

# Contents

<i>List of Figures</i>	viii
<i>List of Tables</i>	x
<i>Notes on Contributors</i>	xiv
Introduction	1
<i>Xiaolan Fu and Luc Soete</i>	

## **Part I Policy, Strategy and Catch-up: Cross-Country Analysis**

1 Innovation Strategies in Brazil, China and India: From Imitation to Deepening Technological Capability in the South	15
<i>Carl Dahlman</i>	
2 Economic Growth and Technological Capabilities in BRICS: Implications for Latecomers to Industrialization	49
<i>Deepak Nayyar</i>	
3 The Changing Geography of Innovation Activities: What do Patents Indicators Imply?	69
<i>Xuan Li and Yogesh A. Pai</i>	

## **Part II Policy, Strategy and Catch-up: Country Case Studies**

4 China's Catch-up and Innovation Model: A Case of the IT industry	89
<i>Xielin Liu</i>	
5 Science and Technology and Economic Growth in South Africa: Performance and Prospects	107
<i>David Kaplan</i>	
6 Market-Oriented Reforms, Domestic Technological Capabilities and Economic Development in Latin America	125
<i>Jorge Katz</i>	

### **Part III Innovation Systems and Technological Capabilities**

- |   |   |     |
|---|---|-----|
| 7 | The Finance of Innovative Investment in Emerging Economies<br><i>Jörg Mayer</i>   | 147 |
| 8 | A Comprehensive Model of Technological Learning: Empirical Research on the Chinese Manufacturing Sector<br><i>Jin Chen, Xiaoyu Pu and Haihua Shen</i> | 170 |
| 9 | The Innovation of SMEs and Development of Industrial Clusters in China<br><i>Jinmin Wang</i>  | 186 |

### **Part IV Foreign Direct Investment and Technology Transfer**

- |    |   |     |
|----|---|-----|
| 10 | FDI, R&D and Innovation Output in the Chinese Automobile Industry<br><i>Chen Fang and Pierre Mohnen</i>   | 203 |
| 11 | The Role of FDI in the Development of Innovative Capacity: The Case of Russian Companies<br><i>Juha Väätänen, Daria Podmetina and Marina Aleksandrova</i> | 221 |
| 12 | Human Capital and Technological Spillovers from FDI in the Chinese Regions: A Threshold Approach<br><i>Miao Fu and Tielu Li</i>                           | 238 |
| 13 | Transnational Corporations from Emerging Economies and South-South FDI<br><i>Torbjörn Fredriksson</i>   | 258 |

### **Part V Technology and Sustainable Development**

- |    |   |     |
|----|---|-----|
| 14 | Technological Competences in Sustainability Technologies in the BRICS Countries<br><i>Rainer Walz</i>   | 281 |
| 15 | Coordination, Convergence or Contradiction: Information and Communication Technologies for Integration and Development in Southern Africa and the Southern Cone<br><i>Patience I. Akpan-Obong and Mary Jane C. Parmentier</i> | 300 |

16	Sustainability of Technology-intensive Social Innovation in India: The Role of Absorptive Capacity and Complementary Assets	320
	<i>Xiaolan Fu and Christine Polzin</i>	
	Conclusions: Science, Technology and Development – Emerging Concepts and Visions	341
	<i>Xiaolan Fu, Luc Soete and Lina Sönne</i>	
	<i>Index</i>	355

# Introduction

*Xiaolan Fu and Luc Soete*

The rise of the emerging economies, especially the Golden BRICS (Brazil, Russia, India, China and South Africa), is changing the landscape of the world economy. These economies have experienced fast economic growth in the past two decades (at least), and are emerging as important economic forces in the global economy. For the past three decades, the average annual gross domestic product (GDP) growth rate of China, for instance, has been as high as 9.8 per cent. This is much higher than the average 3.0 per cent annual growth rate of the world economy. In 2007, the annual GDP growth rate percentage was 13.0 in China, 9.1 in India, 8.1 in Russia, 5.4 in Brazil and 5.1 in South Africa. Again, this is much higher than the world average growth rate of 3.8 per cent in the same year. By 2007, China was ranked amongst the four largest economies in the world in terms of total GDP.

The significance of the rise of the BRICS lies not in the pace and duration of economic growth; both Korea and Japan enjoyed a similar experience during the three decades after 1960 (Kaplinsky, 2006). What is significant, however, is the combination of this fast growth with the large size of the BRICS economies. In 2007, the BRICS countries accounted for 43 per cent of world population, 30 per cent of the global surface area, 13 per cent of world GDP and 12 per cent of global net foreign direct investment (FDI) inflow (Table I.1). The impact of the rise of the BRICS is likely to be much greater than that of the rise of the Asian Tigers.

As one of the main drivers of national competitiveness, technological capabilities in these emerging economies have also grown significantly. The BRICS countries are catching up with the industrialized countries, especially in certain industries. In 2005, the total R&D expenditure in China was about a third of that in the EU as a whole. However, in terms

Table I.1 Overview of the BRICS countries, 2007

	Brazil	Russia	India	China	South Africa	World	BRICS as % of world
Population, total (millions)	192	142	1125	1318	48	6610	43
Surface area (sq. km) (thousands)	8515	17,098	3287	9598	1219	133,946	30
GDP (current US\$) (billions)	1313	1290	1177	3206	283	54,584	13
GDP growth (annual %)	5.4	8.1	9.1	13.0	5.1	3.8	
Exports of goods and services (% of GDP)	14	30	21	42	32	28*	
Imports of goods and services (% of GDP)	12	22	24	32	35	29*	
Mobile phone subscriptions (per 100 people)	63	115	21	42	88	51	
Internet users (per 100 people)	35.2	21.1	7.2	16.1	8.3	21.8	
High-technology exports (% of manufactured exports)	12	7	5	30	6	18	
FDI (Balance of payments, current US\$) (millions)	34,585	55,073	22,950	138,413	5746	2,139,338	12

Note: \*Data for 2006.  
Source: World Bank (2007).

of gross expenditure on R&D, China is now moving close to the EU average. In terms of research per 1000 employees, the Russian Federation in fact ranks higher than the EU average (Figure I.1).

The extent of these activities in relation to technological capabilities raises several important research and policy questions. What are the innovation and technology policies that the BRICS countries have adopted? What role have they played in the catch-up process? What are the determinants of technological learning and innovations in these countries at the firm level? What are the roles of small and medium enterprises (SMEs)? Should a latecomer economy rely on foreign technology transfer or indigenous innovation for technology upgrading? What is the role of technology in confronting the challenges of environmental change and social division for sustainable development? The experiences of the BRICS have important implications for the world and will provide valuable lessons to other developing countries with regard to industrial, technological and trade policies.

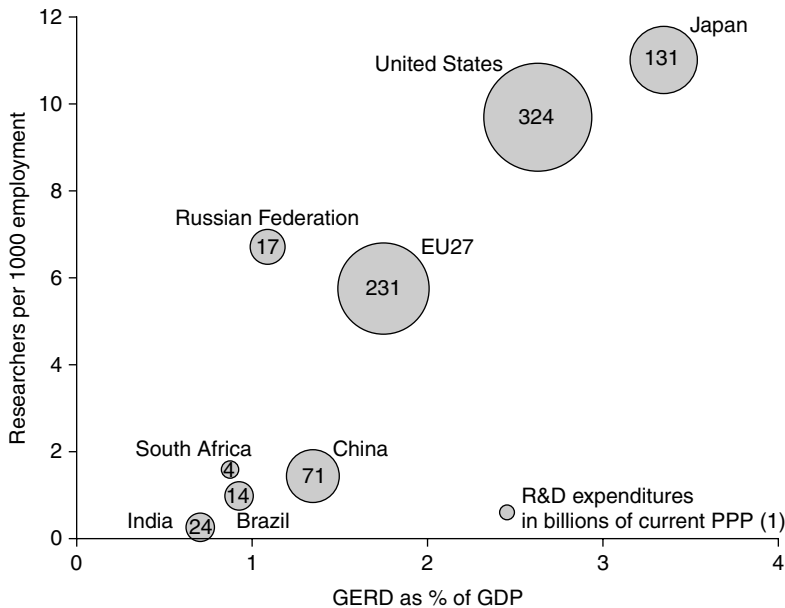


Figure I.1 R&D expenditure in 2005 (circles reflect amount of spending in US\$ billions purchasing power parity (PPP))

Source: Tojo (2008).

The BRICS are a group of the world's largest developing and transition economies. Despite sharing the common features of large size and developing country status, the countries are diverse in their factor endowment, economic structure and development history and strategy. Cross-country international comparison will no doubt provide interesting findings, but this method alone may not be sufficient for in-depth analysis. Therefore, by using *both* cross-country comparisons and in-depth case studies of emerging economies, this book aims to: 1) explore the drivers of technological upgrading and catch-up in the emerging economies, especially in respect to technology and innovation policies, national innovation systems, the role of FDI and SMEs; 2) compare the similarities and differences between the emerging countries and draw policy and practical implications for other developing countries and 3) discuss emerging concepts and visions for future research in this area. The analyses are conducted at multiple levels, ranging from firm to sector, region and country level, and use both quantitative and qualitative research methods.

This volume includes a selection of papers presented at the first Sanjaya Lall Programme Annual Conference in 2008, held at Oxford University. We used a three-tier scrutiny process, involving: 1) an initial selection by conference organizers; 2) a second-round internal review and selection by the editors and 3) a double-blind refereeing procedure. Seventy papers were chosen from a total of 150 submissions in the initial selection process. Around 30 papers were subsequently chosen in the second-round editorial selection. After receiving the referees' reports, the editors decided to include 16 papers in the final volume.

The book is divided into five parts. Parts I and II evaluate the role of innovation policy and strategy in the technological catch-up process of the emerging economies through cross-country comparative studies and in-depth country case studies, respectively. Part III investigates the role of national, regional and sectoral innovation systems and drivers of domestic technological capabilities. Part IV explores the role of inward and outward FDI in technology transfer. Part V discusses the role of technology for sustainable development in the emerging economies.

## **I.1 Policy, strategy and catch-up: Cross-country analysis**

This part consists of three papers exploring the role of innovation policy and strategy in the technological catch-up process of the emerging economies through cross-country comparative studies. In Chapter 1, Dahlman examines the innovation strategies of three of the BRICS

(Brazil, India and China) and compares their economic performance over the last 25 years. The chapter then extracts some implications regarding the link between innovation strategy and economic performance. In light of a theoretical framework that innovation in developing countries should not be defined just in terms of a shifting global technology frontier but rather in terms of what is new inside a country (including any policies and mechanisms which draw on both global knowledge and the domestic R&D effort) the chapter finds that the innovation strategies of these three countries have been quite different. India has been the most autarkic until recently. China has drawn the most on global knowledge, although more recently it has invested massively in its own R&D. Brazil can be placed somewhere in between. It has been almost as closed as India to trade, but more open than India in terms of FDI. Moreover, Brazil is falling behind both other countries in its domestic R&D effort. The three countries have also had very different growth performances over the last 25 years. Findings from this comparative analysis indicate the importance of tapping into global knowledge and using it effectively, as well as the significance of education, reverse engineering, diasporas, competition, stable macro conditions and strong efforts for technology diffusion.

In Chapter 2, Nayyar analyses the implications of the rise of technological capabilities in Brazil, India, China and South Africa for developing countries, with particular focus on latecomers to industrialization. Starting with a review of the development history of the BRICS economies and focusing on the analysis of the nature of technological development in these emerging economies (foundations, dilemmas and specificities), Nayyar argues that the emerging economies are characterized by specificities. In the national context, the size of the economy matters as it determines the number of scientists and engineers and the size of the domestic market. In the international context, which is shared by all countries, there are specificities that characterize the emerging economies in terms of their capacity to exploit available opportunities. Domestic firms in Brazil, India, China and South Africa have such capabilities, which domestic firms in other developing countries may not. Moreover, as the emerging economies are also late industrializers, it is possible that their technologies are more appropriate for countries in the developing world. Therefore, there is much to learn from the experience of technological development in the emerging economies, but such learning should seek to contextualize rather than replicate.

Despite widely accepted evidence of the changing geography of innovation activities based on patent numbers, in Chapter 3 Li and Pai urge



caution in using the conclusion of the WIPO Patent Report that the sharp rise in the number of patents filed in North-east Asia (and particularly in China) indicates a changing geography of innovation. The authors point out that the drawback of such an international comparison not only relates to how to interpret properly the figures on patent filings and 'resident patent filings', but also to high heterogeneity in the value of patents. On the basis of detailed analyses in China and comparison of the legal framework in the EU, US, Brazil and India, this chapter shows that hasty generalization of the changing geography of innovation patterns should be avoided. A full assessment requires further econometric, classificatory and survey research, followed by interdisciplinary interpretation. The way forwards must therefore be to develop a proper set of indicators to monitor the changes in innovation capacities, especially those in the developing countries.

## **I.2 Policy, strategy and catch-up: Country case studies**

This part consists of 3 papers analysing the role of innovation policy and strategy in the technological catch-up process of the emerging economies using in-depth country case studies. Taking into account the need to recognize country-specific contexts in any analysis, Liu provides an in-depth case study of the catch-up strategy of China in Chapter 4. By comparing the history and contexts in which firms attempted to catch-up in the information technology (IT) industries in China and Japan and by examining the different models that they have adopted, this chapter suggests that the context in which Chinese firms are attempting to catch-up is fundamentally different from that facing earlier latecomers such as Japan. It argues that market size, market-oriented innovation, participation in a global alliance, open innovation, spillovers of FDI and the role of government are the main elements of Chinese catch-up strategy.

In Chapter 5, Kaplan presents another interesting case study of the science and technology policy of South Africa. Through a critical review of two recent reports on science and technology development in South Africa, this chapter provides a high-level assessment of the innovation performance of the South African system, identifies the constraints on innovation performance, and examines the government's strategic goals and aspirations for the South African science and technology (S&T) system as detailed in a ten-year plan (DST, 2007). The chapter concludes by highlighting the importance of human capital and argues that rather than using a policy of attempting to advance on all fronts,

priority needs to be given to development of high-level skills. Instead of attempting to do everything at once, policy needs to be sequenced, with the first priority being expansion of high-level skills for innovation.

In addition to the factors that identified by Liu and Kaplan in earlier chapters, structural change is another important driver of technological upgrading of countries. In Chapter 6, Katz examines the linkage between market-oriented reforms, domestic technological capabilities and economic development in Latin America. Market-oriented structural reforms in the past three decades and the globalization of economic activities have brought major changes to Latin America inducing the gradual phasing-out of many industries and institutions of the 'inward-oriented' period of industrialization. Their production structure now features many new sectors of economic activity closer to their natural comparative advantages. A modern sector of economic activity has emerged in natural resource-processing activities, as well as in 'maquila'-type industries and in service sectors catering for local demands in areas such as telecoms, banking and financial services, water provision and sanitation services, and others. Yet such structural transformation has not been strong enough to incorporate the vast majority of the population. Thus, the modernization process has occurred hand-in-hand with a significant expansion in the gap between the rich and poor segments of society. This has clearly resulted in a dramatic sequel of frustration and despair that makes political governability an increasingly difficult issue. Katz argues that the lack of 'initial entitlements' resulting from low quality education, poor health services, insufficient provision of public goods which might 'level the playing field', and different forms of market failure have been instrumental in causing market-oriented structural reforms to fail to deliver a broader pattern of improvement in economic efficiency.

### **I.3 Innovation systems and technological capabilities**

There are three chapters in this part. A sustained rise in innovation presupposes high rates of investment in intangible elements such as education and R&D. For private investment to take place, firms not only need an incentive in terms of expected future profits, but they also need to have access to reliable, adequate and cost-effective sources of finance to fund their investment. In Chapter 7, Mayer analyses the role of different sources of finance for innovative investment and looks at the experience of the BRICS in this regard. The analysis draws on enterprise data to provide statistical evidence on the role of different sources of

investment finance, and examines the role of different sources of investment finance for innovation. Research in this chapter also points to the different approaches employed in the BRICS countries with regard to the model and sources of finance for innovative investment.

In addition to effective financial support for innovation activities, effective technological learning is another important determinant of the catch-up process, especially for firms in developing countries. Developing countries, for example, China, often find that the core technologies used in domestic firms are still in the hands of foreign companies. Technological learning is therefore essential for these firms in order to develop indigenous innovation capability in the context of upgrading the structure of manufacturing industries. In Chapter 8, Chen, Pu and Shen examine the relationship between technological learning, technology capability and innovation performance using data collected from a sample of 92 Chinese firms. Their results highlight the importance of technological learning sources, contents and levels such as internal communications; a focus on the absorption of tacit knowledge; the enforcement of organizational learning from both internal and external sources and the strengthening of the motivation mechanism for technological learning.

In any innovation system, the SMEs play an important role as these firms constitute the most dynamic part of an economy. In Chapter 9, Wang explores the innovation mechanisms underlying the SME industrial clusters in China using a case study of the Yiwu socks cluster in Zhejiang Province. The research in this chapter suggests that the growth and development of the Yiwu socks cluster is a typical example of the evolution of autonomous organizations based on market expansion, technological innovation and regional economic development. The strategic linkage between horizontal co-operation and technological innovation through the local specialized wholesale market and informal social network has generated a special institutional arrangement that can overcome the inadequate innovation incentives for local SMEs and contributes to the upgrading of industrial clusters along the global value chain.

#### **1.4 Foreign direct investment and technology transfer**

Technology transfer through FDI has for a long time been regarded as an important channel for technology upgrading in latecomer economies. Governments of developing countries have made great efforts to attract FDI with the expectation that such investment will lead to the

transfer of advanced technology to their local firms. However, evidence from existing empirical studies is mixed. Research in this area is therefore inconclusive. Lall and Urata (2003) argue that advocates of globalization seem to assume that the private interests of multinationals do not diverge from the social interests of the host countries. Despite the expectation that there will be a 'trading market for technology', researchers find that it is difficult to acquire state-of-the-art technology through inflows of FDI and imports, and that huge inflows of FDI may even weaken indigenous industrial and technological capabilities (Aitken and Harrison, 1999; Wang and Gao, 2005). Given the rise of the BRICS and their emphasis on a more open policy toward FDI, it is important to examine the role of this in technology transfer and technological upgrading in these countries, reflecting upon any implications for other latecomer economies.

China has absorbed a huge inflow of FDI since the economic reforms of 1978 and the country in fact ranks as the largest recipient of FDI in the developing world. In Chapter 10, Chen and Mohnen analyse the determinants of, and the interrelationships between, innovation input and innovation output. In particular, the authors examine whether FDI had any influence on these two aspects of innovation using firm-level data relating to the Chinese automobile industry. They employ a generalized Tobit model to estimate both R&D and the share of innovative sales for 2002/2003 and 2005/2006. The findings show that firms with FDI are less R&D-intensive, but, when they do innovate in new products, they are more innovative in their products than domestically funded firms.

In Chapter 11, Väättänen, Podmetina and Aleksandrova investigate the role of FDI in the development of innovative capacity in Russian companies. The study is based on the survey of 176 R&D-oriented Russian companies conducted in early 2008. The sample is composed of companies which are active in innovation or which represent an industry with high innovation intensity. The survey results show that the labour productivity of foreign-owned companies is 10 per cent higher than domestic companies. Surprisingly, foreign companies have lower R&D expenditure as a percentage of sales: 6.2 per cent against 6.5 for local companies. Contrary to expectations, there were no significant performance differences between foreign and domestic companies in terms of innovative capacity, as measured by new product development or patent activity. The authors argue that the potential effect of FD on the development of innovative capacity of Russian companies remains limited.

For technology transfer through FDI to be successful, the absorptive capacity of local firms is crucial. A threshold level of human capital is often argued to be a necessary precondition if FDI is to promote technology upgrading and economic growth in developing countries (Balasubramanayam et al., 1996). In Chapter 12, Fu and Li examine the role of human capital as a determinant of FDI spillovers using a threshold approach. Based on the threshold regression and Chinese provincial panel data, they find double thresholds of 4.85 and 10.99 per cent for human capital, in terms of the percentage of workers with higher education: 4.85 per cent is the threshold that significantly mitigates the negative effects of FDI, while the most important threshold is 10.99 per cent, which changes the negative effects of FDI into positive spillover effects. This means the impact of FDI on local productivity growth depends on the absorptive capacity of human capital. In China, there are big discrepancies among the regions: some provinces do surpass the sign change threshold and so enjoy positive technology spillovers from FDI, but others do not.

One of the most significant phenomena in the past century has been the rise of outward direct investment from the developing countries. The BRICS have been the leader of this recent surge. In Chapter 13, Torbjorn reviews some recent developments with respect to the growing importance of transnational corporations (TNCs) from the South and their overseas expansion. He argues that the current situation differs from that of the 1970s and 1980s. The scale of the phenomenon is much larger and both the geographical composition of flows and stocks as well as the drivers and determinants are different. He argues that the overseas expansion of latecomer TNCs opens up new possibilities for them to access knowledge and technology in foreign locations. It represents an important complement to other channels of technology transfer – such as licensing, imports and inward FDI. In combination with the observed trend towards more internationalization of R&D, this contributes to a strengthening of the interlinkages between national innovation systems.

## **1.5 Technology and sustainable development**

This part includes four papers which address the role of technology in confronting the challenges of sustainable development, with an emphasis on climate change, social divisions and economic development in general.

From a global perspective, the challenge posed by sustainable development is becoming increasingly urgent. In rapidly growing economies,

knowledge transfer and technology co-operation are becoming important issues in their development process. Based on the heuristics of a system of sustainability innovation approach, Walz analyses, empirically, in Chapter 14 the importance of technological competences and absorptive capacity for sustainable technologies in the BRICS countries. The results show that sustainability-related research is mostly carried out within broader, more sector-oriented programs. With the exception of South Africa, this topic is still underemphasized in the BRICS countries. Developing technological competences in the relevant fields of sustainability is a key indicator of the absorptive capacity of sustainability technologies. International patents and successes in foreign trade indicate the extent to which a country is already able to 'open up' internationally. The resulting pattern shows the various strengths and weaknesses of the BRICS countries. The differences within the countries imply that the analysis must proceed on a technology-specific level. Furthermore, there is a strong need for strategic positioning of the countries and for coordination of the various policy fields involved.

Technology upgrading for inclusive development is an important task for policy-makers and academic researchers. This in particular is a major challenge facing the emerging economies. In Chapter 15, Akpan-Obong and Parmentier present a framework for the study of information and communication technologies (ICTs) in which integration and development are considered to be interrelated processes. The authors explore possible convergence and coordination through a review and analysis of the policies regarding ICTs for development in Brazil and South Africa, comparing them with policies regarding ICTs for integration between their respective regions. The authors adopt an exploratory, qualitative approach and analyse ICT policies at both national and regional levels. Their research shows that while national and regional ICT policies share the goals of development, the emphasis on development policies varies considerably: even policies relating to similar issues are neither coordinated nor connected. The authors argue that research in this field needs to focus on processes and outcomes particularly with respect to compatibility, synergy and enhancements in human development as the ultimate goals of policy and its implementation.

Given the important role that IT can play in the development process, sustainability of the ICT for development projects has been a major bottleneck. In Chapter 16 Fu and Polzin explore the determinants of the sustainability of technology-intensive social innovation with special emphasis on absorptive capacity and complementary assets. Through examination and comparison of a series of case studies from India

they find that absorptive capacity and complementary assets can be critical factors of success and sustainability for ICT-enabled development projects in developing countries. Moreover, customer freedom of choice enables social innovation to meet the needs of the grass roots and thereby enhances the vitality and sustainability of the technology-intensive social innovations.

## References

- Aitken, B. and A. Harrison (1999), 'Do domestic firms benefit from direct foreign investment? Evidence from Venezuela', *American Economic Review*, 9 (3), 605–18.
- Balasubramanayam, V. N., M. Salisu, D. Sapsford (1996), 'Foreign direct investment and economic growth in EP and IS countries', *Economic Journal*, 106(434), 92–105.
- Department of Science and Technology (DST) (2007), 'Innovation towards a knowledge-based economy. Ten-year plan for South Africa (2008–2018)', Draft. Pretoria: DST. 10 July.
- Kaplinsky, R. ed. (2006), 'Asian Drivers: Opportunities and Threats', *IDS Bulletin*, 37 (1).
- Lall, S. and S. Urata (2003), 'Introduction and overview', in S. Lall and S. Urata (eds), *Competitiveness, FDI and Technological Activity in East Asia*, published in association with the World Bank. Cheltenham, UK: Edward Elgar.
- Tojo, Y. (2008), 'New modes of innovation: Increasing role for emerging economies', paper presented at the SLPTMD conference on 'Confronting the challenge of technology for development'. Oxford: Oxford University.
- Wang, Q. and J. Gao (2006), 'A retrospective analysis of the foreign capital attracting practice based on the "exchange-market-for-technology" strategy in china', *Journal of Hubei University* (Philosophy and Social Science), 33(3), 261–4.
- World Bank (2007), *World Development Indicators 2007*. Washington, DC: World Bank.

# Index

- Absorptive capacity 10–12, 226, 238, 240, 254, 271, 324–6, 332–3, 335–6
- Brazil
  - basic economic indicators 18–19, 20–1, 41, 50–4
  - impact of Information and Communications Technologies (ICTs) 312–15
- BRICS
  - and FDI 101–2, 203–4, 214–17, 226–35, 255–66, 273–4
  - and investment 147–61
  - economic and geographic data 2, 51–4,
  - economic growth of 1, 50–6
  - exports of 39–44, 57–9
  - industrialisation in 61–5
  - overview of development and technological performance 341–51
  - R&D expenditure 2
  - sustainable technologies in 281, 288–97
  - technological development in 61–5, 341–51
- Catching up
  - experience of China including IT industry 89–104
  - methods of describing and evaluating 89–90
- China
  - basic economic indicators 18–19, 20–1, 41, 50–4
- Complementary assets
  - concept of 321, 324–7
  - relationship to policy in India 329–35
- Diasporas
  - role in acquisition of foreign knowledge 25–7
- Education
  - role in innovation 16–17, 25, 27–31, 35, 43–4, 62, 65, 143, 240, 242, 245, 249, 251, 254–5, 313–15, 320, 329
- Energy technology 34–5, 44, 119, 126, 270, 281, 283–5, 289, 292–6
- Environmental technology 281–98
- Foreign Direct Investment (FDI)
  - and acquisition of foreign knowledge/technology 8, 10, 23–5
  - and innovation 23–5, 101–2, 212–7, 221–35
  - outward FDI from BRICS 255–66, 273–4
  - receipt by BRICS 101–2, 203–4, 214–17, 226–35
  - South-South 258–75
  - spillover effects of 101–2
- Human capital
  - and innovation 10, 28–31, 122, 238–40, 245–55, 326
  - relationship to FDI 238–40, 245–55
- Industrial clusters 186–99
  - case study: China 190–9
- Information and Communications Technologies (ICTs)
  - catch up experience of China 95–104, 189
  - role in development process 27, 30, 114, 189 300–4, 308–12
- India
  - basic economic indicators 18–19, 20–1, 41
- Industrialisation
  - capacity in BRICS 61–5
  - case study: China 186–99



- Innovation
  - constraints on 114–17
  - indicators of 69–70, 139–42
  - methods of financing 147–61
  - open innovation 97–9
  - and patent filings 70–2, 77, 83
  - process of 127–30, 139–42, 345–50
  - and public policy 15–17, 41, 89–94, 99–101, 117–21, 166–7, 270–2
  - social innovation, concept of 11–12, 320–3
- Innovation strategy and public policy 15–17, 41, 89–94, 99–101, 117–21, 166–7, 270–2
- intellectual property 23, 31, 34, 62, 81, 133, 141, 314
- investment
  - sources and financing in BRICS 147–61
- inward-oriented development 7, 23, 125, 132, 142
- Kaldor-Verdoorn Law 64
- Knowledge
  - dissemination of, including indicators 16–17, 37–41
  - tacit 8, 93, 174–5, 183
- Manufactured exports
  - BRICS as exporters of 39–44, 57–9
- Mercosur
  - role of ICTs in 303–8, 312–6
- Modern Growth Theory
  - relationship to technological capabilities 125–30
- Multinational companies (MNCs)
  - relationship to Foreign Direct Investment 26, 31, 33, 133, 190, 224, 347–9
  - Third World MNCs 258–75
- Organizational learning 176, 324
- Patents 33–4, 110
  - as indicators of innovation 69–82
  - varying country standards 75
- Research and Development (R&D) 31–7, 64, 98–9, 140, 266–8, 289–97, 342–5
- Reverse engineering 20, 26–7, 35–6, 90–1, 102
- SMEs
  - case study: China 190–7
  - and innovation 8, 93, 96, 125, 129, 136, 139, 186–90, 197–9, 341, 350
- Social innovation, concept of 320–3
  - as distinguished from business innovation 322
  - case study: India 329–35
  - measurement of 327–8
- South Africa
  - basic economic indicators 50–4
  - share of hi-tech exports in trade 113–14
- Southern African Development Community (SADC)
  - role of ICTs in 304–6
  - SADC Declaration on ICT 305–6
- Spillover effects 10, 69–70, 225, 233
  - of FDI 10, 101–2, 104, 204, 225, 238–55, 271–2
- Sustainable technology 281–98, 323–7
- Tacit knowledge 8, 93, 174–5, 183
- Technological capabilities of the BRICS
  - impact of government policy on 15–17, 41, 89–94, 99–101, 117–21, 166–7, 270–2
  - and R&D policies 93–4, 117–21
- Technological capabilities 60–3, 132–5, 172–4, 177–8
  - case study: Argentina 132–5
  - case study: Chile 135–9
  - distinction between firm-level v national-level 61–2

- Technological capabilities – *continued*
  - estimates and indicators for Brazil,  
China and India 42
- Technological learning 171–2,  
174–7, 178–82
  - and improvements in technology  
capability 89–92, 181–4
- Technology transfer 4, 8–10,  
34, 97–104, 204, 221–24,  
240, 252, 274, 341–2,  
345, 347, 350
- Trade
  - Relationship to acquisition of  
foreign knowledge 20–3

