

OXFORD

# Structural Change and Industrial Development in the BRICS

Edited by

Wim Naudé, Adam Szirmai,  
and Nobuya Haraguchi



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## Foreword

This book is about the structural transformation and industrialization of Brazil, the Russian Federation, India, China, and South Africa, collectively referred to as the BRICS. They are large, developing countries which, as a group, have come to account for a quarter of world production and are beginning to exert increased influence on other economies—both developing and industrialized—due to their regional leadership, market size, and increased exporting capacities, especially of manufactured goods. Their emergence is diminishing the usefulness of conventional country classification into developed and developing countries for understanding the increasingly multipolar world economy.

Since the first industrial revolution, countries which sustained high growth over a long period of time not only expanded the size of their economies, but also raised the share of manufacturing at the expense of agriculture, thus transforming their economies to more productive activities. Starting in the eighteenth century from Western Europe, and moving to North America and Japan in the nineteenth century and onwards to East Asia and Southeast Asia in the twentieth century, successive emerging economies followed this pattern with manufacturing serving as an engine of economic growth.

Collectively and individually, the BRICS have exhibited similar development characteristics. For example, they have strengthened their integration into the world economy by joining the multilateral trade framework and significantly reducing trade barriers. They have also seen shifts in their manufacturing production and export structures towards more capital- and technology-intensive industries. However, the emerging picture of the development of the BRICS also reveals differences from the development pattern characteristic of the twentieth century. This becomes even more apparent when we look at the experiences of the individual countries. China, which has been the fastest growing country among the BRICS, follows the conventional development path most closely, driven by rapid industrialization and structural upgrading. India, second after China in terms of its growth rate, has also witnessed a significant shift of its economic structure, but unlike China and other successful Asian countries, India has shifted mostly from an agricultural to a service economy with a slight increase in its manufacturing share.

Brazil, the Russian Federation, and South Africa have recorded lower growth rates than China and India, and have also experienced more limited changes in their economic structure with even minor declines in their manufacturing, although this followed substantial earlier growth in manufacturing in the cases of Brazil, Russia, and South Africa. Natural resources have been the main drivers of these economies in recent years.

Their large country size has allowed the BRIC countries (South Africa is the odd one out) to rely more on their domestic markets and production linkages, and diverse human and natural resources for their unique development paths, which exhibit some noticeable differences from those of smaller East Asian Tigers. After having undergone economic restructuring and achieved a certain level of industrialization, the higher income BRICS countries have strengthened an orientation towards resource-based economic growth. Differences in their resource endowments as well as in their development stages have generated different dynamics in their structural transformation. Industrialization, and the development of manufacturing in particular, remains the driver for rapid economic growth and catch-up in developing countries while large countries like the BRICS may take increasingly diverse development paths after achieving a certain level of industrialization.

Can the BRICS sustain their development and promote appropriate structural change? A golden thread running through the book is that innovation, broadly defined, matters. Ultimately, the prosperity of the BRICS depends on whether their entrepreneurs and firms can establish functional partnerships with government to develop new products and improve existing products, as well as introducing new processes and practices to sustain productivity growth and competitiveness.

Given the individual and collective size of the BRICS economies, their global economic, social and environmental impacts will be much greater than the cases of past successful countries. This volume therefore constitutes essential reading for policymakers, scholars, students, and experts interested in the BRICS economies as well as for those who wish to understand the changing dynamics of the world economy.

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This book has grown and structurally ‘evolved’ over the course of two and a half years during which we accumulated a substantial debt to many colleagues, collaborators, and friends. First and foremost we count ourselves fortunate to have had the privilege to work with a team of the world’s foremost experts on the ‘BRICS’. The chapters in this book reflect the depth and scope of their knowledge, which had benefited from sharing and critically discussing their initial ideas during and after an international workshop jointly organized by UNU-MERIT and UNIDO held in Vienna on 16 and 17 August 2012.

Second, we are grateful to Ludovico Alcorta, Director of the Research, Statistics and Industrial Policy Branch of UNIDO for his initiation and support for the project which led to the workshop and ultimately the book. It is, moreover, the second such publication that reflects the collaboration of UNU-MERIT and UNIDO, further cementing the fruitful partnership between the organizations and confirming Ludovico’s vision on the importance of scholarly research on the central role of industry in development.

Third, we wish to acknowledge with warm thanks our supporting staff at UNU-MERIT and UNIDO, in particular Eveline in de Braek (UNU-MERIT) and Monika Marchichi-Obleser (UNIDO). Niki Rodousakis and Nelson Correa, from UNIDO, also provided assistance with an earlier version of the evolving manuscript, and Iguaraya Saavedra (UNIDO) provided administrative and secretarial support during and after the Vienna workshop, for which we are grateful.

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early stage. We are grateful to these referees. The book is much better as a result of their input.

Finally, the contents of this book are the sole responsibility of the authors and editors, and do not necessarily reflect the official position of UNIDO or UNU-MERIT.

*Wim Naudé, Adam Szirmai, and Nobuya Haraguchi*

Maastricht, the Netherlands and Vienna, Austria

4 February 2015

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# List of Abbreviations

ADB	Asian Development Bank
ABDI	Brazilian Industrial Development Agency
AGOA	Africa Growth Opportunity Act
AIO	Asian input-output (tables)
ASEAN	Association of South-East Asian Nations
ASGI	Accelerate and Shared Growth Initiative
ASI	Annual Survey of Industries
BEE	Black Economic Empowerment
BIS	Bank for International Settlements
BNDES	Banco Nacional do Desenvolvimento (Brazil)
BRIC	Brazil, Russia, India, China
BRICS	Brazil, Russia, India, China, South Africa
CAD	comparative-advantage-defying
CAF	comparative-advantage-following
CCMT	Climate Change Mitigation Technologies
CEE	Central and Eastern Europe
CIS	Commonwealth of Independent Countries
CNY	Renminbi Yuan
CPIAL	Consumer Price Index for Agricultural Labourers
CPIIW	Consumer Price Index for Industrial Workers
CSIR	Council for Scientific and Industrial Research
CSO	Central Statistical Organization
CSP	Customized Sector Plan
DTI	Department of Trade and Industry
EOI	export oriented industrialization
EPO	European Patent Office
EPZ	export-processing zone
ERP	effective rate of protection

## List of Abbreviations

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EU	European Union
F&B	food and beverages
FDI	foreign direct investment
FERA	Foreign Exchange Regulation Act (India)
GATT	General Agreement on Tariffs and Trade
GDP	gross domestic product
GEIS	General Export Incentive Scheme
GFCF	gross fixed capital formation
GHG	greenhouse gases
GMM	generalized method of moments
GVCs	global value chains
GW	giga watt
IADB	Inter-American Development Bank
ICEER	import content of export expansion ratio
ICT	information and communications technology
IDC	Development Corporation (South Africa)
IDSB	Industrial Demand–Supply Balance
IGCC	Integrated Gasification Combined Cycle
II–O	international input–output (tables)
ILO	International Labour Organization
IP	industrial policy
IPA	<i>Índice de Preço por Atacado</i> (producer price index, Brazil)
IPAP	Industrial Policy Action Plan
IPR	Industrial Policy Resolutions
IPR	intellectual property rights
ISI	Import Substitution Industrialization
ISIC	International Standard Industrial Classification
IT	information technology
JPO	Japanese Patent Office
JV	joint venture
LFPR	labour force–population ratio
M&A	mergers and acquisitions
MFN	most-favoured nation
MIC	military-industrial complex
MIDP	Motor Industry Development Programme (South Africa)
MIGs	manufactured intermediate goods

MLE	medium and large enterprise
MNC	multinational company
MNE	multinational enterprise
MPS	Material Product System
M RTP	Monopolistic and Restrictive Trade Practices (India)
MVA	manufacturing value added
NAV	norm of absolute values
NBS	National Bureau of Statistics of China
NEDLAC	National Economic Development and Labour Council
NEM	non-equity mode
NGO	non-governmental organization
NIE	newly industrialized economy
NIPF	National Industrial Policy Framework
NIS	National Innovation System
NSA	National Statistical Authority (Russia)
NSSO	National Sample Survey Organization
OBM	own brand manufacturing
OEA	original equipment assembly
OECD	Organisation for Economic Co-operation and Development
OEM	original equipment manufacturing
PDP	Production Development Plan
PITCE	Policy for Industry, Technology and Foreign Trade
PPP	purchasing power parity
PV	photovoltaic
R&D	research and development
RCA	revealed comparative advantage
REER	real effective exchange rate
SACU	Southern Africa Customs Union
SADC	Southern African Development Community
SEZ	special economic zone
SME	small and medium-sized enterprise
SOE	state-owned enterprise
TFP	total factor productivity
TOE	tonnes of oil equivalent
TRIMs	Trade-Related Investment Measures
TVE	township and village enterprises



## List of Abbreviations

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ULC	unit labour costs
UNIDO	United Nations Industrial Development Organization
UNCTAD	United Nations Conference on Trade and Development
UK	United Kingdom
US	United States
USPTO	US Patent and Trademark Office
VA	value added
VS	vertical specialization
WDI	World Development Indicators
WFP	workforce participation rates
WIOD	World Input–Output Database
WPR	worker–population ratio
WTO	World Trade Organization

# Notes on the Contributors

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# 1

## Introduction and Overview

*Wim Naudé, Adam Szirmai, and Nobuya Haraguchi*

### 1.1 Introduction

This book is about the structural transformation of the ‘BRICS’ (Brazil, Russia, India, China, and South Africa). The emergence of the BRICS reflects an ongoing change in the international economic order. They now account for a substantial part of global gross domestic product (GDP), global manufactured value added, and global manufactured exports. Their increased economic weight has led to a realignment of international economic institutions and given an increased voice to emerging economies in international affairs. In July 2014 the BRICS even set up their own development bank, to be based in Shanghai and which will compete with the World Bank. The BRICS also act as influential regional players in their respective regions (*Brazil* in Latin America, *China* in East Asia, *India* in South Asia, *Russia* in Central Asia, and *South Africa* in Southern Africa).

Structural economic transformation, defined as the evolution of an economy’s structure from low-productivity traditional activities (such as in traditional agriculture) to higher productivity modern activities (such as in manufacturing and services) has been a *sine qua non* of economic growth and development ever since the first Industrial Revolution. Such transformation is desirable not only as a source of higher productivity growth and per capita income, but also to achieve greater diversity of the economic structure, which reduces a country’s vulnerability to poverty and external shocks.

Many low- and middle-income countries today strive for structural economic transformation. How this can be marshalled remains at the forefront of the international development agenda. It has led to a resurgence of interest in industrial policy in both developing and in advanced economies as well as in international development organizations. Structural change requires



policies that promote the development, adoption, and use of technologies that will change what an economy produces and how it does so. Structural transformation, productivity increases, and growth trigger further processes of agglomeration and technological advances. Countries can either acquire technologies for industrial production and upgrading externally (through trade or the activities of multinational enterprises) or internally (through domestic innovation and investment in productive capacity and increased scale).

Over the last 30 years, the BRICS have achieved notable structural change and poverty reduction, albeit to different degrees and in different ways. Their experiences offer interesting lessons for low- and middle-income countries desiring structural change, including the growth of ‘dynamic’ sectors, such as manufacturing or market services.

To date, however, despite a large and growing body of literature on the economies of the BRICS, no systematic and comparative empirical analyses have been carried out—to the best of our knowledge—on the nature of structural change in the BRICS since 1980. The comparative role and significance of manufacturing as an engine of growth in the BRICS and the differences between and changes within the countries’ manufacturing sectors has also not yet been studied in depth. There is growing debate over the sustainability and relevance of the example set by BRICS as well as to what extent their structural transformation has had a significant and sustainable impact on poverty reduction. This book aims to address these gaps.

## 1.2 Is Manufacturing Special?

Before providing an overview of the individual chapters in this book, we take up an idea that is either explicit or implicit in all chapters, namely that manufacturing growth may be especially important for structural change and development. Why should manufacturing be special?

There are at least five reasons (see for more detail Szirmai 2013). First, at lower levels of per capita income there is an empirical relationship between manufacturing growth and GDP growth. As GDP per capita rises, the share of manufacturing has been observed to increase until it reaches a peak. Beyond an optimum, the share of manufacturing declines as the service sector assumes a more important role in high income economies. Second, because value added per worker in manufacturing is higher than in the agricultural sector, the transfer of resources to manufacturing carries a ‘productivity bonus’. Third, the manufacturing sector may offer special opportunities for capital accumulation. A higher level of capital per worker is one of the hallmarks of industrial development. Fourth, manufacturing may provide more opportunities for economies of scale (and scope) compared to other sectors such as agriculture

or services. Finally, as was argued by among others Cornwall (1977), manufacturing may be the main driver of technological progress. Technological advance may originate in the manufacturing sector and diffuse to other sectors.

The role of the manufacturing sector in the process of structural change therefore deserves special attention. Although the current literature no longer assumes that manufacturing is the only driver of growth, and each of the five reasons for the ‘special’ nature of manufacturing may be qualified, it is still a crucial sector in economic development and the catching-up process of low and middle-income economies. And as the present book convincingly illustrates, manufacturing has been and still is crucial for economic development in the BRICS. The evolution of manufacturing in the BRICS may hold useful lessons for other countries desirous of structural change.

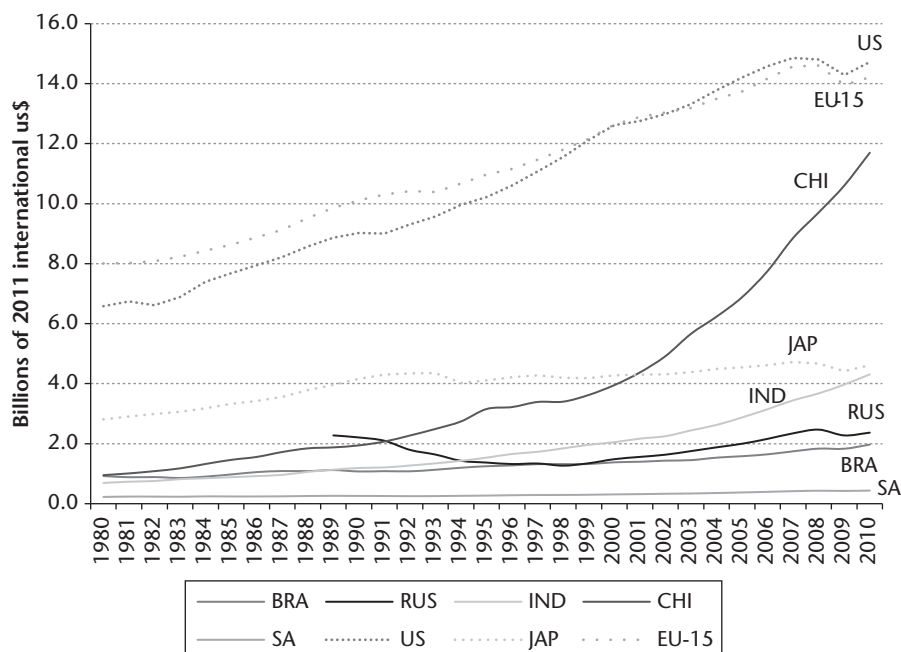
### **1.3 Manufacturing Growth and the Rise of the BRICS**

The key contribution of the chapters that follow is their meticulous documentation of the nature and drivers of manufacturing growth (and in some instances decline) in the BRICS. It is useful therefore to provide a snapshot of the bigger picture at the outset of this book. Not only does this provide a clear perspective on the motivation for the book, namely that the emergence of the BRICS and the differences in their manufacturing growth and patterns of manufacturing development call out for explanations, but it also highlights some of the key themes addressed in the various chapters, such as trade, technology, investment, and industrial policies. It will also show that across the BRICS the respective roles of manufacturing and services are different, the driving sectors within manufacturing are different and the patterns of and routes to industrialization vary. In short, the experiences of the BRICS are very diverse, and not all of these countries are shining examples of successful industrialization.

#### **1.3.1 *The Rise and Global Importance of the BRICS***

As we mentioned at the outset of this chapter, the emergence of the BRICS has resulted in an ongoing change in the international economic order. They now account for a substantial part of global GDP, global manufactured value added, and global manufactured exports. Figure 1.1 depicts the rise of the BRICS (see also Table 2.1 in Chapter 2).

Figure 1.1 shows that among the BRICS, the rise of China and India in terms of economic size has been nothing less than spectacular. Whereas their economies were at comparable levels to those of the other three BRICS in 1980, by 2010 their economies were significantly larger as measured by GDP in billions of purchasing power parity (PPP)-adjusted US dollars.



**Figure 1.1.** Total GDP 1980–2010, BRICS, USA, EU, and Japan (in billions of 2011 GK PPP dollars)

Source: The Conference Board Total Economy Database.

China is expected to overtake the USA as the largest economy in the next two or three decades—if not sooner. India is expected to move to the third position by 2050. Brazil is expected to have a larger economy than Germany by 2036 and to be the world’s fifth largest economy by 2050 (Wilson and Purushothaman 2003). Combined, the economic size of these three countries currently exceeds US\$4.7 trillion in nominal GDP terms, and US\$20.7 trillion in 1990 PPP adjusted GDP.<sup>1</sup> Taken together, therefore, the BRICS are in economic terms already larger than the USA and the European Union. Furthermore, the BRICS contain two of the most populous countries in the world (China and India).

### 1.3.2 The Development Level of the BRICS: GDP per Capita and Productivity

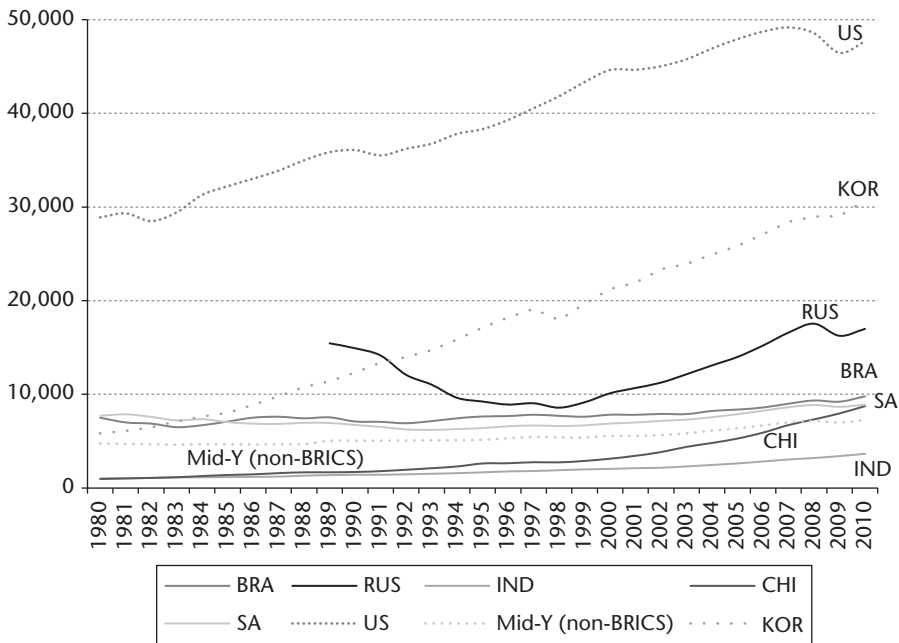
It is not only economic size that matters. A better gauge of economic development is GDP per capita. In such terms, China and India (with the most

<sup>1</sup> Using 1990 PPP dollars, the catch-up pattern is even more pronounced and China has overtaken the USA in 2009.

rapid growth and the largest populations) turn out to be much poorer than the other three countries, although they are rapidly catching up.

Figure 1.2 depicts the evolution of GDP per capita since 1980 (1989 in the case of Russia). It shows that by 2010, Russia was the wealthiest of the BRICS with a per capita GDP in 2011 PPP dollars of 16,983 PPP US\$. Russia is followed by Brazil with a per capita GDP of 9,787 dollars, South Africa with a GDP of 8,901 dollars and China with a GDP per capita of 8,741 dollars. India is by far the poorest of the BRICS with a per capita GDP of 4,649 dollars in 2010. The features of Figure 1.2 that stand out are:

- (i) the rapid growth in GDP per capita in China;
- (ii) the rapid growth in Russia since 1998, following a very dramatic decline after 1989 (net growth over the whole period 1989 and 2010 was less than 0.5 per cent per year, Russia only recovered to 1989 levels of per capita GDP around 2006);
- (iii) more moderate growth in India;
- (iv) slow growth in Brazil and especially South Africa over the whole period.



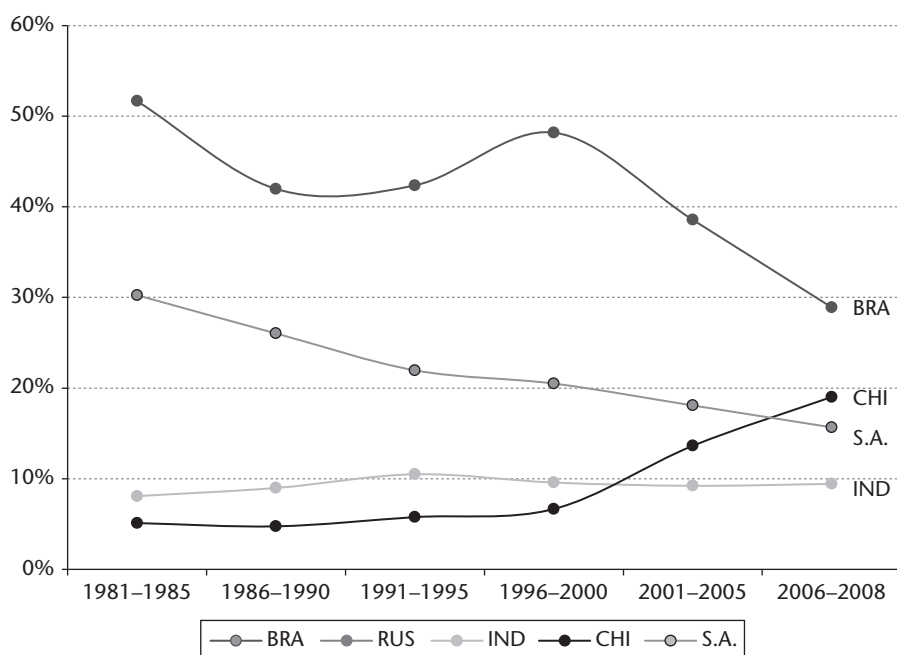
**Figure 1.2.** GDP per capita 1980–2010, BRICS, USA, South Korea, and other mid-income economies (in 2011 EKS PPP dollars)

Source: The Conference Board Total economy database.

Compared to other successful catching-up countries (such as Korea) or the world technological leader (the USA), the BRICS countries are still lagging far behind. The GDP per capita of Brazil, China, and South Africa stands at about one fifth of the US level, while India does not even reach 10 per cent of US per capita GDP.

An important driver of GDP per capita growth is productivity growth. Understanding the evolution of productivity in the BRICS is useful to understanding how their GDP per capita has grown and how they have been catching up and will continue to catch up. In this regard in Figure 1.3 we present estimates of manufacturing labour productivity relative to the USA during our period of analysis. This is of particular interest since labour productivity is often taken as a rough proxy for a country's technological sophistication, and labour productivity relative to the USA taken as a proxy for a country's technology gap.

Figure 1.3 clearly shows the diverging trends within the BRICS. While Brazil and South Africa are falling behind (relative productivity is declining over



**Figure 1.3.** Labour productivity relative to the USA in manufacturing industries, BRICS countries (5 year averages), 1981–2008 (USA = 100)

*Note:* Comparable data for Russia are not available.

*Source:* Brazil, India and China: Szirmai, Statistics of socio-economic development, <<http://www.dynamicsofdevelopment.com/>>; South Africa: van Dijk (2002) (extrapolated until 2008 using several sources).

time), China has managed to reduce the productivity gap. In India comparative productivity is about the same as it was in the early 1990s. Thus it is neither catching up, nor falling behind. Both countries are, however, still very far from the US productivity level (at around 19 per cent and 9 per cent respectively). Productivity and its relationship to innovation and technological upgrading features prominently in Chapters 12, 13, and 15 of this book while Chapter 3 provides a decomposition of productivity changes.

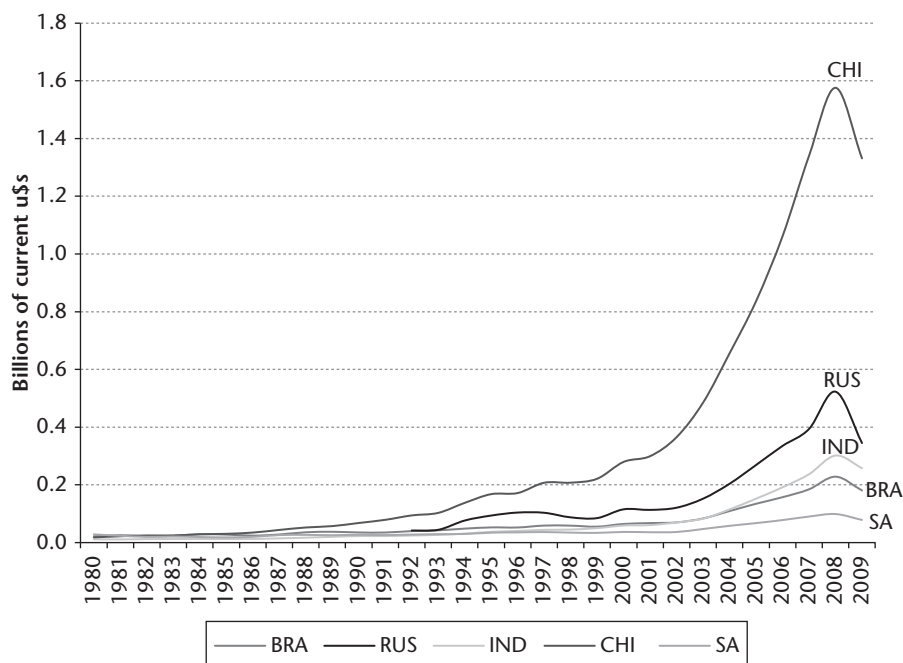
### 1.3.3 *Globalization and the BRICS*

One of the first things that comes to mind when the successful BRICS (China and India) are discussed is the role that export-led growth (exporting manufactured goods) has played. In the case of China especially, opening-up to the world economy at the end of the 1970s is a central part of the narratives in the chapters in this book dealing with this country, most notably Chapters 4 and 5.

India has also experienced major manufacturing export growth, but has increasingly also been exporting IT services. Russia and South Africa are well known for their resource and commodity exports. Brazil has been successful in exporting natural resources as well as certain categories of resource-based manufactured goods and some high-tech manufacturing products. These patterns of integration into the world economy have been important for the relative performance of these economies. It is well established that trade is one of the important mechanisms for access to and adoption of foreign technologies, and issue which Chapter 12 explores in greater detail.

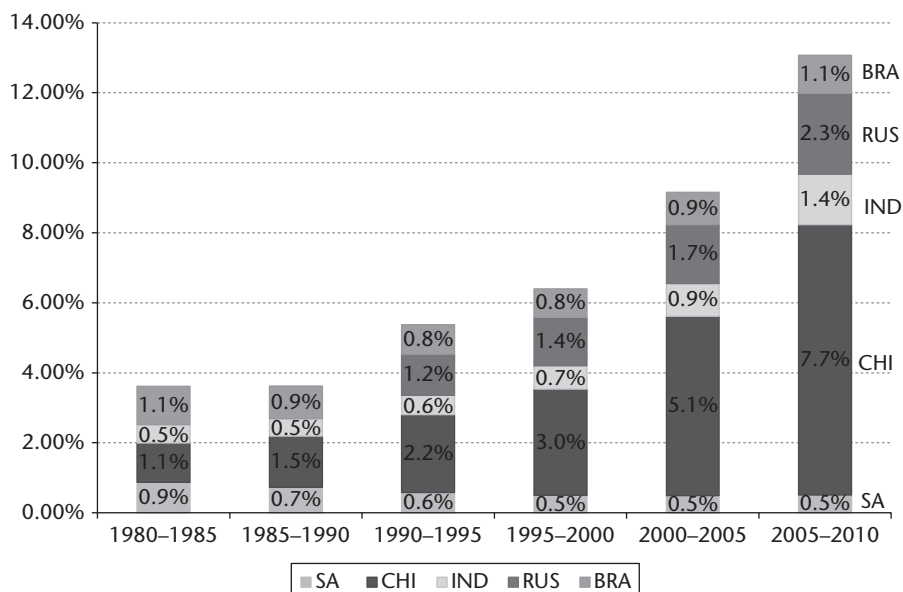
In Figure 1.4 we show that all the BRICS have become more integrated into the global economy over time through exports. As Chapters 2, 10, and 11 show, the BRICS are today integrally part of many global value chains (GVCs). Whereas the BRICS only accounted for less than 4 per cent of world exports during the early 1980s, by 2010 their combined share reached 13 per cent of world exports. The growth of exports in China in particular has been extraordinary. The figure shows that after China, the fastest export growth has been in Russia, India, and Brazil. As discussed by Weiss (see Chapter 14) in per capita terms South Africa had the largest export value among the BRICS over the period 1980–2005. However, in current values, South African exports in 2009 are only at 3.5 times their 1980 value, compared to 97 times in China.

The growing importance of the BRICS in the process of globalization is well illustrated in Figure 1.5 where we depict their share of world exports.



**Figure 1.4.** Total exports from BRICS countries, 1980–2009 (in billions of current dollars)

Source: UNCTAD.



**Figure 1.5.** Total exports from BRICS countries (5 year averages), 1980–2010 (as percentage of world exports)

Source: UNCTAD.

The types of manufactured goods and services exported provide an interesting glimpse into the different patterns of structural change in the BRICS. In the case of service exports—significant in Brazil, India, and South Africa—the main sub-sectors have been the renting of machinery and equipment and other business activities in Brazil, IT services in India, and transport services in South Africa.

A breakdown of shares in manufactured exports is shown in Table 1.1. Looking at Table 1.1 we see that the most radical changes in the structure of manufactured exports have taken place in China and India. Chapter 5 details this for China, and Chapter 8 for India. China especially managed to transform its specialization in manufactured exports, shifting from an export structure concentrated in labour intensive and low-tech products (mainly food and textiles) towards a structure concentrated in capital intensive and high-tech products (metal products, machinery and electrical equipment in China, and chemicals and other manufacturing goods in India). Less radical changes, but in the same direction, can be observed in Brazil and South Africa, where transport equipment, machinery, and electrical equipment have gained market share. In contrast, Russian manufacturing exports show a trend towards specialization in refined petroleum products (driven by its oil and gas resources).

#### 1.3.4 *Manufacturing in the BRICS*

So, the BRICS have risen fast in terms of economic size, and are playing an increasingly important role in the global economy. How important has manufacturing been in this, apart from fuelling China's export-led growth? While the answer to this is complex, and largely one of the key reasons for this book, we can summarize here by way of providing a background, the salient features of manufacturing development and growth in the BRICS. We first present the manufacturing value added growth rates of the BRICS relative to those of the world and then look into the composition of value added and employment in the BRICS in 1980<sup>2</sup> and 2008 (Tables 1.3 and 1.4) and the changes that can be observed between these years (Table 1.4).

Figure 1.6 compares the manufacturing value added growth rates of the BRICS with the world average. Up to 1998, it is hard to judge the BRICS's performance as a whole relative to the world. The world average line was drawn more or less between the high and low performers among the BRICS. However, from 1999 until the financial crisis in 2008, except for a few countries in a few years, all the BRICS countries have consistently

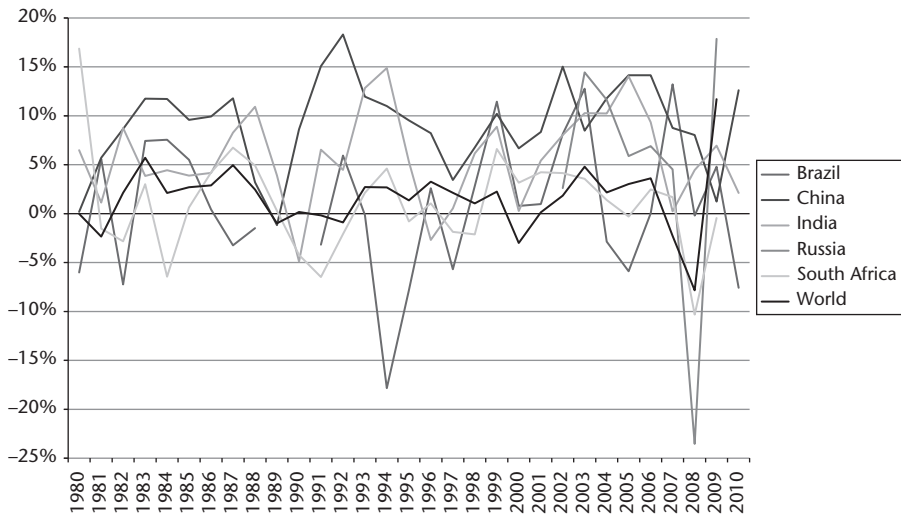
<sup>2</sup> In the cases of China and Russia, comparable data are only available since 1987 and 1995 respectively. In what follows, our starting point for the two economies will be given by those years.



**Table 1.1.** Change in sectoral composition of manufacturing exports from BRICS, 1980–2009 (% share of manufacturing exports)

	Brazil			Russia			India			China			South Africa		
	1983	2009	Δ	1996	2009	Δ	1980	2009	Δ	1985	2009	Δ	1980	2009	Δ
Food, beverages, and tobacco	32.8	30.5	–2.4	2.7	3.3	0.6	9.6	5.2	–4.4	15.7	1.9	–13.7	18.8	7.1	–11.6
Textiles and textiles products	4.6	0.9	–3.6	1.2	0.2	–1.0	26.6	5.5	–21.0	22.4	4.9	–17.5	1.5	0.8	–0.7
Leather, leather goods, and footwear	6.4	2.5	–3.9	0.7	0.2	–0.5	12.1	8.0	–4.1	4.8	10.4	5.6	0.9	0.4	–0.5
Wood and products of wood, and cork	1.6	1.6	0.0	2.2	3.0	0.8	0.8	0.1	–0.7	0.0	0.7	0.7	0.4	0.3	–0.2
Pulp, paper, paper products, and publishing	3.3	5.0	1.7	4.1	2.3	–1.8	0.2	0.5	0.3	0.0	0.9	0.9	3.9	3.1	–0.7
Coke, refined petroleum products, nuclear fuel	7.2	3.2	–4.0	18.7	40.7	22.0	2.1	16.2	14.2	41.0	1.3	–39.6	0.6	3.7	3.1
Chemicals and chemical products	8.2	11.5	3.3	14.1	11.6	–2.5	10.6	12.6	2.0	5.4	5.6	0.2	14.5	10.2	–4.3
Rubber and plastics products	0.9	2.3	1.4	1.0	0.8	–0.2	2.2	1.2	–1.0	0.8	3.4	2.6	0.6	1.2	0.6
Other non-metallic mineral products	0.7	1.4	0.7	0.8	0.8	0.0	1.2	1.2	–0.1	0.2	2.0	1.8	1.5	0.8	–0.7
Basic metals and metal products	13.9	13.1	–0.8	39.0	26.6	–12.4	7.6	9.9	2.3	3.5	8.6	5.1	40.6	39.1	–1.5
Machinery NEC	5.9	7.9	2.0	3.9	3.0	–0.8	6.1	4.8	–1.3	0.9	22.0	21.1	4.0	9.6	5.7
Electrical and optical equipment	3.1	5.6	2.4	3.4	2.9	–0.4	3.5	6.6	3.1	1.5	26.5	25.0	1.6	3.9	2.4
Transport equipment	10.8	13.3	2.6	7.8	3.2	–4.7	14.4	6.5	–7.9	0.8	5.7	4.9	2.9	14.4	11.5
Furniture, manufacturing n.e.c., and recycling	0.5	1.1	0.7	0.4	1.3	0.9	3.1	21.6	18.5	3.2	6.0	2.8	8.3	5.3	–3.0
<b>Total</b>	<b>100</b>	<b>100</b>	<b>—</b>	<b>100</b>	<b>100</b>	<b>—</b>	<b>100</b>	<b>100</b>	<b>—</b>	<b>100</b>	<b>100</b>	<b>—</b>	<b>100</b>	<b>100</b>	<b>—</b>

Source: UN-COMTRADE.



**Figure 1.6.** Manufacturing value added growth rates of the BRICS and the world (%)

*Note:* Manufacturing value added is calculated as the share of gross manufacturing value added in GDP multiplied by constant GDP (at 2000 prices). Gross output shows similar growth trends

*Source:* World Development Indicators.

**Table 1.2.** Backward domestic linkages (output multiplier effects)

	1995			2005			2009		
	Agr	Serv	Man	Agr	Serv	Man	Agr	Serv	Man
Brazil	1.51	1.53	1.98	1.71	1.56	2.05	1.73	1.58	2.10
China	1.74	2.00	2.48	1.81	1.97	2.53	1.84	2.00	2.70
India	1.37	1.54	2.23	1.36	1.45	2.04	1.29	1.42	2.06
Russia	1.82	1.59	1.96	1.69	1.65	2.00	1.78	1.74	2.11
South Africa	1.69	1.58	1.98	1.94	1.80	2.13			

*Source:* The World Input–Output Database for Brazil, China, India, and Russia. OECD STAN Input–output Database for South Africa (available only for 1995 and 2005).

**Table 1.3.** Sectoral shares of value added (at constant prices), BRICS, 1980–2008 (in %)

	Brazil		Russia		India		China		South Africa	
	1980	2008	1995	2008	1980	2008	1987	2008	1980	2008
Agriculture	4.4	5.8	7.6	4.4	36.0	16.1	30.0	9.7	3.4	2.6
Mining	1.3	2.4	12.8	8.8	2.7	2.5	4.0	4.6	13.3	6.1
Manufacturing	19.6	17.4	16.5	16.9	14.5	16.3	19.7	34.5	21.6	18.4
Utilities	2.2	3.8	4.5	2.7	1.4	1.9	2.3	2.9	1.8	2.1
Construction	8.0	5.1	4.8	6.2	7.7	8.0	6.4	5.8	4.0	3.3
Services	64.5	65.5	53.7	60.9	37.7	55.2	37.6	42.6	55.9	67.5
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

*Source:* Timmer (2012), G. J. de Vries et al. (this volume), and K. De Vries et al. (2013).

**Table 1.4.** Sectoral shares of employment, 1980–2008 (in %)

	Brazil		Russia		India		China		South Africa	
	1980	2008	1995	2008	1980	2008	1987	2008	1980	2008
Agriculture	38.4	17.8	27.7	21.5	69.5	55.1	58.0	39.6	26.0	14.0
Mining	0.5	0.3	1.4	1.2	0.5	0.5	1.8	1.3	9.4	2.2
Manufacturing	12.8	13.0	17.3	13.7	10.5	12.3	16.3	18.7	16.5	13.1
Utilities	0.8	0.4	1.9	2.3	0.2	0.3	0.3	0.5	0.9	0.6
Construction	8.9	7.2	7.7	7.3	2.1	6.9	4.6	6.8	5.2	7.6
Services	38.6	61.3	44.0	54.0	17.2	25.0	19.0	33.2	42.0	62.5
<b>Total</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>	<b>100.0</b>

Source: Timmer (2012), G. J. de Vries et al. (this volume), and K. De Vries et al. (2013).

outperformed the world average and expanded their manufacturing production. Their high manufacturing value added growth coupled with the sector's high and increasing backward linkages with their domestic economies compared to other sectors (Table 1.2) indicates that, from the end of the 1990s, manufacturing in the BRICS helped to drive their economic development more than the share of manufacturing in GDP might imply.

Tables 1.3 and 1.5 show that China is the only country where the share of manufacturing increased dramatically between 1987 and 2008. By 2008, manufacturing accounted for no less than 34.5 per cent of Chinese GDP. The combined industrial sector (mining, manufacturing, utilities, and construction) accounted for 47.8 per cent of GDP, exceeding the share of services which stood at 42.6 per cent. In India, there has been a modest increase in the share of manufacturing, but services have become by far the largest sector of the economy.

In Russia, the share of manufacturing remained more or less stable. In Brazil and South Africa it declined somewhat, pointing to de-industrialization. In these three countries the share of the service sector increased. In 2008, services stood at almost 65 per cent of GDP on average.

In South Africa and Russia, at the beginning of the period, the relatively large contribution of mining to GDP stands out. While in South Africa it accounted for 13.3 per cent of GDP, in Russia this was 12.8 per cent. By 2008, the shares of mining in both countries had declined, in the case of South Africa very substantially. China and India have experienced most structural change, with large declines in the shares of agriculture and large increases in respectively, manufacturing and services.

Table 1.4 highlights the fact that the contribution of manufacturing to employment remains limited, even in the most industrialized of the BRICS, China (18.7 per cent). This of course is due to higher than average labour productivity in manufacturing.

**Table 1.5.** Changes in sectoral shares of value added (VA) and employment (N), BRICS, 1980–2008 (in percentage points)

	Brazil (1980–2008)		Russia (1995–2008)		India (1980–2008)		China (1987–2008)		South Africa (1980–2008)	
	VA	N	VA	N	VA	N	VA	N	VA	N
Agriculture	1.39	–20.63	–3.20	–6.18	–19.93	–14.43	–20.31	–18.43	–0.78	–12.04
Mining	1.16	–0.20	–3.98	–0.18	–0.22	0.03	0.59	–0.53	–7.19	–7.24
Manufacturing	–2.25	0.24	0.40	–3.58	1.79	1.78	14.78	2.38	–3.20	–3.40
Utilities	1.64	–0.34	–1.80	0.36	0.50	0.02	0.58	0.21	0.33	–0.26
Construction	–2.91	–1.76	1.4	–0.40	0.38	4.80	–0.59	2.20	–0.70	2.45
Services	0.96	22.7	7.2	9.98	17.48	7.79	4.95	14.2	11.53	20.5

Source: Based on Tables 1a and 1b.

Thus, China's and India's fast GDP per capita growth has been accompanied by structural changes away from agriculture, and into manufacturing and services, respectively. In Russia, rapid growth since 1997 has not seen a growing manufacturing share. This lack of industrial expansion is typical of gas/oil-rich countries.

The other resource-rich BRICS economy—South Africa—has experienced a shrinking manufacturing share—but mysteriously an even larger decline in the relative share of mining, over a period that includes one of the strongest commodity booms since the Second World War. As David Kaplan concludes in Chapter 9: 'In the absence of significant policy support for growth and development and job creation, the prospects for significant employment gain in South African manufacturing are likely to be limited and the share of manufacturing, while by no means constituting wholesale de-industrialization, is likely to diminish *pari passu* with growth in per capita income'. As in Russia, the service sector has become the dominant sector in South Africa, and it is also dominant in Brazil. In fact, the service sector was already by far the largest sector in Brazil in 1980.

Given the discussion of the 'special' nature of manufacturing in Section 1.2, we should ask what has been the contribution of manufacturing growth to aggregate productivity growth in the BRICS? Did manufacturing growth also drive productivity changes? Table 1.6 reproduces the sectoral contributions to aggregate productivity growth—the sum of contributions of within sector productivity increases and contributions due to sectoral shifts of employment—for the period 1980–2008.<sup>3</sup> The contributions are presented as

<sup>3</sup> In Table 1.5 the sectoral contribution is calculated by first distinguishing between expanding and contracting sectors. For the expanding sectors the contribution to aggregate productivity growth consists of the contribution of intrasectoral productivity growth plus (or minus) the product of the increase in the sectoral employment share from the beginning to the end of the

**Table 1.6.** Sectoral contribution to total labour productivity growth, BRICS, 1980–2008 (in percentage points)

	Brazil	Russia	India	China	South Africa
	1980–2008	1995–2008	1980–2008	1987–2008	1980–2007
Agriculture	0.22 (351)	0.05 (2)	0.44 (11)	0.73 (9)	0.04 (13)
Mining	0.08 (128)	0.15 (5)	0.09 (2)	0.50 (6)	0.32 (103)
Manufacturing	–0.05 (–88)	0.80 (25)	0.65 (16)	3.20 (39)	0.08 (24)
Utilities	0.13 (216)	–0.05 (–1)	0.09 (2)	0.24 (3)	0.06 (19)
Construction	–0.05 (–80)	0.31 (10)	0.21 (5)	0.39 (5)	–0.09 (–27)
Trade, restaurants, and hotels	–0.15 (–236)	0.82 (25)	0.66 (17)	0.71 (9)	–0.16 (–50)
Transport and telecommunications	–0.02 (–33)	0.29 (9)	0.37 (9)	0.69 (8)	0.14 (44)
Financing, Real Estate, and Business	0.01 (19)	1.06 (33)	0.77 (19)	1.13 (14)	0.10 (32)
Other services	–0.11 (–177)	–0.23 (–7)	0.70 (17)	0.68 (8)	–0.18 (–57)
<b>Total</b>	<b>0.06</b> <b>(100)</b>	<b>3.20</b> <b>(100)</b>	<b>3.99</b> <b>(100)</b>	<b>8.27</b> <b>(100)</b>	<b>0.32</b> <b>(100)</b>

<sup>a</sup> Between brackets percentage of total productivity growth.

Source: Authors' estimations based on Timmer (2012), G. J. de Vries et al. (this volume), and K. De Vries et al. (2013).

percentage points. The figures in parentheses are the contributions calculated as a percentage of total productivity growth over the whole period. (When productivity growth is very low, the percentages can be very high. In this respect, percentage points are more revealing.)

In four of the five countries manufacturing makes a substantially positive contribution to aggregate productivity growth. The only exception is Brazil, where the manufacturing sector has a marginal negative contribution, and almost all of the (negligible) productivity growth is explained by what happened in agriculture and utilities. In China, manufacturing makes by far the greatest sectoral contribution to productivity growth, accounting for 39 per cent of total growth. In Russia, India, and South Africa the service

period and the difference between that sector's average labour productivity over the period and the average productivity of all shrinking sectors (This methodology is developed in Van Ark and Timmer 2003, see also Wang and Szirmai 2008). For shrinking sectors, the contribution equals the intrasectoral productivity contribution. The method is similar to the shift and share methods used in Chapter 3, with the difference that in Chapter 3 the sectoral contribution refers only to the intrasectoral effect. The reallocation effect is not allocated to specific sectors. Nevertheless the results are comparable. Shift and share methods are explained in more detail in Chapters 3, 7, and 8.

sectors are the most important drivers of growth with an exceptionally large contribution of trade (25 per cent) and finance (33 per cent) in Russia. In India all service sectors contribute to growth. In South Africa the record is more mixed. Transport and finance contribute positively, while other sectors make negative contributions to a slow aggregate rate of productivity growth. The subsequent chapters will provide more evidence on sectoral contributions which are in line with these estimates. However, the outcome of the analysis depends on the period chosen. In Chapter 3, the analysis focuses on a more dynamic period in the 1990s.

Summarizing the above trends, it is clear that the most rapid economic growth has occurred in the BRICS where most structural change has taken place and where manufacturing continues to play a substantial role such as China, and to a lesser extent India. The different patterns of structural change illustrate the extreme heterogeneity of the BRICS—a theme emphasized in many of the chapters that follow.

## 1.4 Overview of this book

Against the background sketched above, we can now summarize the contributions of the chapters in this book. Part I consists of two chapters with *comparative analyses* of the experiences of the BRICS. Part II presents six *country studies* exploring the nature of structural change in a specific country context and over a specific period. Part III presents seven studies of various *cross-cutting themes* and their relevance for the BRICS. In a short chapter in Part IV, the editors reflect on the lessons learned.

### 1.4.1 Part I: Comparative Analyses

In Chapter 2, entitled *Structural Change in the BRICS's Manufacturing Industries*, Nobuya Haraguchi and Gorazd Rezonja focus on changes in the sectoral composition of GDP in the five BRICS countries. Using econometric methods, they predict the value added and employment levels of manufacturing sectors, on the basis of data for a set of large countries, controlling for population density and resource endowments. They then compare the actual sectoral trends of the five countries. This shows whether or not a country is doing better or worse than predicted, and in which sectors such advantages are concentrated. Chinese performance in manufacturing was better than the predicted average, while India's performance was worse. Brazil, Russia, and South Africa had already passed the stage of development associated with rapid industrialization. The manufacturing strengths of these countries lie in the natural resource-based industries.

The chapter also analyses the strength of production linkages in an input–output context using data from the World Input–Output Database. China has strong production linkages with both domestic and foreign suppliers. In Russia, foreign linkages have decreased over time, while its domestic linkages have increased. India is the only country among the BRICS whose domestic linkages have declined, while its international linkages have increased. Brazil has increased its domestic linkages in the natural resource-based industries and in the transport equipment industries. South Africa is highly dependent on foreign inputs. In the period studied, China has emerged as a dominant supplier to other BRICS’s manufacturing industries. In terms of market orientation, the manufacturing industries of Brazil, India, and South Africa are more oriented towards the domestic market than those of China and Russia.

Chapter 3, entitled *Deconstructing the BRICS* has been written by a group of five researchers—Gaaitzen J. de Vries, Abdul A. Erumban, Marcel P. Timmer, Ilya Voskoboynikov, and Harry X. Wu—associated with the Groningen Growth and Development Centre. Applying shift and share methods to a detailed sectoral dataset of value added and employment, they analyse the contribution of structural change to aggregate labour productivity growth in four of the five BRICS, namely Brazil, China, India, and Russia, from the mid-1990s to 2008. The aim is to discover whether structural change is growth enhancing or growth reducing (McMillan and Rodrik 2011). The authors find strong growth enhancing effects of structural change in China, India, and Russia, but not in Brazil. The chapter contains two interesting novelties, first the importance of the level of disaggregation and second, the distinction between formal and informal activities. The level of aggregation makes a great deal of difference. If only a few large sectors are distinguished, reallocation is not very important. When thirty-five sectors are distinguished, reallocation contributes much more. New insights emerge when the distinction between formal and informal sectors is taken into account. In the case of Brazil, increased formalization appears to be growth enhancing, while in India the increase in informality is growth reducing.

#### 1.4.2 Part II: Country Experiences

Six chapters comprise Part II: two chapters dealing with China, and a chapter dealing each respectively with Russia, Brazil, India, and South Africa.

Chapter 4, by Justin Yifu Lin and Miaojie Yu is entitled *Industrial Upgrading and Poverty Reduction in China*. The authors discuss China’s economic reforms since 1978 and how these enabled structural change and poverty reduction. They distinguish between comparative advantage defying policies prior to 1978 and comparative advantage following the policy change. Against this backdrop the chapter presents a wealth of empirical data on growth, structural

change, exports, revealed comparative advantage, employment, and poverty reduction. Three broad lessons for structural change are derived from the successful reform experiences of China. First, policy should identify and facilitate the development of industries consistent with a country's latent comparative advantage. Second, pro-active industrial policy can play a crucial role in helping an economy transform itself in line with its actual and latent comparative advantage. Structural transformation requires the coordination of firms in different sectors and first-mover firms engaging in risky technological innovations should be supported; and, third, developing countries can try to empirically identify their future or latent comparative advantages by comparing themselves with other countries with similar characteristics but higher levels of per capita income.

Chapter 5 by Ximing Yue entitled *Structural Change, Employment, and Poverty Alleviation in China* complements Chapter 4. While the emphasis in Chapter 4 is on policy assessment, Chapter 5 scrutinizes empirical trends in China's structural change, using original datasets which present somewhat lower—though still very high—growth rates, than those deriving from official statistics. Capital accumulation is identified as the most important source of growth, with increases in total factor productivity only making very modest contributions. In this respect, the chapter differs from previous assessments of the sources of growth. An interesting contribution of this chapter is its analysis of the impact of structural change in industry on the employment of migrant workers, documenting the vast flow of migrant workers to urban areas and analysing the sectors in which they are employed. Manufacturing absorbs by far the largest proportion of migrants (almost half), followed by wholesale and retail trade and the construction sector. The chapter shows that migration has had very significant contributions to rural poverty reduction, both in terms of headcounts and poverty rates.

We turn to the experience of Russia in Chapter 6. Written by Boris Kuznetsov, Andrei Yakovlev, and Vladimir Gimpelson it is entitled *Industrialization in the Russian Federation*. In contrast to the Chinese experience, the Russian experience since 1989 provides an example of de-industrialization rather than industrialization, with a declining role of manufacturing as a major driver of the economy and an increased role for primary resource-based extraction industries. The authors argue that in spite of its diminishing share in the economy, manufacturing continues to be the backbone of the economy, generating and absorbing most technological innovations. But it is also one of the more vulnerable sectors in a globalized environment. The chapter discusses successive policy reforms and their effects, providing very interesting and novel information on manufacturing employment trends. In the Russian context, manufacturing employment is much stable than output, providing a kind of safety net in periods of crisis.



The country experience of Brazil is discussed in Chapter 7 by Dante Aldrichi and Renato Colistete, and is entitled *Industrial Growth and Structural Change: Brazil in a Long-Run Perspective*. It presents and critically discusses time series of economic growth and growth of manufacturing value from the mid-nineteenth century onwards. The authors criticize the conclusions of Jeffrey Williams and others that nineteenth-century Brazil suffered from de-industrialization due to upswings in its terms of trade. They find no relationship between the barter terms of trade and industrialization; they do find positive linkages between primary exports and investment in industrial activities. Subsequently, the authors perform decompositions of manufacturing labour productivity for different sub-periods between 1945 and 2009, analysing the sectoral contributions to aggregate growth using shift and share methods. There is a strong contrast between the dynamic period until 1973, with expanding manufacturing activities and increasing productivity, and the lost decade of the 1980s and sluggish productivity performance after 1995. In recent years, employment has primarily been created in low productivity sectors. Manufacturing's contribution to aggregate national productivity growth after 1995 was negative. As also discussed in Chapter 3, there is evidence of a shift from informal to formal activities in Brazil, which in itself is a growth enhancing transformation. In recent decades, the Brazilian manufacturing sector has been characterized by very slow or even negative productivity growth. Compared to its Asian competitors Brazil is falling behind.

Chapter 8, written by Aradhna Aggarwal and Nagesh Kumar and entitled *Structural Change, Industrialization, and Poverty Reduction: The Case of India* is a detailed case study of the Indian experience. The chapter opens with an interesting analysis of the linkages between structural change (industrialization) and poverty reduction. Whether or not structural change contributes to poverty reduction depends on whether there is net new employment creation, on the wage differentials between newly emerging sectors and shrinking sectors, and on within-sector productivity trends. The chapter concludes that there have been substantial declines in poverty in India, even though poverty head counts and poverty rates still remain unacceptably high in 2009. The authors use regression techniques to analyse the extent to which structural change and the growth of the manufacturing sector contributes to poverty reduction. Interestingly enough, rapid growth accompanied by structural change in general is poverty enhancing. But structural change in the specific form of expansion of the share of manufacturing in GDP contributes to poverty reduction. The chapter also contains an extensive empirical analysis of Indian patterns of structural change, sectoral contributions to growth, growth of capital and employment, and a comparison of different growth accounting estimates of the contributions of growth. At the level of the total economy, the liberalization of the Indian economy has contributed to much

better performance in the last three decades. But manufacturing played a much more important role prior to 1980 than in recent decades, when the role of services has become more prominent. Within services, there has been a shift towards more dynamic market services. Within manufacturing, structural change has actually been growth reducing. Workers were increasingly absorbed into low productivity activities. Overall, the Indian economy is characterized by high degrees of informality. The informal sector has lower wages and worse working conditions.

The last chapter (Chapter 9) in Part II is on South Africa. Authored by David Kaplan it is entitled *The Structure and Performance of Manufacturing in South Africa*. In South Africa, the growth of manufacturing has been moderate and the share of manufacturing in GDP has been declining. Within South African manufacturing, the sectors that have been losing share are those with high semi-skilled and unskilled multipliers. While this means that high skilled sectors are gaining in importance, the net effect is a decline in total manufacturing employment since 1990. This is reinforced by the highly capital intensive nature of production, which is not really in line with South Africa's comparative advantages, given its vast reserves of unskilled labour. Its hourly and unit labour costs are much higher than those of comparable countries, especially in labour intensive areas. In addition to high labour costs in general, there are also increasing differentials between the remuneration of skilled and unskilled labour. At the higher end of the employment sector there are skill constraints, a shortage of sufficient skilled labour. Kaplan argues that due to the complementarities of different manufacturing sectors, the skill constraint also weakens the demand for labour by the more labour intensive low skilled sectors. This creates a major challenge for industrial policy.

### 1.4.3 Part III: Thematic Perspectives

The seven chapters that comprise Part III all deal with central themes in the structural change of the BRICS. These are their role in global value chains, the role of domestic versus foreign demand, or domestic versus foreign investment and technology/innovation, and whether or not industrial policies have made a difference.

Chapter 10, by Fred Nixon, entitled *The Dynamics of Global Value Chain Development: A BRICS PERSPECTIVE* is the first of the thematic chapters. The chapter discusses the implications of the emergence of global value chains (GVCs) for the industrial development of the BRICS and the challenges it poses to industrial policy. The chapter opens with general discussion of the emergence of GVCs and the implications for economic development. Global value chains provide new opportunities for emerging economies, because these can focus on niches in the GVC where they have developed advantages rather than having to

develop a complete domestic supply chain. It also poses serious challenges of how to upgrade within and between GVCs. If such upgrading fails, a country may remain stuck in low value added activities at the bottom of the supply chain. The chapter then goes on to analyse case studies of upgrading and capability building in general and more specifically in the context of the BRICS. As countries shift manufacturing structures from labour-intensive to capital-intensive industries, opportunities for value addition increase while the scope of the domestic production in the range of GVC activities tends to be narrower. Thus, where to specialize and how to upgrade are very pertinent issues to the BRICS as they strive to move towards capital and technologically sophisticated industries. Upgrading within and between GVCs cannot be sustained, if indigenous technological capabilities are not further developed.

Chapter 11 continues the discussion of global value chains, this time focusing on one of the most important GVCs for developing countries, namely the food value chain. Written by Ruth Rama and entitled *Foreign Multinational Enterprises in the Food and Beverages Industries of the BRICS*, this chapter shows that a large part of investment flows in the food and beverages sectors are still within the advanced economies. Nevertheless, the BRICS countries account for a quite substantial percentage of the total number of affiliates of large multinational companies (MNCs) (12 per cent). Developing countries in total account for 24 per cent, which serves to highlight the prominent position of the BRICS in the developing world. In recent years, China has been most successful in attracting foreign investment, at the expense of Brazil, the previously preferred location. South Africa is the least successful. The chapter goes on to analyse the degree of 'embeddedness' of multinational affiliates in the domestic BRICS economies, focusing on familiarity with and knowledge of the local milieu, partnerships with local actors, and R&D activities in the host countries. On balance 'embeddedness' is still rather limited. Transnational companies tend to prefer acquiring host country companies rather than collaborating with domestic enterprises. In terms of R&D, there has been an increase in the amount of R&D performed in the BRICS, although there are questions about the transmission of new knowledge via multinational conduits. Finally, in addition to hosting affiliates of MNCs, the BRICS also have outward flows of foreign direct investment (FDI) and are emerging as new players in global markets.

In Chapter 12, Wim Naudé, Adam Szirmai, and Alejandro Lavopa shift the discussion to a second cross-cutting theme, namely the domestic or international sources of technology acquisition, growth, and catch-up. Entitled *Industrialization and Technological Change in the BRICS: The Role of Foreign and Domestic Investment*, this chapter presents data on foreign and domestic investment in the five countries and analyses how these have driven technology acquisition and innovation. The chapter compares the various BRICS in

terms of their patterns of technological performance, as measured by R&D, patents, and publications and their investment flows. They find that technological progress has been most significant in China, followed by India, and by a lesser extent in Brazil, Russia, and South Africa. The latter two remain economies that are essentially dominated by natural resource extraction and services, and are faced with difficulties in their political and social transition processes. One possible explanation for the differences in technological progress may be the success and relative failures of the various countries' educational policies. China and India stand out from the other countries in terms of the success of higher education—in turning out and attracting highly skilled labour. Finally, they find that the most significant difference between China and the other BRICS is the degree to which FDI and its technological benefits have been directed towards the manufacturing sector. The analysis of domestic and foreign investment suggests that an exclusive reliance on either FDI or only on domestic investment and initiatives, is unlikely to achieve substantial structural change and industrialization.

In Chapter 13, entitled *Investment, Technological Change, and Institutional Change in Industrial Development: The Case of China*, Yanyun Zhao and Siming Liu covers similar issues as those discussed in Chapter 12, but now from an exclusively Chinese perspective. Compared to Chapter 12, this chapter provides a more detailed analysis of the different kinds of foreign and domestic investment and their contributions to capital formation and technological upgrading. The impact of foreign and domestic investment is tackled in a sources-of-growth regression framework. The author concludes that foreign investment was more important before 2002. It compensated for relatively low technological levels of Chinese firms and allowed for the introduction of advanced foreign production facilities into China. Like Ximing Yue in Chapter 5, Zhao concludes that capital inputs were a major source of growth. The effects of changes in labour input were not significant. In the early stage of the manufacturing development in China, foreign capital played a complementary role in the technological development of domestic firms. However, as Chinese firms increased technological capabilities, foreign firms have played less of a facilitating role in domestic technological change but gradually turned to being competitors for Chinese firms. On balance, the chapter concludes that both domestic capital and foreign capital have contributed positively to the growth of value added in Chinese manufacturing. But the effect of domestic investment is significantly larger than that of foreign investment. This conclusion is in line with the findings of Chapter 12.

In Chapter 14, entitled *Internal and External Demand and Manufacturing Development in the BRICS*, John Weiss tackles a third cross-cutting theme, namely the respective roles played by domestic and external demand in economic development. Significant trade reform in the BRICS accompanied with exchange

rate depreciations in both nominal and real terms led to trade liberalization with lower levels of import protection. Given this background in the trade regimes of the BRICS, the chapter first looks at the export shares in three technology categories: low-tech, medium-low-tech, and medium-high plus high-tech. With the exception of Brazil, the export share for the low-tech category declines over time. Next, Applying a shift-share analysis method, the author decomposes changes in production into demand driven growth (holding export shares constant), export driven growth and import substitution (allowing for changing import shares). The conclusions are very interesting. In all cases, internal demand growth dominates. In a few instances (particularly in South Africa) there is negative import substitution (imports rising as a share of consumption). In all instances, exports take a minority share in additional production. In the case of total manufacturing, the share of export expansion ranges from 17 per cent in India, to 22 per cent in China, Brazil, and Russia, and to 23 per cent in South Africa. The relatively low share of exports in additional production can be explained by the large internal markets of the BRICS. Relatively low shares in an accounting framework, however, do not mean that exports have been unimportant in the transformation of the economies of the BRICS countries.

A major challenge for industrialization in the twenty-first century is environmental sustainability. The BRICS are growing rapidly and are presently contributing increasingly to global CO<sub>2</sub> emissions. The question is whether they will follow the path of the environmental Kuznets curve, in which per capita pollution first increases with income per capita before subsequently declining as environmental technologies kick in. Alternatively, they might jump to more environmentally sustainable production and energy technologies reducing their per capita pollution at an earlier stage of development. Such issues are examined in Chapter 15 by Michiko Iizuka, Eva Dantas, and Maria Isabel de Bodas Freitas, focusing on the production and use of renewable energy technologies. Entitled *The Diffusion of Renewable Energy Technologies in the BRICS*, this chapter examines the diffusion of renewable energy technologies in the BRICS, focusing on the use of renewable energy technologies (in particular wind energy and solar energy) and the production capabilities to manufacture renewable energy equipment (e.g. solar cells or wind turbines). They present empirical data on both diffusion of renewable energy technologies in the BRICS, with a special focus on the co-evolution of use and production. The installed capacity to produce wind energy has grown very rapidly in China and India from the mid 2000s onwards and had the highest rate of diffusion amongst the BRICS. In 2010, China was the leading country and India the fifth largest producer of wind energy in the world. The other BRICS countries are lagging far behind China and India and behind the world average. Brazil is leading in hydro electric energy, which supplies most of its energy needs. In terms of the use of solar energy, China and India are ahead of