 2010). In terms of university-driven development, a number of barriers associated the commercialization of university research remain in place (Wu, 2010), with communication channels between universities and the private sector generally found to be of poor quality (Guan et al., 2005).

Finally, this paper has sought to benchmark the super-regions of China, in order to speculate on their economic trajectories. Future research in this area would be advised to examine competitiveness at a less aggregated spatial level, in order to assess the extent to which intra-region connections have developed, and the extent to which the benefits are evenly or unevenly spread throughout the regions as a whole.

References

Acs, Z. J. Anselin, L. and Varga, A. 2002. Patents and innovation counts as measures of regional production of new knowledge. *Research Policy* 31(7): 1069-1085.

Aghion, P. Blom, N. Blundell, R. Griffith, R. and Howitt, P. 2005. Competition and innovation: An inverted U relationship. *Quarterly Journal of Economics* 120(2): 701-728.

Aiginger, K. 2006. Competitiveness: from a dangerous obsession to a welfare creating ability with positive externalities. *Journal of Industry, Competition and Trade* 6(2): 161-177.

Asheim, B and Vang, J. 2004 .What can regional systems of innovation and learning offer developing countries?, *Paper presented at the Second Globelics Conferences*, 16th-20th October, Beijing.

Awokuse, T. O. and Yin, H. 2010. Intellectual property rights protection and the surge in China. *Journal of Comparative Economics* 38(2): 217-224.

Ballot, G. Fakhfakh, F. and Taymaz, E. 2001. Firms' human capital, R&D and performace: a study on French and Swedish firms. *Labour Economics* 8(4): 443-462.

Barney, J. B. 1995. Looking inside for competitive advantage. *Academy of Management Executive* 9(4): 46-61.

Bathelt, H. Malmberg, A. and Maskell, P. 2004. Clusters and knowledge: local buzz, global pipelines, and the process of knowledge creation. *Progress in Human Geography* 28(1):31-56.

Bilbao-Osorio, B. and Rodríguez-Pose, A. 2004. From R&D to innovation and economic growth in the EU. *Growth and Change* 35(4), 434-455.

Blomström, M. and Kokko, A. 1998. Multinational corporations and spillovers. *Journal of Economic Surveys* 12(3): 1-31.
Boschma, R. and Frenken, K. 2006. Why is economic geography not an evolutionary science? Towards an evolutionary economic geography, *Journal of Economic Geography* 6(3): 273–302.
Chang, G. 2008. Restructuring of large industrial SOEs in transitional China: A case study in Lanzhou. *Tijdschrift voor Economische en Sociale Geografie*, 99(1), 84-93.
Cheng, G. He, L. and Dong, W. 2004. In the depth of the global factories: An investigation of living circumstances of off-farm workers in the Pearl River Delta of China. *China Youth Daily*, 12, 31.
Cheung, K-Y. and Lin, P. 2004. Spillover effects of FDI on innovation in China: Evidence from the provincial data. *China Economic Review* 15(1): 25-44.
Coe, D.T. and Helpman, E. 1995. International R&D Spillovers. *European Economic Review* 39(5): 859-887.
Cohen, W. and Levinthal, L. 1990. Absorptive Capacity: A New Perspective on Learning and Innovation. *Administrative Science Quarterly* 35(1): 128–152.
Cooke P. 2004. Regional innovation systems: An evolutionary approach, in Cooke P., Heidenreich M. and Braczyk H. (Eds) *Regional Innovation Systems: The Role of Governance in a Globalised World*, pp. 1–18, Routledge: London.
Crossley, M. and Murby, M. 1994. Textbook provision and the quality of the school curriculum in developing countries: issues and policy options. *Comparative Education* 30(2): 99-114.
Dai, D. and Xu, T. 2000. Research on the policy and legislation environment of enterprise technology innovation. *Paper Presented in the China-US Joint Conference on Technology Innovation Management*, Beijing, 24-27 April.
Démurger, S. 2001. Infrastructure development and economic growth: an explanation for regional disparities in China? *Journal of Comparative Economics* 29(1): 95-117.
Du, J. Lu, Y. and Tao, Z. 2008. Economic institutions and FDI location choice: evidence of US multinationals in China. *Journal of Comparative Economics* 36(3): 412-429.
Eun, J-H. Lee, K. and Wu, G. 2006. Explaining the "university-run enterprises" in China: A theoretical framework for university-industry framework in developing countries and its application to China. *Research Policy* 35(9): 1329-1346.
Fan, C. S. and Hu, Y. 2007. Foreign direct investment and indigenous technological efforts: evidence from China. *Economics Letters* 96(2): 253-258.
Fleisher, B. Li, H. and Zhao, M. Q. 2010. Human capital, economic growth, and regional inequality in China. *Journal of Development Economics* 92(2): 215-231.
Friedmann, J. 2006. Four theses in the study of China's urbanization. *International Journal of Urban and Regional Research* 30(2): 440-451.
Fu, X. 2004. Limited linkages from growth engines and regional disparities in China. *Journal of Comparative Economics* 32 (1), 148-164.
Fu, X. 2007. Trade-cum-FDI, human capital inequality and the dual economy in China: The Signer perspective. *Economic Change and Restructuring* 40(1/2): 137-155.
Fu, X. 2008. Foreign direct investment, absorptive capacity and regional innovation capabilities: Evidence from China. *Oxford Development Studies* 36(1): 89-110.
Fu, X. Pietrobelli, C. and Soete, L. 2011. The role of foreign technology and indigenous innovation in the emerging economies: technological change and catching-up. *World Development* 39(7): 1204-1212.
Gan, C. K. 2003. The relationship between FDI and the development of Shanghai industries. *Shanghai Economy* 3: 35-39.

Gao, J. 2000. Growing technological innovation capability of Chinese firms before S&T take-off. *Paper presented at the China-US Joint Conference on Technological Innovation*, Beijing 24-27 April.
Gao, J. and Fu, J. 1996. The key problems of technological innovation in business firms. *Zhongwai Keji Zhengce Yu Guani [Science and Technology International]*, 1: 24-33.
Garofoli, G. (ed.) 1992. *Endogenous Development and Southern Europe*. Aldershot: Avebury.
Garofoli, G. 2002. Local development in Europe: Theoretical models and international comparisons. *European Urban and Regional Studies* 9(3): 225-239.
Gereffi, G. 2009. Development models and industrial upgrading in China and Mexico. *European Sociological Review* 25(1): 37-51.
Gilson, L. 2005. Trust and the development of health care as a social institution. *Social Science and Medicine* 56(7): 1453-1468.
Giuliani, E. 2005. Cluster absorptive capacity: Why do some clusters forge ahead and others lag behind? European Urban and Regional Studies 12(3): 269-288.
Goolsbee, A. 1998. Does government R&D policy mainly benefit scientists and engineers? *American Economic Review* 88(2): 298-302.
Greenaway, S. Upward, R. and Wright, P. 2002. Sectoral and geographic mobility of labour markets and structural adjustment. *University of Nottingham Research Paper*, #2002/18.
Groenewold, N. Lee, G. P. and Chen, A. P. 2007. Regional output spillovers in China: Estimates from a VAR model. *Papers in Regional Science* 86(1): 101-122.
Groenewold, N. Chen, A. and Lee, G. 2010. Inter-regional spillovers of policy shocks in China. *Regional Studies* 44(1): 81-101.
Gu, S. and Lundvall, B. Å. 2006. China's innovation system and the move toward harmonious growth and endogenous innovation. *Innovation: Management, Policy and Practice* 8(1): 1-26.
Guan, J. and Liu, S. 2005. Comparing regional innovative capacities of PR China-based on data analysis of the national patents. *International Journal of Technology Management* 32(3/4): 225-245.
Guan, Q. and Zhu, H. (eds.) 1992. *Studies on Guangdong's Foreign Trade*. Guangzhou: South China University of Science and Technology Press.
Harris R.G. 2001. The knowledge-based economy: Intellectual origins and new economic perspectives. *International Journal of Management Reviews* 3(1): 21–40.
He, C., Wei, Y.D., and Xie, X. 2008. Globalization, institutional change, and industrial location: Economic transition and industrial concentration in China. *Regional Studies* 42(7): 923-945.
Hooley, G. and Greenley, G. 2005. The resource underpinnings of competitive positions. *Journal of Strategic Marketing* 13(2): 93-116.
Hu, A. and Jefferson, G. 2002. FDI impact on spillover: evidence from China's electronic and textile industries. *World Economy* 25(8): 1063-1076.
Hu, A. and Jefferson, G. 2004. Returns to research and development in Chinese industry: evidence from state-owned enterprises in Beijing. *China Economics Review* 15(1): 86-107.
Hu, M-C. and Mathews, J. A. 2005. National innovative capacity in East Asia. *Research Policy* 34(9): 1322-1349.
Huang, L., Liu; X. and Xu, L. 2012. Regional innovation and spillover effects of foreign direct investment in China: A threshold approach. *Regional Studies*, 46(5): 583-596.
Huang, Y. (2008) *Capitalism with Chinese Characteristics: Entrepreneurship and the State*. Cambridge: Cambridge University Press.

Huggins, R. 2003. Creating a UK competitiveness index: regional and local benchmarking. *Regional Studies* 37(1): 89-96.
Huggins, R. 2010. Regional competitiveness intelligence: benchmarking and policy-making. *Regional Studies*, 44(5), 639-658.
Huggins, R. and Izushi H. 2007. *Competing for Knowledge: Creating, Connecting, and Growing*. London: Routledge.
Huggins, R. and Izushi, H. (Eds) 2011. *Competition, Competitive Advantage, and Clusters: The Ideas of Michael Porter*, Oxford: Oxford University Press.
Huggins, R., Demirbag, M. and Ratcheva, V. 2007.Global knowledge and R&D foreign direct investment flows: Recent patterns in Asia Pacific, Europe, and North America. *International Review of Applied Economics* 21(3): 437-451.
Jaffe, A. 1986. Technological opportunity and spillovers of R&D: Evidence from firms; patents, profits and market value. *American Economic Review* 76(5): 984-1001.
Jaffe, A. 1989. Characterizing the 'technological position' of firms, with application to quantifying technological opportunity and research spillovers. *Research Policy* 18(2): 87-97.
Jefferson, G. H. and Kaifeng, Z. 2002. An investigation of firm-level R&D capabilities in East Asia. *Davidson Institute Working Paper* #583.
Ke, S. 2010. Determinants of economic growth and spread-backwash effects in western and eastern China. *Asian Economics Journal* 24(2): 179-202.
Ke, S. and Feser, E. 2010. Count on the growth pole strategy for regional economic growth? Spread-backwash effects in Greater Central China. *Regional Studies* 44(9): 1131-1147.
Kim, T.-Y., Delios, A. and Xu, D. 2010. Organizational geography, experiential learning and subsidiary exit: Japanese foreign expansions in China, 1979–2001. *Journal of Economic Geography* 10(4): 579-597.
Kroll, H. and Liefner, I. 2008. Spin-off enterprises as a means of technology commercialisation in a transforming economy: Evidence from three universities in China. *Technovation* 28(5): 298-313.
Krugman, P. (2005) 'Second winds for industrial regions?', in D. Coyle, W. Alexander, and B. Ashcroft (eds.) *New Wealth for Old Nations: Scotland's Economic Prospects*, Princeton, NJ: Princeton University Press, pp. 35-47.
Li, H. S. 2004. Balanced and unbalanced strategies-on the evolution of development strategies in regional economy of new China. *Development Researches* 2, 20-21.
Li, X. 2002. The changing spatial networks of large state–owned enterprises in reform–era China: A company case study. *Tijdschrift voor Economische en Sociale Geografie*, 93(4), 383-396.
Li, X. 2009. China's regional innovation capacity in transition: an empirical approach. *Research Policy* 38(2): 338-357.
Li, X. and Liu, X. 2005. Foreign direct investment and economic growth: An increasingly endogenous relationship. *World Development* 33(3): 393-407.
Liefner, I., Hennemann, S. and Xin, L. 2006. Cooperation in the innovation process in developing countries: empirical evidence from Zhongguancun, Beijing. *Environment and Planning A* 38(1): 111–130.
Liefner, I. and Hennemann, S. 2011. Structural holes and new dimensions of distance: the spatial configuration of the scientific knowledge network of China's optical technology sector, *Environment and Planning A*, 43(4), 810-829.
Lin, G. C. S. 1999. 'State policy and spatial restructuring in post-reform China, 1978-95', *International Journal of Urban and Regional Research*, 23(4), 670-696.

Lin, G.C.S. 2009. Scaling-up regional development in globalizing China: Local capital accumulation, land-centred politics, and reproduction of space. *Regional Studies* 43(3): 429-447.
Lin, P. (2002) 'R&D in China and the Implications for Industrial Restructuring', *Centre for Public Policy Studies Working Paper Series*, #128.
Liu, H. and Jiang, Y. 2001. Technology transfer from higher education institutions to industry in China: nature and implications. *Technovation* 21(3): 175-188.
Liu, X. and White, S. 2000. China's national innovation system in transition: An activity-based analysis. *Paper presented at the Sino-US Conference on Technological Innovation*, April 24th-26th, Beijing.
Liu, X. and White, S. 2001a. Comparing innovation systems: a framework and application to China's transitional context. *Research Policy* 30(7): 1091-1114.
Liu, X. and White, S. 2001b. An exploration into regional variation in innovative activity in China. *International Journal of Technology Management* 21(1/2): 114-129.
Liu, Z. 2008. Foreign direct investment and technology spillovers: theory and evidence. *Journal of Development Economics* 85(1/2): 176-193.
Lu, J. 2010. Agglomeration of economic activities in China: Evidence from establishment censuses. *Regional Studies* 44(3): 281-297.
Lu, L. and Wei, Y.D. 2007. Domesticating globalisation, new economic spaces and regional polarisation in Guangdong province, China. *Tijdschrift voor Economische en Sociale Geografie* 98(2), 225-244.
Lu, M. and Wang, E.R. 2002. Forging ahead and falling behind: changing regional inequalities in post-reform China. *Growth and Change* 33(1): 42-71.
Luo, S.G. and Zeng, Z.G. 2001. Analyses of sustainable development mechanism in southern Jiangsu province. *UNCRD Research Report Series* 42, 103-115.
Lüthje, B. 2004. Global production networks and industrial upgrading in China: the case of electronics contract manufacturing, *East-West Centre Working Papers*, #74.
Mahroum, S., Huggins, R., Clayton, N., Pain. K. and Taylor, P. 2008. *Innovation by Adoption: Measuring and Mapping Absorptive Capacity in UK Nations and Regions*. London: NESTA.
Martin, R. and Sunley, P. 2006. Path dependence and regional economic evolution, *Journal of Economic Geography*, 6 (4), 395-437.
Martin, R. and Sunley, P. 2011. Regional competitiveness: clusters or dynamic competitive advantage? In R. Huggins and H. Izushi (Eds.) *Competition, Competitive Advantage, and Clusters: The Ideas of Michael Porter*, Oxford: Oxford University Press, pp.211-238.
Mathews, J. A. 2001. National systems of economic learning: the case of technology diffusion management in East Asia. *International Journal of Technology Management*, 22(5/6): 455-479.
Myrdal, G. 1957. *Economic Theory and Underdeveloped Regions*. New York, NY: Harper and Row.
Nahapiet, J. and Ghoshal, S. 1998. Social capital, intellectual capital, and the organizational advantage. *Academy of Management Review* 23(2): 242–266.
Perkmann, M. 2006. Extraregional linkages and the territorial embeddedness of multinational branch plants: Evidence from the south Tyrol region in Northeast Italy. *Economic Geography* 82(4): 421-441.
Phan P.H, Venkataraman S. and Velamuri S.R. (Eds) 2008. *Entrepreneurship in Emerging Regions around the World: Theory, Evidence and Implications*. Cheltenham: Edward Elgar.
Porter M. 1998. *On Competition*. Cambridge, MA: Harvard Business School.

Radosevic, S. 2002. Regional innovation systems in central and eastern Europe: Determinants, organizers and alignments. *Journal of Technology Transfer* 27(1): 87-96.
Ran, J. Voon, J. P. and Li, G. 2007. How does FDI affect China? Evidence form industries and provinces. *Journal of Comparative Economics* 35(4): 744-799.
Romer, P.M. 1993. Idea gaps and object gaps in economic development. *Journal of Monetary Economics* 32(3): 543-573.
Rui, L. M. 2006. The weekend engineers in South Jiangsu and some implications. *Hongqi Literature* 18, 21-23.
Sanders, R. and Yang, C. 2003. China's path to the new economy: an institutional approach. *Journal of Transforming Economies and Societies*, 10(2): 32-45.
Scherngell, T. and Hu, Y. 2011. Collaborative knowledge production in China: Regional evidence from a gravity Model Approach. *Regional Studies*, 45(6): 755-772.
Scott A.J. and Garofoli G. (Eds) 2007. *Development on the Ground: Clusters, Networks and Regions in Emerging Economies*. London: Routledge.
Shie, V.H., Meer, C.D. and Shin, N.-F. (2012) Locating China in the twenty-first-century knowledge-based economy, *Journal of Contemporary China*, 21(73): 113-130.
Solinger, D. J. 2006. The creation of a new underclass in China and its implications, *Environment and Urbanization* 18(1): 177-193.
Storper, M. 1997. *The Regional World: Territorial Development in a Global Economy*, New York, NY: Guilford.
Sun, Y. 2003. Geographic patterns of industrial innovation in China during the 1990s. *Tijdschrift voor Economische en Sociale Geografie*, 94(3), 376-389.
Sun, Y. and Du, D. 2011. Domestic firm innovation and networking with foreign firms in China's ICT industry. *Environment and Planning A*, 43(4): 786-809.
Tan, Y. 2011. *Chinnovation: How Chinese Innovators are Changing the World*. London: John Wiley & Sons.
Tylecote, A. 2006. Twin innovation systems, intermediate technology and economic development: history and prospect for China. *Innovation: Management, Policy and Practice*, 8(1): 62-83.
Van den Bosch, F.A.J., Volberda, H.W. and de Boer, M. 1999. Co-evolution of firm absorptive capacity and knowledge environment: Organizational forms and combinative capabilities. *Organization Science* 10(5): 551-568.
Vázquez-Barquero, A. 2007. Endogenous development: Analytical and policy issues, in Scott A.J. and Garofoli G. (Eds) *Development on the Ground: Clusters, Networks and Regions in Emerging Economies*, pp. 23-43, London: Routledge.
Venables, A.J. 2005. Spatial disparities in developing countries: cities, regions, and international trade. *Journal of Economic Geography*, 5(1): 3-21.
Viotti, E. B. 2002. National learning systems. A new approach on technical changes in later industrializing economies and evidences from the cases of Brazil and South Korea. *Technological Forecasting and Social Change* 69(7): 653-680.
Vogel, E. 1989. *One Step Ahead in China: Guangdong Under Reform*. Cambridge, MA: Harvard University Press.
Wang, C. and Kafouros, M. I. 2009. What factors determine innovation performance in emerging economies? Evidence from China. *International Business Review* 18(6): 606-616.
Wang J. and Bradbury J. 1986. The changing Industrial geography of the Chinese Special Economic Zones. *Economic Geography* 62(4): 307-320.
Wang, M. Y. and Meng, X. 2004. Global-local initiatives in FDI: The experience of Shenzhen, China. *Asia Pacific Viewpoint* 45(2): 181-196.

Wei, Y. H. D. 2010. Beyond new regionalism, beyond global production networks: remaking the Sunan model China. *Environment and Planning C*, 28(1), 72-96.

Wei, Y.H.D. and Ye, X. 2009. Beyond convergence: Space, scale, and regional equslity in China. *Tijdschrift voor Economische en Sociale Geografie* 100(1), 58-90.

Wei, Y., Liu, X., Parker, D. and Vaidya, K. 1999. The regional distribution of foreign direct investment in China. *Regional Studies* 33(9): 857-867.

Wei, Y.D., Li, W. and Wang, C. 2007. Restructuring industrial districts, scaling up regional development: A study of the Wenzhou model, China, *Economic Geography* 83(4): 421-444.

Wen, M. 2007. Foreign direct investment, regional market conditions, and regional development: A panel study on China. *Economics of Transition* 15(1): 125-151.

Wu, W. 2007a. Cultivating research universities and industrial linkages: The case of Shanghai, China. *World Development* 35(6): 1075-1093.

Wu, W. 2007b. State policies, enterprise dynamism, and innovation system in Shanghai, China. *Growth and Change*, 38(4), 544-566.

Wu, W. 2010. Managing and incentivizing research commercialization in Chinese universities. *Journal of Technology Transfer* 35(2): 203-224.

Xie, Y. C. and Costa, F. J. 1991. The impact of economic reforms on the urban economy of the People's Republic of China. *The Professional Geographer* 43(3): 318-335.

Xu, Q. Gao, J. and Yan, M. C. 2005. Community centers in urban China: context, development, and limitations. *Journal of Community Practice* 13(3), 73-90.

Xue, L. 2004. University-market linkages in China: The case of university-affiliated enterprises. *Paper presented at the symposium on University, Research Institute and Industry Relations in the U.S., Taiwan and Mainland China*, September 7th – 8th, Palo Alto, CA.

Yang, C. 2009. Strategic coupling of regional development in global production networks: Redistribution of Taiwanese personal computer investment from the Pearl River Delta to the Yangtze River Delta, China. *Regional Studies* 43(3): 385-407.

Yang, C. and Liao, H. 2010. Backward linkages of cross-border production networks of Taiwanese PC investment in the Pearl River Delta, China, *Tijdschrift voor Economische en Sociale Geografie*, 101(2), 199-217.

Zhang, K. H. 2001. Does foreign direct investment promote economic growth? Evidence from East Asia and Latin America. *Contemporary Economic Policy* 19(2): 175-185.

Zhang, X. and Kanbur, R. 2005. Spatial inequality in education and health care in China. *China Economics Review* 16(2): 189-204.

Zhao, S.X. and Tong, S.P. 2001. Unequal economic development in China: Spatial disparity and regional policy: 1985-95. *Regional Studies* 34(6): 549-561.

Zhao, S.X.B. and Zhang, L. 2007. Foreign direct investment and the formation of global city-regions in China. *Regional Studies* 41(7): 979–994.

Zhao, Y. 2002. 'Earnings differentials between state and non-state enterprises in urban China', *Pacific Economic Review*, 7 (1), 181-197.

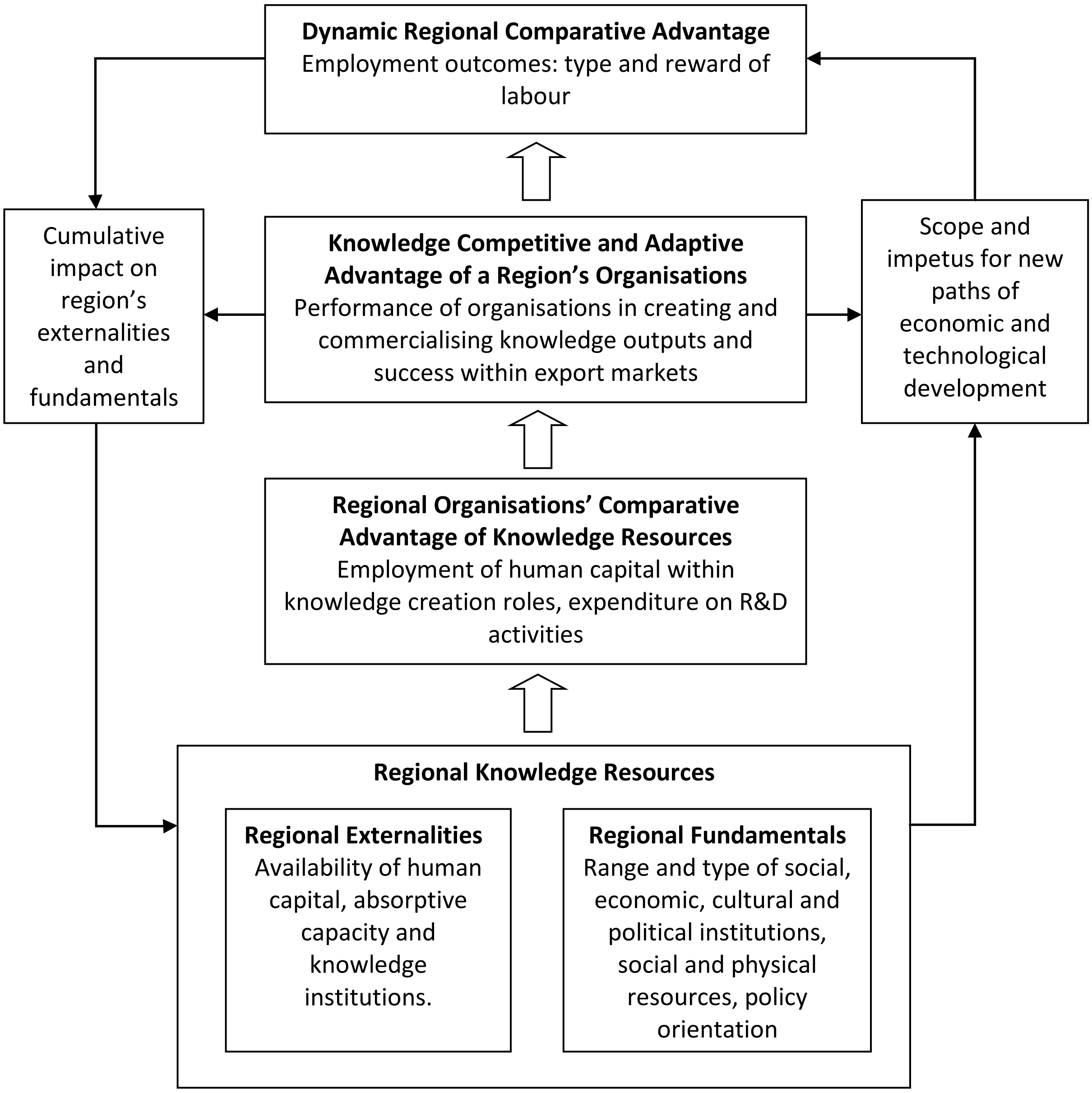
Zheng, Y. 2006. The comparison of FDI technology diffusion between the Yangtze River Delta and the Pearl River Delta. *Commercial Research* 344(12): 23-34.

Zhou, Y. 2005. The making of an innovative region from a centrally planned economy: institutional evolution in Zhongguancun Science Park in Beijing. *Environment and Planning A* 37(6): 1113–1134.

Zhou, Y. and Xin, T. 2003. An innovative region in China: interaction between multinational corporations and local firms in a high-tech cluster in Beijing. *Economic Geography* 79(2): 129-152.

Zhou, Y., Sun, Y., Wei, Y.H.D. and Lin, G.C.S. 2011. De-centering 'spatial fix': Patterns of territorialization and regional technological dynamism of ICT hubs in China. *Journal of Economic Geography* 11(1): 119-150.

Figure 1: Regional competitiveness and dynamic competitive advantage in the knowledge economy



Source: Adapted from Martin and Sunley (2011)

Figure 2: Registered foreign investment as a proportion of GDP

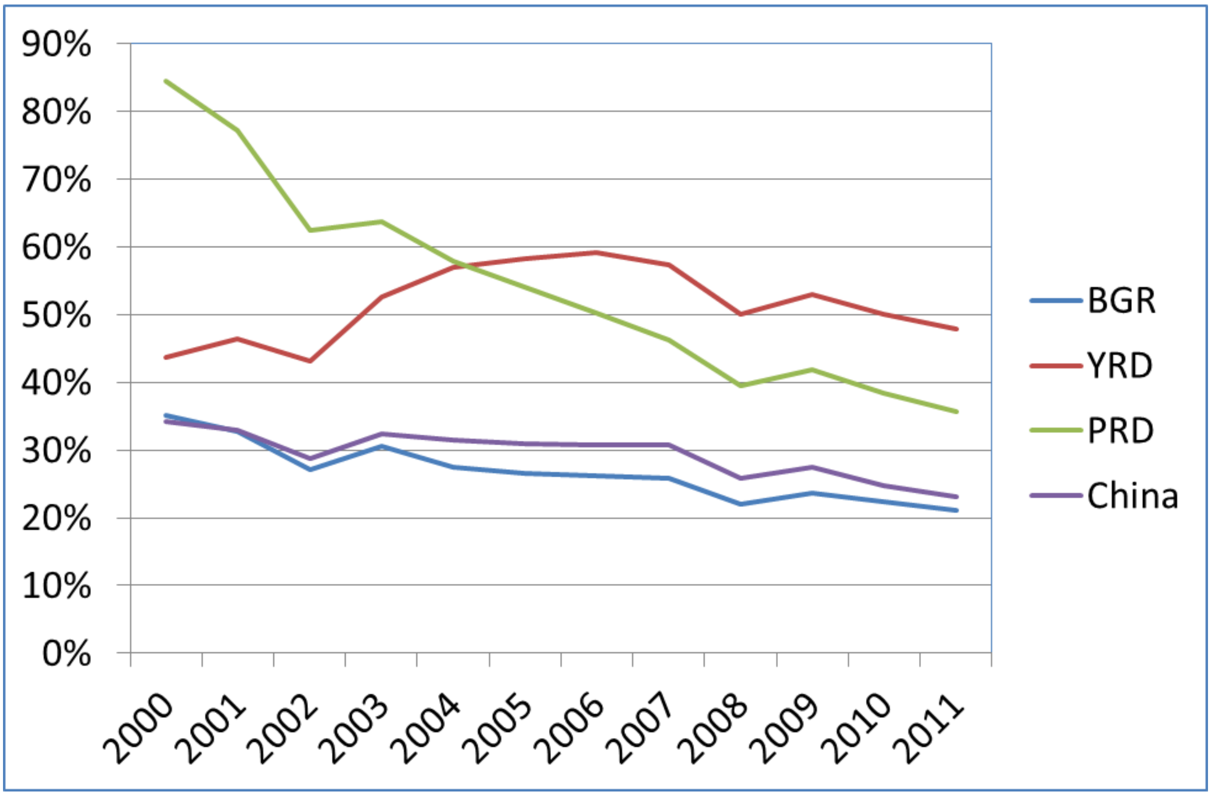


Figure 3: Patents granted per capita 1998-2011

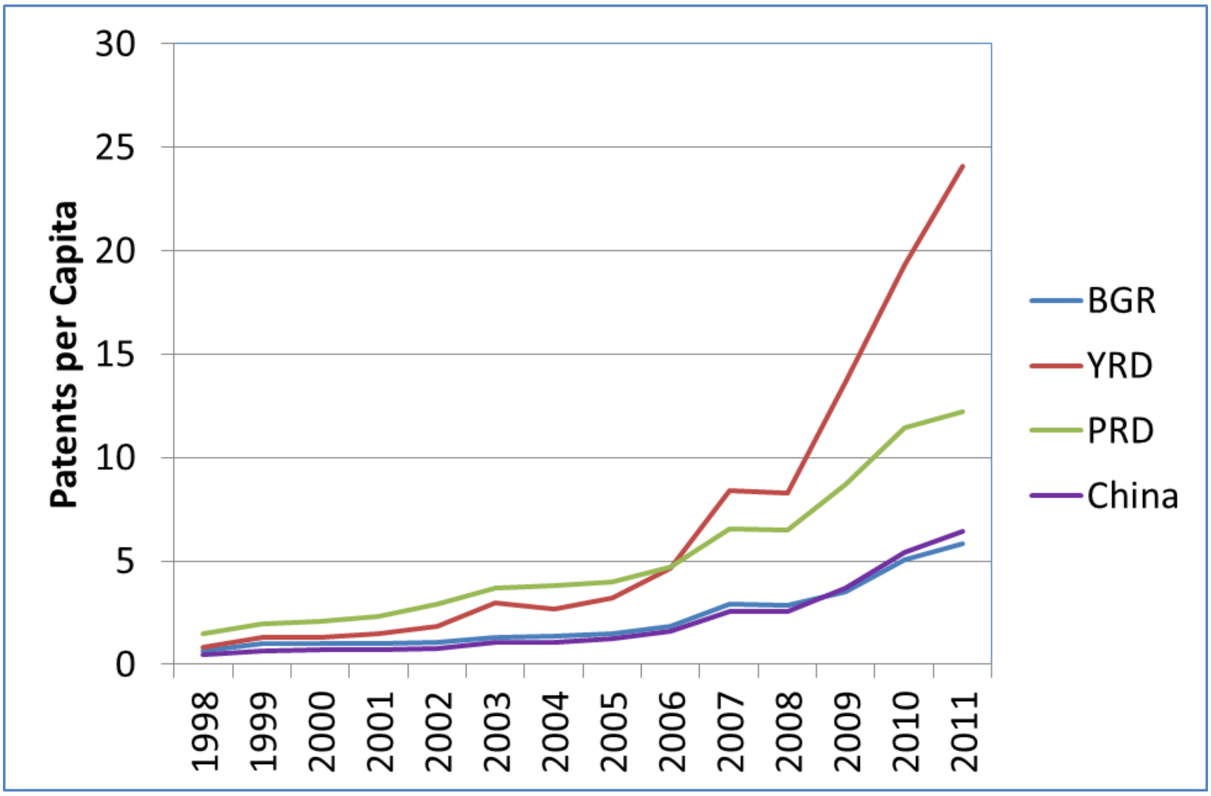


Figure 4: Invent patents granted as a percentage of all patents granted, 1995-2011

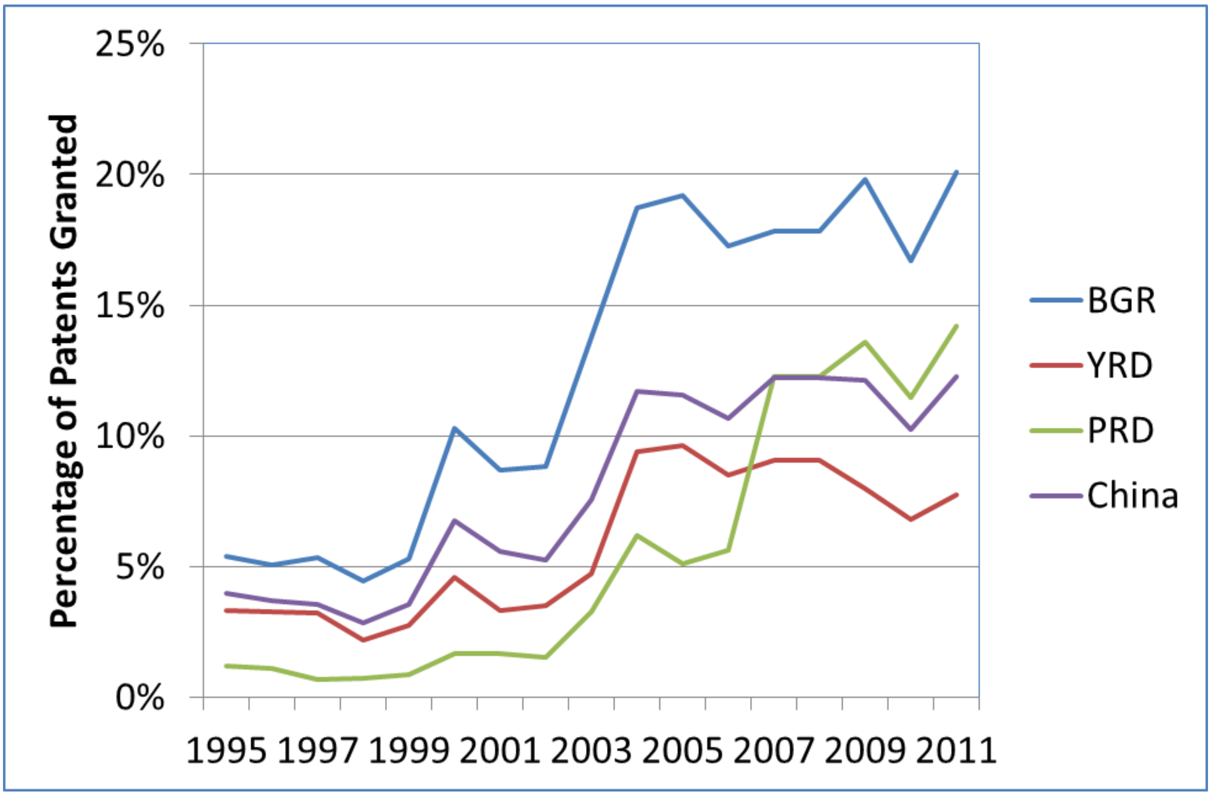


Table 1: Area, Population and GDP for the Three Regions (2011)

Region	Area (km^2)	Population (million persons)	GDP (US $ billion)	GDP per capita (US $)
BGR	520,906	246.35	2,857.18	11,598.06
YRD	210,741	157.09	2,402.60	15,294.41
PRD	179,800	105.05	1,270.49	12,094.16
Three Region Total	911,447	508.49	6,530.27	12,842.48
National Total	9,600,000	1,340.42	11,272.60	8,400.10

Table 2: Performance benchmarking measures of competitiveness by component of dynamic regional comparative framework

Component	Measure	Period of Data Included in Regression
Regional Knowledge Resources	Senior Secondary School Enrolment	n/a
	College and University Enrolment	2000-2011
	Senior Secondary School Qualifications held by Population	n/a
	College and University Qualifications held by Population	n/a
	Number of Foreign Enterprise	n/a
	Foreign Investment at Year End	2000-2011
	Health Care Institutions	2000-2011
	Passenger Traffic	2000-2011
	Textbooks Published	2000-2011
	Community Service Providers	2000-2011
Deployment of Knowledge Resources	Scientific and Technical Staff by Sector	n/a
	R&D Employees (full-time equivalent)	2006-2011
	R&D Expenditure	2000-2011
	R&D Projects	n/a
Knowledge Competitive and Adaptive Advantage of Organizations	Total Patents Granted	2000-2011
	Invention Patents Granted	2000-2011
	Utility Model Patents Granted	n/a
	Design Patents Granted	n/a
	New Products (units)	n/a
	Expenditure on New Products	n/a
	Sales Revenue of New Products	n/a
	New Products sold as Exports	n/a
	Value of Exports	2000-2011
Dynamic Regional Comparative Advantage	Average Wage	2000-2011
	Urban Unemployment Rate	n/a

Table 3: Human capital resources 2011

		BGR	YRD	PRD
Index of Proportion of Population in Education	Primary Education	83.4	71.1	105.7
	Junior Secondary	79.1	68.8	120.6
	Senior Secondary	86.2	81.6	114.6
	Higher Education	111.6	113.8	84.4
Index of Proportion of Population in Holding Qualifications		**BGR**	**YRD**	**PRD**
Index of Proportion of Population Holding Qualifications	Senior Secondary	104.4	107.9	129.8
	College and Higher Education	113.2	137.2	105.2
Foreign Investment		**BGR**	**YRD**	**PRD**
Number of foreign Enterprises		93,418	141,240	97,084
Foreign Investment (US$100 million)		6042	11,521	4525
Index of foreign enterprises per capita[a]		113.9	270.1	277.6
Index of foreign investment per capita		114.2	341.4	200.5

Note: China = 100

Source: National Bureau of Statistics of China

Table 4: Deployment of R&D inputs across the three regions

Employment of Scientific and Technical Staff	BGR	YRD	PRD
Engineering	179.3	90.5	15.9
Agriculture	19.9	9.5	1.6
Scientific Research	9.3	5.6	0.6
Health Care	180.4	110.8	27.9
Teaching	470.1	249.0	88.9
Total	858.9	465.4	135.0

Enterprise R&D Inputs (2011)	BGR	YRD	PRD
R&D Employees (full-time equivalent)	377,500	570,498	346,260
R&D Employees (per 10,000 population)	15.3	36.3	33.0
R&D Expenditure (US$ million)	22,589	23,391	13,371
R&D Expenditure (% of GDP)	2.2%	2.2%	2.0%
R&D Projects	55,610	72,983	29,243
R&D Projects (per 10,000 population)	2.3	4.6	2.8

Source: National Bureau of Statistics of China

Table 5: Innovative outputs by type and region, 2011

Patents Granted	BGR	YRD	PRD
Total Patents Granted	144,009	377,964	128,413
Total Patents Granted (per 10,000 population)	5.8	24.1	12.2
Invention Patents Granted	28,897	29,338	18,242
Invention Patents Granted (per 10,000 population)	1.2	1.9	1.7
Utility Model Patents Granted	93,106	132,794	51,402
Utility Model Patents Granted (per 10,000 population)	3.8	8.5	4.9
Design Patents Granted	22,006	215,832	58,769
Design Patents Granted (per 10,000 population)	0.9	13.7	5.6
Product Development and Sales	**BGR**	**YRD**	**PRD**
New Products (units)	60,644	87,921	32,879
Expenditure on new products (US$ million)	35,746	53,282	25,460
Expenditure on new products (% GDP)	1.3%	2.2%	2.0%
Sales revenue new products (US$ million)	557,644	779,905	190,084
Sales revenue new products (% GDP)	19.5%	32.5%	27.0%
Ratio of expenditure to sales	16.4	16.1	14.5
Proportion sold as exports	16.3%	24.4%	39.5%
International Markets	**BGR**	**YRD**	**PRD**
Value of Exports (US$ million)	308,804	738,613	531,927
Value of Exports (US$ per capita)	1,254	4,702	5,064
Percentage of GDP	10.8%	30.7%	41.9%

Source: National Bureau of Statistics of China

Table 6: Employment as a proportion of working age population and unemployment rates, 2011

	BGR	YRD	PRD
Average Wage (US$)	9821	11,908	10,759
Average Wage Index	104.7	127.0	114.7
Unemployment in urban areas	3.4%	3.2%	2.5%
Unemployment Index	97.7	91.7	71.4

Source: National Bureau of Statistics of China

Table 7: Panel regression of dynamic competitive advantage framework components

Panel A – Comparative Advantage of Knowledge Resources				
	R&D Expenditure	R&D Personnel		
College Enrolment	0.00185 (0.077)	-0.00191 (0.479)		
Foreign Investment	-0.00240 (0.166)	-0.00166 (0.630)		
Health Care Institutions	-0.00001 (0.837)	-0.00013 (0.157)		
Passenger Traffic	**0.00011** (0.000)	-0.00002 (0.583)		
Textbooks Published	0.00013 (0.342)	0.00028 (0.360)		
Community Service Providers	-0.00014 (0.160)	-0.00018 (0.379)		
Constant	**0.00039** (0.000)	**0.00157** (0.000)		
N	310	186		
R^2	0.141	0.030		
Panel B – Knowledge Competitive Advantage				
	Exports	Exports	Patents Granted	Patents Granted
R&D Expenditure	**62.655** (0.000)	**75.929** (0.001)	**126.789** (0.001)	**179.789** (0.003)
R&D Personnel		-2.104 (0.881)		**127.866** (0.002)
Constant	0.053 (0.061)	-0.075 (0.078)	-0.077 (0.228)	-0.228 (0.056)
N	310	155	310	155
R^2	0.042	0.078	0.033	0.133
Panel C – Dynamic Regional Comparative Advantage				
	Average Wage	Average Wage		
Exports	-0.002 (0.763)	-0.003 (0.698)		
Patents Granted	0.002 (0.543)			
Invention Patents Granted		**0.048** (0.025)		
Constant	-0.006 (0.103)	-0.005 (0.135)		
N	310	310		
R^2	0.001	0.016		

Notes: p-values in parentheses; emboldened coefficients are significant at the 5 percent level

Table 8: Summary of strengths and weaknesses of three regions

		BGR	YRD	PRD
Knowledge Resources	Performance	Medium	High	Medium
	Process	Medium	High	Low
	Policy	Low	Medium	High
Deployment of Knowledge Resources	Performance	Medium	High	Medium
	Process	Medium	High	Low
	Policy	Medium	High	Low
Knowledge Competitive Advantage	Performance	Low	High	Medium
	Process	Low	Medium	Low
	Policy	Medium	High	Medium
Dynamic Comparative Advantage	Performance	Low	High	Medium
	Process	Low	High	Low
	Policy	Low	High	Low