CENTRE of POLICY STUDIES and the IMPACT PROJECT

Eleventh Floor, Menzies Building
Monash University, Wellington Road
CLAYTON Vic 3800 AUSTRALIA

Telephone:
(03) 9905 2398, (03) 9905 5112

from overseas:
61 3 9905 2398 or
61 3 9905 5112

Fax:
(03) 9905 2426

61 3 9905 2426

e-mail: impact@buseco.monash.edu.au

Internet home page: http//www.monash.edu.au/policy/

China's Growing Demand for Energy and Primary Input - Terms of Trade Effects on Neighbouring Countries

by

YINHUA MAI
PHILIP ADAMS
PETER B. DIXON
Centre of Policy Studies
Monash University

General Paper No. G-196 August 2009

ISSN 1 031 9034 ISBN 978 1 921654 03 9

The Centre of Policy Studies (COPS) is a research centre at Monash University devoted to economy-wide modelling of economic policy issues.

China's Growing Demand for Energy and Primary Inputs – Terms of trade Effects on Neighbouring Countries*

Dr. Yinhua MAI
Prof. Philip Adams
Prof. Peter Dixon

Centre of Policy Studies
Monash University

20 August 2009

*** The authors would like to express their sincere appreciation to the funding institute of this study - The Asian Development Bank Institute.** **The views expressed in this paper are the views of the authors and do not necessarily reflect the views or policies of ADBI, the Asian Development Bank (ADB), its Board of Directors, or the governments they represent. ADBI does not guarantee the accuracy of the data included in this paper and accepts no responsibility for any consequences of their use. Terminology used may not necessarily be consistent with ADB official terms.**

The Centre of Policy Studies

Centre of Policy Studies
Building 11E
Monash University
Clayton, Victoria 3800
Australia
Web address: http://www.monash.edu.au/policy/

ABN No 12 377 614 012

Contacts:

Dr. Yinhua Mai
Senior Research Fellow
Tel: 61-3-99055482
Fax: 61-3-99052426
Yinhua.Mai@buseco.monash.edu.au

Prof. Philip Adams
Director
Tel: 61-3-99055094
Fax: 61-3-99052426
Philip.Adams@BusEco.monash.edu.au

Acronyms and Initials

ADBI	Asian Development Bank Institute
BOTE	Back Of The Envelope model
CES	Constant Elasticity of Substitution
CET	Constant Elasticity of Transformation
CGE	Computable General Equilibrium
COMTRAD	United Nations Commodity Trade Statistics Database
CoPS	Centre of Policy Studies
EU	European Union
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
GNE	Gross National Expenditure
GNP	Gross National Product
GTAP	Global Trade Analysis Project
MMC	the Monash Multi-Country model
nec	not elsewhere classified
ROW	Rest Of the World
UN	United Nation
US	the United States
USA	the United States of America
WDI	World Development Indicators
WTO	World Trade Organisation

Executive Summary

1. The impact of an awakening China has become a prominent topic in economic discussions. One area of particular concern has been the impact of China's industrialisation on world prices for primary commodities.
2. The purpose of this study is to analyse the terms of trade effects of China's rapid growth on its neighbouring countries. The analysis is conducted using a dynamic Computable General Equilibrium (CGE) framework, the MMC model.
3. The advantage of using the MMC model is that it provides a detailed representation of the structures of the economies of concern. Most importantly, the MMC model provides a framework under which a vast number of assumptions based on both empirical data and economic theories are made explicit and can therefore be examined closely to gain a deeper understanding of the issue (see Section 1.1 and Appendix A).
4. In this study, we first simulate a "real" or *convergence scenario* – showing how the economies of China and its neighbours might evolve based on historical data between 1997-2005 and on prevailing historical trends between 2005-2010. We then simulate a *baseline scenario*, in which it is assumed that technological progress in China proceeds in line with progress in the United States, rather than at the rate consistent with convergence. Comparing the baseline with the convergence scenario yields estimates of the effects of China's technological convergence on the terms of trade in China and elsewhere (see Section 1.2; Chapter 2; and Section 3.1).
5. The convergence simulation is based on historical trends, demonstrating observed stylised effects of China's rapid economic growth that have raised terms-of-trade concerns in the literature such as (see Chapter 3):
    - a rapid growth in demand for imports of energy and primary inputs;
    - a rapid growth in manufactured exports; and
    - limited land and natural resource in China.

6. The simulation results show that, indeed, China's technological convergence leads to increased world prices for mining products and to lower world prices for manufactures, especially those it exports extensively (see Chapter 4).
7. However, this study also identified positive effects that China's convergence has on the neighbouring countries' terms of trade. The rise in the prices of energy and primary inputs tends to increase the export price index of exporters of these products. The fall in the price of manufactured goods reduces the import price index for countries that source a significant share of their manufactured imports from China. Furthermore, China's convergence leads to expansion in world trade which, in turn, leads to increased demand for exports of transportation and insurance services. Consequently, China's convergence tends to have a positive impact on prices of services exports (Chapter 4 and 8).
8. The overall impact of the convergence on terms of trade varies depending on the economic structure of each of the neighbouring countries. For Indonesia and Australia, China's convergence leads to improved terms of trade (2.8 and 1.4 per cent respectively. For Singapore and Malaysia, the positive and negative effects almost completely offset one another (Table 4.1 and Figure 4.1).
9. Japan depends on imports for energy and primary inputs; but Japan also sources a large share of its manufactured imports from China and supply transport and insurance services to trade activities. Consequently, for Japan, China's convergence leads to a small negative terms of trade effects (-0.8 per cent). India depends on imports for energy and exports similar manufactured products as China does. As a result, the negative terms of trade effect for India (-3.5%) is estimated to be the largest among the neighbouring countries (Table 4.1 and Figure 4.1).
10. Due to the offsetting factors, the magnitude of the overall impact on each of the neighbouring countries' terms of trade is small, ranging from 0.1 to 3.5 per cent (Figure 4.1 and Table 4.1).
11. The impact of China's convergence on the total exports of the neighbouring countries is also small (Figure 5.1 and Table 5.1). While exports from neighbouring countries to their traditional markets are replaced by Chinese exports, China itself becomes an important export market. Because China is part of a production network involving its neighbouring countries, its

convergence brings about increased imports into China of not only agricultural and mining products, but also manufactures (see Section 5.1).

12. The neighbouring countries that are negatively affected in terms of trade by China's convergence may be positively affected in real GDP and real GNP. For Malaysia, Singapore, and the Republic of Korea, China's convergence leads to increased real GNP (0.4, 1.0, and 0.5 per cent respectively, see Table 5.10), even though the overall terms of trade impact of China's convergence on these countries are negative. This is due to either China's convergence leads to increased demand for goods and services produced in these countries; and/or these countries are important sources of FDI flows into China.
13. If endogenous productivity improvement due to increased trade and investment flows is taken into account, the positive impact of china's convergence on its neighbouring countries' real GDP and GNP should be more significant than those reported in this study.
14. Therefore China's technological convergence and the resulting rapid economic growth should not raise alarm in the neighbouring countries as a source of negative welfare impact. On the contrary, China's convergence presents a new market for the neighbouring countries to invest in, to export to and to source imports from.
15. The challenge China's convergence brings to the neighbouring countries is the change in economic structure required to benefit from China's convergence. This is the challenge to shift from traditional markets to new markets that successful firms are alert to.
16. A close investigation of historical data in this study shows that the neighbouring countries are adapting well to this challenge. This is reflected in China taking an increasingly larger share in neighbouring countries trade and investment portfolio (see, for example, Box 5.1 in Chapter 5).
17. An important change occurred in the past decade or two was that the neighbouring countries have engaged China in the electronic production network in the region. The network greatly expanded regional trade in electronic products that enabled China to become both a good source of manufactured imports, and a good market for manufactured exports. This change is identified in this study as a factor significantly offset the negative effects of rising energy price on neighbouring countries' terms of trade.

18. Changes of assumptions about user preferences in favour of imports and China's energy efficiency do not change the main conclusions presented above (see Chapters 6 and 7).
19. A number of caveats apply to the modelling reported in this paper, of which the following two are in our opinion the most important. Firstly, although we capture FDI flows between economies, we assume that there is no *endogenous* productivity growth associated with these flows. A further investigation on this issue may prove to be important as the main benefit of FDI comes from the associated spill-over effects in productivity (see Sections 5.2 and 8.2). Secondly we have not considered the effects of changes in the third and fourth modes of services trade that involve cross-border movement of capital and labour. Services trade is becoming increasingly important, especially for developed countries. The discussion of how China's rapid growth impact on developed countries' terms of trade therefore should not ignore the special nature of services trade (see Section 8.2).

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

1. Introduction

1.1. The purpose of the research

Issues associated with a country's terms of trade have been a long standing concern in the economics of development. In the 1950s and the 1960s, the concern was about the relative prices between primary commodities and manufactured goods. The rapid technological progress in manufacturing raised concern that developing countries' terms of trade would improve as they export primary commodities and import manufactures. However, Prebisch (1950) and Singer (1950) argued that there were reasons for developing countries' terms of trade to worsen. For examples, many commodity exports were subject to substitution by synthetic products; and the income and price elasticity of demand for commodities exported by developing countries were less than that for products embodying higher technology.

Since the 1970s, the concern has been about relative prices within manufactured goods. Manufactured exports from developing countries typically have a lower technological content and their prices are therefore likely to fall relative to prices of exports from developed countries (Singer 1971; Wood 1997; Maizels, Palaskas and Crowe 1998).

Since the mid-1990s, the impact of an awakening China on the world has become a prominent topic in economic discussions (Weiss 2004; Phelps 2004). China became a net importer of crude oil in the early 1990s. Since then it has become increasingly reliant on imported energy, importing one third of its consumption of crude oil in recent years. The rapid growth of its manufacturing industries also brought about increased demand for primary commodities, such as iron ore and base metal products. The increasing demand for energy and primary inputs plus the rapid growth of manufactured exports from China has raised concerns about its terms of trade impact on both developing and developed economies.

Kaplinkky (2006) observed that "the expansion in Chinese commodity imports has been closely reflected in the global prices of many hard commodities". He commented that "China's demand for imports and growth in exports has been so great as to lead to a shortage of global shipping capacity, manifesting itself in 2001". The study

concluded from a detailed price analysis that, for manufactured goods, "the greater China's participation in global product markets, the more likely prices will fall".

Phelps (2004) – using a theoretical model with two countries and two final-use commodities – argued that China's economic awakening has led to a worsening in terms of trade for those economies that are technologically ahead of China and that China is now catching up to.

The purpose of this study is to analyse the terms of trade effects of China's rapid growth on its neighbouring countries using a dynamic Computable General Equilibrium (CGE) framework. The advantage of using a CGE framework is that it provides a detailed representation of the structures of the economies of concern. The CGE model used in this study features:

- optimisation behaviour of economic agents in determining supply and demand of commodities and services, as well as primary production factors;
- input-output linkages between industries, and between industries and final users;
- bilateral trade linkages between countries;
- bilateral investment linkages between countries;
- linkages between microeconomic variables such as price and quantity of oil imports and macroeconomic variables such as terms of trade and real GNP;
- a realistic baseline forecast for China and neighbouring countries that incorporates resource limits in primary factors (including capital, labour and natural resources); and
- a simulation approach that allows the impacts of China's growth to be separated from those of other factors that influence the neighbouring countries' terms of trade, such as the rise in oil prices due to supply disturbances in the Middle-East.

With rapid globalisation in the past three decades, the linkages between economies in the world have become increasingly sophisticated, increasing the complexity of analysing terms of trade issues. If China's appetite for energy contributes to higher energy prices, then energy exporters are likely to enjoy a favourable change in their

terms of trade while energy importers may suffer deterioration in their terms of trade. If China's demand for primary products contributes to a higher non-energy commodity prices, then exporters of primary products will gain while importers of these products may suffer. If higher energy and commodity prices lead to higher prices for manufactured goods, then countries that are net importers of manufactured goods may suffer terms-of-trade loss. It follows that the effects of China's increasing demand for energy and primary products on the terms of trade of its neighbouring countries will depend very much on the economic structures of these economies.

The structural details provided by the CGE model used in this study accommodate the sophisticated nature of the issue at hand. Most importantly, a detailed CGE model provide a framework under which a vast number of assumptions based on both empirical data and economic theories are made explicit and can therefore be examined closely to gain a deeper understanding of the issue.

In the next section we introduce our approach to this analysis.

1.2. Methodology

In this study, we place China's increasing demand for energy and primary inputs in the context of its convergence in per capita income with developed countries achieved via technological progress. Improved technological progress underlies rapid economic growth in China and hence rapid growth in Chinese demand for energy and other primary inputs.

In this study, we conduct a historical simulation to estimate the degree of catching-up in technology that occurred during 1997 [1] to 2005. The estimated speed of technological progress during the historical period is then used to simulate the effects of China's technological convergence from 1999 to 2010.

This study is composed of three analytical parts. The first part is a historical simulation for the period of 1997 to 2005. The purpose of the historical simulation is

[1] The year of the model database is 1997. However, the input-output structure represented in the model database for most countries is earlier than 1997 – a year when Asian financial crisis affected most of the countries in this study. Different countries conduct their survey for input-output tables at different years. For example, the year of input-output table used in the model database for Japan and the Republic of Korea is 1995, and for Taiwan is 1996. Only for China, the input output table was for the year 1997. However, in 1997 China was not severely affected by the Asian Financial Crisis.

to calibrate the model with historical data, as well as to estimate quantitatively China's technological progress relative to developed countries.

The second part of the study is to simulate China's technological convergence with developed countries, and to analyse the effects of the convergence on China and its neighbouring countries.

In the third part, we test the robustness of our analysis. For this purpose, we supplement the simulation of China's convergence in technology with two other simulations:

1. a change in user preferences towards imported goods, especially manufactured goods that affects prices of manufactured exports; and
2. an alternative scenario of China's energy efficiency that affects China's demand for energy and therefore the world prices for energy products.

We conduct the simulations using the MONASH Multi-Country (MMC) model. The MMC model is a dynamic CGE model of twelve countries/regions: China, India, Indonesia, Thailand, Malaysia, the Philippines, Singapore, Australia, the Republic of Korea, Japan, the United States and the Rest Of the World (ROW) region. It has all the features suitable for analysing terms of trade effects outlined in Section 1.1 (See Appendix A or Mai 2004).

1.3. The structure of the report

This report has eight chapters. After the introduction, Chapter 2 contains a discussion of the methodology, data sources, and findings of the historical simulation.

In Chapter 3 we introduce how China's technological convergence with developed countries is simulated. We also analyse the effects of the convergence on China.

The effects of China's convergence on its neighbouring countries are presented in Chapters 4 and 5. Chapter 4 contains an analysis of the terms of trade effects, and Chapter 5 an analysis of the income and industry effects.

In Chapter 6 we shed light on how the analysis presented in Chapters 3 to 5 would change if there is a change in user preferences towards imported goods. In Chapter 7 we try to understand how the analysis would change if China improves its energy efficiency while achieving technological convergence.

We summarise the findings of this study and discuss further areas of research in Chapter 8.

2. The historical simulation

As the first step of this research, we calibrate the model with historical data, and in the process, estimate empirically China's technological convergence with developed countries. This chapter contains a discussion on the methodology of the historical simulation (Section 2.1), the data used (Section 2.2), and a brief overview of the findings of the historical simulation (Section 2.3).

2.1. How does a historical simulation work?

In a standard policy simulation using a CGE model, quantities and prices of production outputs and inputs, consumption, and international trade are typical endogenous variables; while production technology and consumer preferences are typical exogenous variables. In these simulations, the model is informed of a change in a technology or policy variable (such as a deterioration in agricultural productivity or a tariff cut), and the model calculates the resulting changes to GDP, consumption, output, employment and other endogenous variables.

In a historical simulation, the model operates in a reverse fashion with GDP, production, consumption and international trade exogenous, and the corresponding technical and preference change variables (such as multi-factor productivity) endogenous. In a historical simulation, the model is informed of changes in GDP, consumption, investment, and other observed variables during a historical period. It then calculates the necessary changes in technology and preferences.

The historical-simulation technique using a CGE model was first applied in a systematic manner by Dixon and Rimmer (2002) when they developed the MONASH model of the Australian economy. Since then, many others have used the approach to calibrate other dynamic models and to estimate technology and preference changes (Mai, Perkins and Horridge 2003).

The MMC model is a very large model with millions of equations and variables. The detail is necessary for answering practical policy questions. However, the few equations listed in Box 2.1 can provide a good understanding of the fundamentals of the model. Together they form the Back-Of-The-Envelope (BOTE) model (Dixon et al 1982 and Dixon and Rimmer 2002) that is very useful in explaining simulation

results. In the following paragraphs, we use the BOTE model presented in Box 2.1 to explain the methodology of the historical simulation conducted for this study.

The modelling starts with a database that provides a picture of the various economies in the model in 1997 (See Figure 2.1 for an outline of the structure of the database). The GTAP version 5 database (Dimaranan and McDougall 2002) is the main source of input-output and international trade data for the MMC model.

The historical simulation is an effort to understand how the various economies in the model evolved from 1997 to 2005. In the context of the BOTE model, we force the model to replicate observed growth in the following macroeconomic variables for the period 1997-2005:

- real GDP (Y), GDP price index (P_g), consumption (C), investment (I), government expenditure (G), exports (X) and imports (M); and
- population and employment (L) for each country in the model.

The model has dynamic equations that link the economies from one year to the next. One such equation block models the accumulation of physical capital where the capital stock in the following year equals the capital stock in the current year plus investment in the current year minus depreciation (Equation (5) in Box 2.1). Once we inform the model the growth in investment (I), the growth in aggregate capital stock (K) is determined by the equation block modelling the accumulation of capital stock through investment in the model.

After we have informed the model of Y, L and I (and thus K), changes in technology (A) will be solved for by the aggregate production function (Equation (2) in Box 2.1). Since growth in the GDP price index (P_g) is also tied down, Equation (3) in Box 1 will solve for the capital rental (Q) and Equation (4) will solve for the wage level (W).

Box 2.1 The BOTE Model

The two most important relationships in the MMC model are the GDP identity and the aggregate production function:

$$Y = C + I + G + X - M, \quad \text{and} \tag{1}$$

$$Y = \frac{1}{A} * F(K, L) \quad , \tag{2}$$

where Y is GDP;
C is consumption;
I is investment;
G is government expenditure;
X is exports;
M is imports;
K is aggregate capital stock;
L is aggregate employment; and decreases in A allow for technological progress.

Equilibrium in the capital market requires the real cost of capital to be equal to the marginal physical product of capital. Hence:

$$\frac{Q}{P_g} = \frac{1}{A} * F_k(K/L) \quad . \tag{3}$$

where
Q is the rental per unit of capital;
P_g is the price of a unit of GDP; and
F_k is the partial derivative of F with respect to K. We write F_k as a function of K/L under the assumption that F is homogenous of degree one.

Labour-market equilibrium requires:

$$\frac{W}{P_g} = \frac{1}{A} * F_\ell(K/L) \quad , \tag{4}$$

where
W is the wage rate; and
F_ℓ is the partial derivative of F with respect to L.

The final equation in our BOTE model explains capital in the current plus one year as the sum of net capital in the current year plus investment. Hence:

$$K_1 = K + I - D. \tag{5}$$

where
K and K_1 are the capital stock in the current and following year respectively; and
I and D are investment and depreciation in the current year.

At the industry level, we force the model to replicate historical growth for output (Y_i), employment (L_i), wages (W_i) and the price of output (P_i)[2]. Consequently, the industry versions of the aggregate production function (2) and factor market equilibrium conditions (2) and (3) can jointly solve for industry specific capital stock (K_i), rental (Q_i) and technology (A_i).

2.2. Data sources and related issues

The main sources of data for the macroeconomic variables are *World Development Indicators* published by the World Bank and *UNSTATS* published by the United Nation. These two sources are supplemented by country sources, such as the China National Statistical Bureau, the Singapore Department of Statistics, and the US Bureau of Economic Analysis (see the list of statistical references).

The main sources for the industry data are:

- World Bank: World Development Indicators
- United Nation: UNSTATS
- United Nation: COMTRADE for trade statistics
- International Labour Organisation: for wage and employment data
- BP and International Energy Agency: for energy data
- United Nation Industrial Development Organisation: for manufacturing data
- Food and Agriculture Organisation: for agricultural data and
- Country sources such as China National Bureau of Statistics and US Bureau of Economic Analysis (see the list of statistical references).

Tables 2.2 and 2.3 present the growth rates of key macroeconomic variables during 1997-2005 for each country in the model. The data from various sources were adjusted so that they are consistent with each other and are consistent with the model database for the year 1997. The data consistency issue is further discussed in Box 2.2.

[2] i denotes industry i. In the full model there are 57 industries (see Table 2.1).

Box 2.2 Data Consistency Issues

One challenge of the historical simulation is to bring together data from various sources in order to understand what occurred to the Chinese (and other) economy(ies) during 1997-2005. Data from different sources are invariably inconsistent with one another; even data from the same source could be inconsistent for various reasons. A major task involved is to absorb information presented from various data sources and make them coherent.

For example, the growth rates of consumption, investment, government expenditure, exports, imports and real GDP during 1997-2005 should be coherent in terms of the GDP identity. As discussed in Section 2, the main data source for the growth rates of real GDP and its expenditure components is the *World Development Indicators* (WDI) published by the World Bank. Before we impose on the model these growth rates, we check whether the real GDP growth and the growth rates of its components satisfy the GDP identity:

$$Y = C + I + G + X - M \qquad (1)$$

Where GDP, C, I, G, X, and M are levels of GDP, consumption, investment, government expenditure, exports and imports.

To do this, we multiply the levels of C, I, G, X and M in the MMC database (for which the source of data is the GTAP version 5 database) with the respective WDI growth rates to see if the implied changes in GDP components sum to the level of GDP in the MMC database multiplied by the WDI growth rate for real GDP. We illustrate this here for the year 1998 for China.

	1997 levels in MMC database	WDI rates of growth in 1998	Resulting changes in 1998	Scaled rates of growth
	(a)	(b)	(a)*(b)/100	
Consumption	414093	6.8	27993	5.6
Investment	309995	12.6	38904	10.4
Government	104350	9.6	9976	8.0
Exports	241436	7.2	17287	6.0
Imports	-215161	3.1	-6692	2.6
Sum of GDP components	854713		**87468**	
Real GDP	854713	7.8	**66668**	

We can see from the above calculation that the growth rates of GDP components imply a larger change in real GDP (87468) than that suggested by the real GDP growth rate of 7.8 per cent (66668).

To deal with this inconsistency in data, we scale the growth rates of GDP components proportionally so that they are consistent with the real GDP growth rate of 7.8 per cent for the year 1998 (in terms of GDP identity). In this case, we choose to consider real GDP growth as being more reliable than the growth rates of its components. We therefore maintain the real GDP growth as 7.8 per cent for China in 1998.

While the growth rates of GDP components are adjusted, the pattern presented by the WDI data is preserved. That is, consumption grew slower and investment grew faster than real GDP (see the middle and last column in the table above). While in most of the years, trade grew much faster than real GDP, in this particular year, trade grew slower than real GDP. Exports grew faster than imports (see table above).

This way, we have incorporated information presented by the WDI database regarding the growth rates of all the six macroeconomic variables into the historical simulation while maintaining the data coherence in terms of the GDP identity.

Table 2.2 shows that China enjoyed a high GDP growth of around 9 per cent from 1997 to 2005. Within Gross National Expenditure (GNE), real investment (or gross fixed capital formation) grew much faster then real private and government consumption indicating a high saving rate in China. Both export and import volumes grew at double digits, much faster than real GDP and GNE. The volume of export grew faster then the volume of imports contributing to China's current account surplus during the period.

2.3. China's technological progress during 1997-2005

Table 2.4 presents a summary of observed employment and output data for China and the United States. It also shows estimates of technological progress during 1997-2005, based on results from the historical simulation[3].

Table 2.4 shows that China's total primary-factor-augmented productivity grew rapidly during 1997-2005. At an aggregate level, China's total primary-factor-augmented productivity grew by 4.4 per cent per year during 1997-2005, much faster than the 1.3 per cent per annum growth rate for the United States. At the industry level, technological progress was faster in China for all sectors other than agriculture and communication.

For China, The mining sector is estimated to have experienced the largest improvement (Table 2.4). The historical simulation covers a period during which China overhauled its oil and gas industry in order to create vertically-integrated oil giants that can compete with its international rivals (for more details, See Yan eds. 1998 and Mai 2002). As a result of the reform, the mining industry had a significant reduction in employment during the period (Table 2.4).

[3] In this study, technological progress means improvement in total primary-factor-augmented productivity, defined as an increase in output relative to a weighted average of all primary-factor inputs. See also Appendix B for glossary.

3. China's technological convergence

In this chapter we introduce how we simulated China's technological convergence with developed countries (Section 3.1). In Section 3.2 we discuss the effects of the convergence on China's real GDP and GNP. In Section 3.3 we analyse the effects of the convergence on China's terms of trade. We present the commodity and industry effects of the convergence in Section 3.4.

3.1. Simulating China's convergence

The historical simulation outlined in Chapter 2 represents a "real" scenario for the period 1997 to 2005, in which China continues its convergence in technology with developed countries – a journey it embarked on since 1978. To analyse the effects of the technological convergence from 1997 to 2005, we compare the "real" scenario with a baseline in which China does not catch up in technology. A natural way to obtain such a baseline is to assume that, on average, China's productivity improves in line with that of the Unites States, as estimated for the period 1997-2005.

The estimated productivity improvement through the historical simulation is presented in Table 2.4. Economy-wide productivity for China improved at an average annual rate of 4.4 per cent, 3.1 percentage points higher than the annual rate of improvement in the United States. In our baseline we assume that China's economy-wide productivity grows at 1.3 per cent as in the United States. However, China maintains the sectoral pattern of productivity improvement estimated in the historical simulation. A detailed exogenous shocks applied in the simulation of China's convergence is presented in Table 3.1.

To see the effects of China's catching up in a longer time frame, we extend the "real" scenario to the year 2010 through a forecast simulation. The forecast simulation is a projection for the economies in the model from 2005 to 2010. In the forecast simulation, we assume that China and the United States continue their growth trend of 1997-2005. For those countries that were affected by the Asian financial crisis around

1997-1998, we assume that their trend rates of growth during 2005-2010 resemble those of 1990-2005[4] (Table 3.2).

The "real" scenario, consisting of the historical simulation for the period 1997-2005 and the forecast simulation for the period 2005-2010, forms the convergence scenario. By removing the annual technological progress (Table 3.1) for the years between 2000[5] and 2010, we derive the baseline – a scenario where China does not catch up with developed countries.

Figure 3.1 shows that the effects of the convergence are measured by the difference between the convergence scenario and the baseline, or the deviations of economic variables from their baseline levels in 2010.

Tables 3.3 and 3.4 present a summary of the growth trend for key macroeconomic variables in the baseline scenario for the economies in the model.

3.2. Effects of the convergence on China's real GDP and GNP

During 1997-2005, China's average annual growth rate of real GDP was 8.9 per cent (Table 2.2). During the forecast period of 2005-2010, we assume that China continues its historical growth trend of 1997-2005. Therefore, in the convergence scenario during 1999-2010, China's average annual growth rate of real GDP is 8.9 per cent.

Table 3.3 shows that without the technological convergence, China's real GDP would grow at a rate of 4.8 per cent per year, much lower than the convergence rate of 8.9 per cent. Figure 3.2 illustrates the different growth path China would take with and without the technological convergence.

With the technological convergence, China's GDP is likely to be over fifty per cent higher in 2010 (Table 3.5). In terms of the BOTE model presented in Box 2.1, we can think of the simulation of China's technological convergence as being a strong negative deviation in the A variable for China relative to the baseline case. From the aggregate production function (Equation (2) in Box 2.1), a strong negative deviation in the A variable contributes to a positive deviation in real GDP.

---

[4] Alternatively, we could consider using the growth trend from 1999-2005; however, we were concerned that the period would represent better a trend of recovery from the Asian financial crisis rather than a long-term trend of growth.

[5] We started the simulation in 2000 to avoid the contamination of the Asian financial crisis that happened during 1997-1998.

In a long-run simulation such as this, we assume that aggregate employment (L) is determined by demographic factors and thus is not affected by the extra technical progress in China. Accordingly, aggregate employment does not deviate from its baseline value[6], and so does not contribute to the positive deviation in real GDP (Figure 3.3 or Table 3.5).

A positive deviation in capital stock, however, does contribute to the positive deviation in real GDP (Figure 3.3 or Table 3.5). The positive deviation in capital stock can be explained by the capital market equilibrium condition, Equation (3) in Box 2.1:

$$\frac{Q}{P_g} = \frac{1}{A} * F_k(K/L) \quad . \tag{3}$$

The technical progress boosts the average capital rental (Q), reduces production costs (and thus P_g), and thereby generates increases in (Q/P_g). However, this effect is weak relative to the increase in 1/A, the technological progress (Table 3.5). Consequently, F_k in equation (9) declines, implying an increase in K/L. We assume that technical progress in China does not affect aggregate employment (L). Thus, K must increase. This means that technology progress was the source but not the only factor contributing to the much higher GDP growth in the convergence scenario compared to the non-convergence scenario. A key factor here is that technology progress leads to rapid accumulation of capital stock.

Table 3.5 shows that the 44 per cent increase in real GNP – the preferred welfare measure than real GDP – is smaller than that of real GDP following China's convergence. This is mainly due to two factors: the increase in capital income that partly underlies the increased GDP accrues to foreigners (See Appendix B for the definition of GNP); and a decline in terms of trade that is discussed in details in Section 3.3.

All else unchanged, a deterioration in the terms of trade reduces the price of output (which includes exports but not imports) relative to the price of expenditure (which includes imports but not exports). Reductions in the price of output (or GDP) relative to the price of expenditure (or GNE), in most cases, cause real GDP to increase

[6] Although aggregate employment is exogenous, employment by industries is endogenous as labour is mobile between industries/sectors within each country. This allows the industrial sector to draw labour from the agricultural sectors in China (see discussion about factor market closure in Appendix A).

relative to real GNP.

3.3. Effects of the convergence on China's terms of trade

The simulation results show that China's terms of trade declines significantly as a result of the technological convergence (Figure 3.4). Starting from the same level in 1999, China's terms of trade is about 10 per cent lower by 2010 with the technological convergence than without it. In the baseline (without China's convergence), China's terms of trade *grows* at an average annual rate of 0.7 per cent from 1999 to 2010. With the technological convergence, China's terms of trade *declines* at an average annual rate of 0.3 per cent during the same period of time (Figure 3.4).

In the model, the terms-of-trade variable is calculated as an export price index divided by an import price index. The export (import) price index is, in turn, calculated as the weighted average of export (import) prices for the 57 commodities and services in the model (listed in Table 2.1).

Figure 3.5 shows that the decline in China's terms of trade is caused by a strong decline in China's export price index, combined with a moderate increase in China's import price index. More specifically, in 2010, the 10 per cent decline in terms of trade is caused by a decline in export price index of nearly 9 per cent and an increase in import price index of nearly 2 per cent (Table 3.6).

The main factor that influences China's export prices is the strong technological progress in the convergence scenario relative to the baseline. The improvement in the total primary-factor-augmented productivity in China reduces production costs, leading to reduced output and export prices.

The decline in the export price index for agriculture products is less then that for manufactured goods (Table 3.6). This is because the agriculture sector is estimated to have experienced a slower productivity improvement than the manufacturing sector in the historical simulation (Table 3.1). Furthermore, the agricultural sector uses land as a primary-factor input. In these simulations we do not allow the additional technological progress to affect the amount of land available for producers. Fixing land's availability limits the agricultural sector's ability to reduce costs.

Although the mining sector experienced a larger productivity improvement than the manufacturing sector (Table 3.1), its production is significantly limited by the availability of resources, especially for the oil industry. In the simulation, we assume that China's technological convergence has little influence on oil production in China. Even though the convergence brings about a higher demand for oil, China's oil production continues its resource-limited growth of 2 per cent per year[7]. This means that China's oil price rises with the strong increase in demand caused by the technological convergence.

The decrease in the export price index for the mining sector is due to a decline in the export price for coal. Continuing the historical trend (Figure 3.6), coal becomes dominate in China's mining exports by 2010 in the baseline (see the second column in Table 3.6[8]). With the technological convergence, China's export price for coal is lower than in the case with no technological progress. The availability of resource for coal is less of a constraint in China than that for oil and gas.

The shares of mining and agricultural products in China's total exports, however, are insignificant compared to that of manufactured goods. Manufactures comprise the bulk of China's total exports[9]. The 9-percentage-point fall in the export price index is therefore mainly attributable to the fall in the export price index for manufactures (Table 3.6).

The 2-percentage-point rise in China's import price index is mainly attributable to large rises in the prices for agricultural and mining products. As a result of China's convergence, the import price index for manufactured goods rises only slightly by about half a per cent. The import price index of agriculture and mining rises significantly by 4 and 14 per cent respectively (Table 3.6). This is because China's convergence leads to increased demand for imported energy and primary inputs, such as oil, iron ore, wool, and cotton.

---

[7] China's self-sufficiency policy determined that China reached its domestic-resource limit before it turned to imports in a large scale in the early 1990s.

[8] Table 3.6 shows that the share of coal in total exports is 0.4 per cent; while that of mining products is 0.5 per cent in 2010. Coal therefore has a dominate share in the exports of mining products in 2010.

[9] Note that the service exports presented in Table 3.3 include only cross border transactions, or the first two modes of trade in services (See Appendix C for definitions). The bulk of services trade involves movement of people and capital across borders – the third and forth modes of service trade which are not explicitly discussed in this study. Trade in services therefore appears to be insignificant compared to merchandise trade in Table 3.3.

Oil, In particular, registers the largest rise in the import price as a result of China's technological convergence. In the simulation, China's convergence is assumed *not* to have significant impact on oil production in China and in other countries. Oil production is assumed to be mainly determined by supply side factors such as resource constraints in China and monopolistic production behaviour in the Middle East.

3.4. Effects of the convergence on China's economic structure

As a result of the technological convergence, China's exports increase by 46 per cent and China's imports increase by 45 per cent, relative to their baseline levels in 2010. Imports and exports of all commodities and services rise relative to their baseline levels (Table 3.7).

On the export side, the increase in manufactured exports is larger than those in agricultural and mining exports. By contrast, the increase in manufactured imports is smaller than those in agricultural and mining imports (Table 3.7).

The deviation from baseline of value added by industries shows a similar pattern to that of the export volumes. Table 3.8 shows that, following the technological convergence, value added in all sectors expands. However, value added of the manufacturing and services sectors rises more than that of the agricultural and mining sectors (Table 3.8).

In the simulation of the convergence scenario, we assume that China's productivity improves in all sectors relative to the baseline. The improvement in the agricultural sector is, however, slower than in manufacturing and services (Table 3.1). Furthermore, the agricultural sector has land as a fixed production factor limiting its scope to expand production. Although the mining sector experiences the largest increase in productivity, its production is significantly limited by resource constraints, as discussed in Section 3.3. Thus technological convergence causes China to increase its specialisation in manufacturing. Due to the resource limits, China becomes more dependent on imports for agricultural and mining products.

4. Terms of trade effects of China's convergence on neighbouring countries

In Chapter 3, we simulated the effects of China's rapid economic growth between 1999 and 2010, stimulated by its technological convergence. As a result, the prices of agricultural and mining products in China rise relative to their levels without convergence, while the prices of manufactures[10] fall relative to their no-convergence levels. Consequently, China, as a net importer of agricultural and mining products and a net exporter of manufactures, experiences a significant fall in its terms of trade. In this chapter, we analyse the effects of China's technological convergence on the terms of trade of neighbouring countries.

Figure 4.1 and Table 4.1 show that, as a result of China's technological convergence, the terms of trade of countries rich in resources, such as Indonesia, Australia and the ROW improve. The terms of trade for US also improves. India, having an endowment and production pattern similar to that of China, suffers the largest deterioration in its terms of trade.

The magnitude of the terms of trade effects, however, is generally small for the neighbouring countries analysed in this study. The terms of trade effects are small because China's convergence has both positive and negative influences on export and import price indices.

In the eight sections of this chapter, we discuss how China's convergence impacts on the terms of trade of Japan, the Republic of Korea, India, Indonesia, Malaysia, Singapore, Thailand and the Philippines.

4.1. Japan

China's technological convergence has a small negative impact on Japan's terms of trade. The deviation of Japan's terms of trade from its baseline level in 2010 is -0.8 per cent (about 14 times less than that for China, see Figure 4.1 and Table 4.1).

On the export side, the deviation (from baseline) of the export price index is just 0.1 per cent. This is due to the off-setting effects caused by a fall (negative deviation from

[10] Except those manufactures that use intensively mining products (especially crude oil) as intermediate inputs, such as the petroleum and coal products.

baseline) in the export price index for manufactures and a rise (positive deviation from baseline) in the export price index for services (see third column of Table 4.2).

Japan's export price index for services rises because services trade in the model includes transport and insurance margins demanded by international trade transactions. With China's catching up in technology, total world trade expands[11] leading to increased demand for transportation and insurance services.

With the very small deviation in the export price index, the negative deviation of Japan's terms of trade is mainly attributable to a positive deviation in the imports price index of 0.9 per cent. The positive deviation in Japan's import price index, in turn, is caused by a significant rise in import prices for agricultural and mining products. In particular, the price index of Japan's mining imports rises by 11 per cent due to China's catching-up (column (b) of Table 4.3).

However, the effects on Japan's import price index of the rise in prices for mining imports are largely offset by the fall in prices for manufactured imports (column (c) in Table 4.3). Prices for manufactured imports fall mainly due to a fall in the price of manufactured imports from China (Figure 4.2).

Although the rise in prices of mining imports exceeds in absolute terms the fall in prices of manufactured imports, manufactured imports have a dominate share in Japan's total imports (see column (a) in Table 4.3). Thus, overall, there is a moderate rise in Japan's import price index, leading to small fall in the terms of trade.

4.2. The Republic of Korea

The Republic of Korea also experiences a small negative deviation in its terms of trade due to China's technological convergence. The deviation in Korea's terms of trade from baseline in 2010 is -0.7 per cent, similar to that for Japan (Figure 4.1). However, both Korea's import and export price indices increase more than those for Japan (Table 4.1).

Although China's convergence tends to bring down the world-wide price for manufactures, Korea's export price index for manufactures rises because its manufactured exports are oil intensive. As China's convergence pushes up prices for

[11] See the first row of Table 5.1.

mining products (especially crude oil), the prices for petroleum and coal products[12] that use mining products as the main intermediate input also rise significantly (Figure 4.3). Figure 4.4 shows that petroleum products have a rather significant share in Korea's total exports[13] (different to the situation in Japan). This leads to a small rise in Korea's export price index for manufactures.

The import price index for manufactures falls less in Korea than in Japan because Korea imports a smaller proportion of manufactured imports from China than Japan (Figure 4.5). China's export price index for manufactures fall significantly as it catches up with developed countries in production technology (Figure 4.2). Consequently, Japan, importing a larger proportion of manufactures from China, experiences a larger fall in its import price for manufactures.

[12] The petroleum and coal products are part of manufactures.

[13] For a discussion of the historical trend, see Box 4.1.

Box 4.1 The baseline simulation and historical trends

In Section 4.2, we showed that China's convergence causes Korea's export price for manufactures to rise largely due to an increase in the price of petroleum and coal products. This finding is heavily influenced by our baseline simulation which shows, for Korea, the share of petroleum and coal products in total exports increasing from 2.5 per cent in 1997 to 3.6 per cent in 2010 (see Figure 4.4). This raises the question of whether the baseline simulation reflects reality.

As discussed in Section 3.1, the baseline is the convergence scenario removed of faster-than-US annual technological progress for China. The robustness of the baseline simulation therefore depends on the robustness of the convergence simulation.

In the convergence simulation, we aim to simulate "reality", with the economies in the model evolving from 1997 to 2010 according to the trends suggested by historical data. More specifically, the simulation of how each economy in the model evolves from 1997 to 2005 is based on data sources discussed in Chapter 2 and listed in the Statistical References of this report. In simulating how the economies evolve from 2005 to 2010, we assume continuation of the historical trends (see Section 3.1 for details).

To verify the robustness of the convergence simulation, the table below presents UN COMTRAD data on the value of exports of petroleum and coal products, and of total merchandise exports for Korea. We can see from Table B4.1 that the share of petroleum and coal products in total merchandise exports increased from 1 percent in 1990 to 3.9 per cent in 1997, and further to 5.4 per cent in 2005. This historical trend is reflected in the convergence and thus the baseline simulation for Korea as shown in Figure 4.4.

Table B4.1. Korea, the Rep: share of petroleum and coal in total merchandise exports

	Shares of petroleum and coal products in merchandise exports	Value of petroleum products	Value of coal products	Total merchandise exports
	%	US$ million	US$ million	US$ million
1990	1.0	627.9	4.0	65015.7
1997	3.9	5264.0	7.8	136151.0
2005	5.4	15473.4	3.7	284418.2

Source: United Nation, COMTRAD. The shares are calculated by the authors.

Note: The shares presented in this table are not strictly comparable with those presented in Figure 4.4. The shares presented in Figure 4.4 are shares in total exports, including exports of services.

4.3. India

For India, China's convergence leads to an overall fall in export prices and to a rise in import prices. As a result, India's terms of trade falls relative to its value in the baseline by 3.5 per cent in 2010. Note that this is a larger change than those simulated for China's other neighbouring countries (Figure 4.1 and Table 4.1).

On the import side, the import price index for mining rises in India as in Japan and Korea. However, unlike for Japan and Korea, the rise in the import price index for mining is not offset by a fall in the import price index for manufactures (see the third column of Table 4.5).

In India's case, two factors contribute to a rise in the import price index for manufactures: a significant share of petroleum and coal products in total imports; and a small share of manufactured imports from China in total manufactured imports.

Figure 4.6 shows that India has the largest share of petroleum and coal products in total imports among the nine economies that are analysed in detail in this study. The large rise in the import price for petroleum and coal products following China's convergence (Figure 4.7) therefore place a significant upward pressure on India's import price index for manufactures.

Furthermore, India imports less manufactures from China than other economies presented in Figure 4.5. The large fall in the price of manufactured imports from China (Figure 4.2) is therefore not sufficient to offset the upward pressure on India's import price index for manufactures discussed above.

On the export side, the downward pressure that China's convergence places on the export price index for manufactures plays a more significant role for India than for other countries analysed in this study. This is because India's exports concentrate on labour intensive manufactures, in particular, wearing apparels and manufacturing nec (Figure 4.8). As a result of China's convergence, these products have larger price falls than do the capital intensive ones, such as motor vehicles and non-ferrous metals (Table 4.6).

To summarise, India's terms of trade worsens mainly due to the following characteristics in its trade structure:

- a significant share of mining products in total imports;

- a significant share of petroleum and coal products in total imports;
- a small share of manufactured imports from China in total manufactured imports; and
- a concentration of labour-intensive manufactures in its total exports.

4.4. Indonesia

For Indonesia, the story is quite different from the previous three cases. As a result of China's convergence, Indonesia's terms of trade improves by 2.8 per cent in 2010 (Figure 4.1 and Table 4.1).

Table 4.7 shows that the improvement in terms of trade for Indonesia is mainly attributable to a large rise in its export price index. Indonesia's export price index rises by 4.4 per cent in 2010, much more than the rise in its import price index of 1.6 per cent (Table 4.7).

For Indonesia, the rise in the export price index of mining products following China's convergence plays a significant role. In contrast to other economies analysed in this chapter, Indonesia has a significant share of mining products in its total exports (Figure 4.9).

4.5. Malaysia

The simulation results show that China's convergence has little impact on Malaysia's terms of trade (down 0.1 per cent in 2010, see Figure 4.1 and Table 4.1). For Malaysia, changes to both export and import price index are small, -0.2 and -0.1 per cent respectively (Table 4.8).

On the export side, electronic equipment has the dominate share in Malaysia's total exports (Figure 4.10). Following China's convergence, prices for electronic equipment falls significantly (Figure 4.11). Malaysia's export price index for manufactures therefore falls (third column of Table 4.8).

On the other hand, mining products comprise a significant share in total exports in Malaysia – although not as large as in Indonesia (Figure 4.9). As a result, the effects of the rises in the export price indices for agriculture, mining and services almost completely offset the effects of the fall in the export price index for manufactures.

Thus China's convergence leads to a very small change in Malaysia's export price index.

Similarly, on the import side, a small fall in the import price index for manufactures combined with a dominate share of manufactures in total imports has a negative effect on Malaysia's import price index. However, this negative effect is almost completely offset by the effect of the rise in the import prices for agriculture, mining and services (Table 4.8).

4.6. Singapore

China's convergence has little impact on Singapore's terms of trade (Figure 4.1 and Table 4.1), with both the export and import price indexes rising relative to baseline values by similar amounts (Table 4.9).

Petroleum and coal products have a significant share in Singapore's manufactured exports (Figure 4.4 and Table 4.9). The large rise in the export price for petroleum and coal products therefore places upward pressure on Singapore export price index for manufactures. This upward pressure is, however, largely offset by a fall in export price for electronic equipment (Figures 4.10 and 4.11). The result is a small rise in the export price index for manufactures. The small rise in the export price index for manufactures reinforces the rise in the export price for services[14] leading to an increase in the Singapore's overall export price index (Table 4.9).

On the import side, the downward pressure placed on the import price index for manufactures by the fall in import price for electronic equipment more than offsets the upward pressure placed by the rise in import prices for petroleum and coal products. This leads to a small fall in the import price index for manufactures (Table 4.9).

The fall in the import price index for manufactures offsets the effects of a large rise in the import price for mining products leading to only a small rise in the overall import price index for Singapore (Table 4.9).

To summarise, the positive factors that have strong influence on Singapore's terms trade are:

[14] As discussed above, China's convergence leads to increased world trade (Table 5.1) that, in turn, leads to increased demand for international trade margins such as transport and insurance services. The export price index for services therefore rises.

- a significant share of petroleum and coal products in total exports combined with a large rise in the export price index for these products;
- a dominate share of electronic equipments in total imports combined with a fall in the import price index for these products; and
- a large share of services in total exports combined with a rise in the export price index for services.

The negative factors that have strong influence on Singapore's terms trade are:

- a significant share of mining products in total imports combined with a large rise in the import price index for these products;
- a significant share of petroleum and coal products in total imports combined with a large rise in the import price index for these products; and
- a dominate share of electronic equipments in total exports combined with a fall in the export price for these products.

The offsetting factors with more or less equal strength result in a small overall effect of China's convergence on Singapore's terms of trade.

4.7. Thailand

As a result of China's convergence, Thailand's terms of trade falls relative to its baseline value by 1.5 per cent in 2010 (Figure 4.1 and Table 4.1). The export price index falls by a relatively small 0.3 per cent, while the import price index rises by 1.2 per cent in 2010 (Table 4.10).

For Thailand, a dominate share of electronic equipment and machinery and equipment nec in total exports combined with a fall in the export prices for these products leads to a fall in the export price index for manufactures. This negative effect on Thailand's export price index is largely offset by the effect of a rise in the export price index for services. The result is a very small fall in the overall export price index for Thailand (Table 4.10).

Similarly on the import side, a dominate share of electronic equipment and machinery and equipment nec in total imports combined with a fall in the import prices for these products leads to a fall in the import price index for manufactures. This negative effect on Thailand's import price index offsets partially the effect of a large rise in the

import price index for mining products. The result is a moderate rise in import price index of 1.2 per cent (Table 4.10).

4.8. The Philippines

The simulation results show that China's convergence results in a fall of 0.9 per cent in the Philippine's terms of trade (Figure 4.1 and Table 4.1). The fall in terms of trade is attributable to a rise in the import price index of 0.9 per cent (Table 4.11), with the export price index changing little.

On the export side, a dominate share of electronic equipment in total exports combined with a fall in the export prices for these products leads to a fall in the export price index for manufactures. This negative effect on the Philippine's export price index is offset by the effect of a rise in the export price index for services (Table 4.11).

On the import side, a dominate share of electronic equipments in total imports combined with a fall in the import prices for these products leads to a fall in the import price index for manufactures. This negative effect on the Philippine's import price index offsets partially the effect of a large rise in the import price index for mining products. The result is a rise in import price index of 0.9 per cent (Table 4.11).

To summarise, the two positive factors that have strong influence on the Philippine's terms of trade are:

- a dominate share of electronic equipments in total imports combined with a fall in the import price for these products; and
- a rise in the export price index for services.

The two negative factors that have strong influence on the Philippine's terms of trade are:

- a dominate share of electronic equipments in total exports combined with a fall in the export price for these products; and
- a large rise in the import price index for mining products.

5. The growth effects of China's convergence on neighbouring countries

In Chapter 4 we analysed the effects of China's convergence on its neighbouring countries' terms of trade. While the terms of trade effects on different neighbouring countries vary, the overall magnitude of the impacts is small. China's convergence creates both positive and negative influences on its neighbouring country's terms of trade.

In this chapter, we analyse the income effects of China's convergence on its neighbouring countries. We also discuss the effects of China's convergence on its neighbouring countries' trade volumes and production mix.

5.1. Effects on export volumes and production mix

China's convergence leads to small changes in the total export volumes of its neighbouring countries (Figure 5.1 and Table 5.1). While the neighbouring countries export less to their traditional markets such as the USA, Japan and ROW[15], they export more to China (Table 5.2).

Table 5.2 shows that, in the USA, Japan, and ROW markets, China's convergence leads to a large increase in imports from China while imports from all other countries/regions fall. However, for China's neighbouring countries, this negative impact on their exports is greatly softened by a large increase in their exports to China.

For Korea and Japan that send a larger proportion of exports to China than other countries presented in Figure 5.2[16], the fall in their exports to other markets is more than compensated by the increase in their exports to China, leading to an increase in their total export volumes (Table 5.1 and Figure 5.1).

[15] ROW includes European Union (EU).

[16] See more discussions about shares of export to China in Box 5.1.

Box 5.1 Historical trends in country export shares to China

Figure 5.2 shows that, in the convergence simulation, the shares of the neighbouring countries' exports to China increase significantly from 1997 to 2010. For example, the share of Korea's exports to China increases from about 10 per cent in 1997 to over 30 per cent in 2010.

As discussed in the Section 3.1, in the convergence scenario, we aim to simulate the "reality" – what happened based on historical data between 1997-2005 and on prevailing historical trends between 2005-2010. It is important to verify whether the changes in the shares of exports to China represented by the convergence simulation consistent with historical trends.

For this purpose, we present relevant UN COMTRAD data in the table below. We can see from the table that, the shares of merchandise exports to China increase significantly from 1997 to 2005 for the countries concerned.

Table B5.1. Shares of exports to China in total exports

	Shares of merchandise exports to China in total merchandise exports	Value of merchandise exports to China	Value of total merchandise exports
	%	US$ million	US$ million
India			
1997	2.1	718	34,794
2005	6.6	6,785	103,404
Indonesia			
1997	4.2	2,229	53,444
2005	7.8	6,662	85,660
Thailand			
1997	3.1	1,790	58,283
2005	8.3	9,134	110,110
Malaysia			
1997	2.4	1,874	78,729
2005	6.6	9,302	140,963
The Philippines			
1997	1.0	244	25,228
2005	9.9	4,077	41,221
Singapore			
1997	3.3	4,066	124,988
2005	8.6	19,757	229,652
Korea, the Rep.			
1997	10.0	13,572	136,151
2005	21.8	61,915	284,418
Japan			
1997	5.2	21,746	421,053
2005	13.5	80,074	594,941

Source: United Nation, COMTRAD, http://comtrade.un.org/db, accessed December 2006. The shares are calculated by the authors.

Note: The shares presented in this table are not strictly comparable with those presented in Figure 5.2. The shares presented in Figure 5.2 are total exports, including exports of services.

In terms of commodity composition, exports of manufactures fall for most of the neighbouring countries except for Korea and Japan. Exports of agricultural products, mining products and services, on the other hand, rise as a result of China's convergence (Table 5.3).

Again, the fall in the exports of manufactures is due to the fall in exports of these products to non-China markets. To the China market, the neighbouring countries' exports of manufactures increase as a result of the convergence (Table 5.4).

Indeed, China's convergence not only leads to a large increase in China's exports of manufactures, it also leads to a large increase in China's imports of manufactures. The large increase in China's imports of manufactures, in turn, is mainly attributable to the large increase in China's imports of electronic equipments, machinery and equipment nec, and chemical-rubber-plastic products (Table 5.5).

Table 5.6 shows that, while wearing apparels and manufacturing nec have large shares in China's total exports, they have insignificant shares in China's total imports. In contrast, electronic equipment, machinery and equipment nec, and chemical-rubber-plastic products have large shares in both China's total exports and imports. This signifies that, for these products, China is part of a production network. The production in China of, for example, electronic equipment requires imports of electronic equipment from its neighbouring countries as intermediate inputs.

The technological convergence intensifies China's role in the network. The convergence leads to a large increase in the neighbouring countries' exports (imports) of electronic equipment, machinery and equipment nec, and chemical-rubber-plastic products to (from) China; on the other hand, the neighbouring countries' total exports (imports) of these products to the world either fall or increase less (Tables 5.7 and 5.8). Therefore, as a result of China' convergence, the neighbouring countries reduce their trade with non-China partners and trade more with China in these products.

Table 5.9 shows that, for the neighbouring countries, China's convergence leads to a pattern of change in the production mix similar to that for the exports. Other than a few exceptions, value added for manufactures contracts, while that for primary and services sectors expands for the neighbouring countries.

5.2. Why the GDP effects are small?

The impact of China's convergence on real GDP of neighbouring countries is mixed, but overall very small under one percentage point for all but India. India's real GDP decreases by about 1 per cent as a result of China's technological convergence (Table 5.10).

From the production function, or equation (2) in Box 2.1, we can see that output can expand only when there are increases in production factors employed (an increase in L or K) or improvement in productivity (a reduction in A).

In the simulation of China's convergence, we assumed the following:

- aggregate employment is determined by long-run factors such as population growth and labour force participation rates and therefore is exogenous in the simulation of China's convergence in technology; and
- productivity of the neighbouring countries is also exogenous.

Thus, the changes in output mainly come from changes in capital stock[17] employed.

From the equilibrium condition in the capital market, or equation (3) in Box 2.1, we can see that, with the L and A exogenous. Changes in capital stock (K) are mainly determined by changes in rental price relative to output price (Q/P_g). Q/P_g, in turn, is a function of rate of return on capital and terms of trade[18].

As discussed in Chapter 4, China' convergence leads to small change in the neighbouring countries' terms of trade.

Table 5.10 shows that China's convergence also leads to small changes in the neighbouring countries' rate of return on capital. This is because China has a high saving rate (Figure 5.3). Foreign capital accounts only for a very small proportion of China's total capital stock. When China converges with developed countries in technology, the additional capital required to finance the increase in GDP comes

[17] Producers in the model also use land or resource as a production factor. For simplification, this is not represented in Equation (2) in Box 2.1. In the model simulations, we assumed that land or resource is a fixed production factor.

[18] The terms Q/P_g can be expanded to $\frac{Q}{P_2}\frac{P_2}{P_g}$ where P_2 is asset price. The first term is rate of return on capital. The second term is a function of terms of trade because P_2 include import price but not export price and P_g include export prices but not import prices.

mainly from domestic savings.

The small changes in rates of return to capital and terms of trade lead to small changes in the Q/Pg term and thus small changes in capital stock. As a result, China's convergence leads to small changes in real GDP for the neighbouring countries[19].

It is natural to raise the question that, if China can finance its high growth out of domestic savings, why is it important for China to open its economy to foreign investment? The answer lies at the spill-over effects of foreign investment. Foreign investment brings about more advanced production technology as well as management skills. The key benefit of foreign investment is the improvement in productivity as other players in the host industry catch up with the performance standard set by the foreign investors (Mai 2004).

It is interesting to see how the simulation results would change if productivity in China and its neighbouring countries responded endogenously to flows of FDI. While there are many theories about why FDI would bring productivity improvement, empirical estimates of such productivity improvement are scarce. Further modelling research on this issue is important, but beyond the scope of the current study (see discussions in Section 8.2).

5.3. Effects on GNP

The effects of China' convergence on real GNP of China and its neighbouring countries are presented in Table 5.10. For China, the convergence leads to a much smaller increase in real GNP than in real GDP. For the neighbouring countries, the results vary.

The difference between effects on real GDP and GNP can be largely explained by each country's terms of trade (see Appendix B for glossary). As discussed before, all else unchanged, an improvement (deterioration) in the terms of trade increases (reduces) the price of output (which includes exports but not imports) relative to the price of expenditure (which includes imports but not exports). Increases in the price of output (or GDP) relative to the price of expenditure (or GNE) will, in most cases,

[19] Changes in indirect taxes will also affect real GDP. That effect is small in this simulation and is therefore ignored in the discussion.

cause real GNP to increase relative to real GDP. Such is the case for China and most of the countries.

Another factor that explains the difference between real GDP and GNP is net income from abroad. As a result of China's convergence, China's rental price for capital rises significantly while rental prices for capital in other countries either fall slightly or remain largely unchanged (Figure 5.4). Those countries that hold a larger proportion of their outward investment stock in China therefore benefit more from China's convergence.

For Singapore, real GNP rises notably more than real GDP, even though Singapore's terms of trade declines as a result of China's convergence. This is because Singapore is among the ten largest source countries for foreign investment in China. This factor made a notable difference for Singapore because Singapore's outward stock of foreign investment is very large relative to its GDP (Figure 5.5).

6. User preferences for manufactured imports

In Chapters 2 to 5, we simulated China's technological convergence and analysed its impact on China's neighbouring countries. In our analysis, the price for manufactured goods emerges as a key factor at play. It is therefore important to examine assumptions made in the analysis of Chapters 2 to 5 that might have a strong influence on the price for manufactured goods. Unchanged user preferences for manufactured imports is one such assumption.

In the analysis of Chapter 2 to 5, we assume that there are no changes in user preference for manufactured imports. In this Chapter, we investigate what if we assume China's rapid expansion in exports leads to (or coincides with) such a change in preference.

In Section 6.1 we discuss why this issue is important, and how we simulated changes in user preferences. In section 6.2 we discuss the effects on trade volumes and terms of trade. In section 6.3 we discuss the effects on real GDP and GNP.

6.1. Implied export demand curves and user preferences

In general, the demand for exports from China (or any other countries/regions in the model) is negatively related to the corresponding prices. In the model, exports from China (or another country/region in the model) are demanded in other countries/regions by producers as intermediate inputs, households as private consumption, and investors to make capital goods. These economic agents in the model exhibit optimisation behaviour – they minimise production costs or maximise utilities. Their decision regarding how much imported goods to purchase involves comparing the prices of imports relative to those of domestically produced ones, the *Armington assumption*. Similarly, their decision regarding how much imported goods from China to buy involves comparing the prices of imports from China relative to those of imports from other countries/regions. Thus, there are *implicit* export demand curves in the model that are downward sloping[20].

[20] The slope of the export demand curve is determined by the trade structure and the Armington elasticity. We conducted a sensitivity analysis by increasing the Armington elasticity by 50%. The main conclusions of the study are not sensitive to the change in the magnitude of the Armington elasticity.

The position (or the shift) of the export demand curves can be an important factor influencing export prices. In other words, factors in additional to relative-price changes may affect quantities of demand for exports or vice versa.

In our historical simulations, we repeatedly found that relative-price changes alone are not sufficient to explain the rapid growth of imports observed in historical periods. In an age of rapid globalisation, economic agents in various countries are ready to use more imports beyond what would be suggested by relative-price changes. In other words, there has been a shift in user preferences towards imported goods.

In the historical simulation for this study, we found that to accommodate the high growth in import volumes, the world experienced an average of 2.6 per cent increase in the ratio of imports to domestic goods over and above that caused by changes in the prices for imports relative to those of domestic goods. In other words, during 1997-2005, there was a shift in user preferences in favour of imports. An average user tended to purchase 2.6 per cent more imports even if there was no change in the price of imports relative to that of domestic goods.

While it's not clear what courses the shift in user preferences, it is important to understand whether such changes affect our analysis. In the convergence simulation discussed in Chapters 3-5, we assume that there is no shift in user preferences towards imports. In this chapter, we investigate how the analysis in Chapters 3-5 would differ if China's technological convergence coincides with a period when economic agents in various countries tend to buy more imports even if there are no changes in the relative prices of imports versus domestic goods.

For this purpose, we simulate China's convergence again assuming there is one-percentage-point change in *user preference* in favour of manufactured imports[21] in all countries/regions in the model. We reference the results from the historical simulation to decide the size of the change (one per cent) in user preferences assumed in the simulation. Although the simulation is illustrative, it can still help us to gain insights into how the changes in the user preferences affect our understanding on the terms of trade effects of China's convergence.

[21] We assume that is a change in user preferences for only non-energy and non-base-metal manufactures that comprise that bulk of exports from China.

A comparison of the results is presented in Tables 6.1 to 6.4. In these tables, the columns labelled “standard” contain the same results presented in Chapters 2 to 5. The columns labelled “with changes in user preferences” contain the new simulation results.

6.2. Trade and terms of trade effects

With the change in user preference in favour of imports, the convergence leads to a larger increase in export volume (Table 6.1), and a smaller decrease in export price for China (Table 6.2 and Box 6.1).

For most of the neighbouring countries, the reductions in export volumes of manufactures are smaller. For the Republic of Korea and Japan, the increases in their manufactured exports caused by China’s convergence are larger (compare the third and forth columns of Table 6.1). The increased demand for exports from all countries is combined with a smaller reduction (or larger increase) in export prices (third and forth column of Table 6.2 and the first and second columns of Table 6.3).

The increases in import prices, however, are also larger (compare the fifth and the sixth columns of Table 6.2 and the third and forth columns of Table 6.3). This dilutes the effects of the smaller decreases (or larger increases) in export price on terms of trade. The result is that the terms of trade impact of China’s convergence remains small as in the standard case.

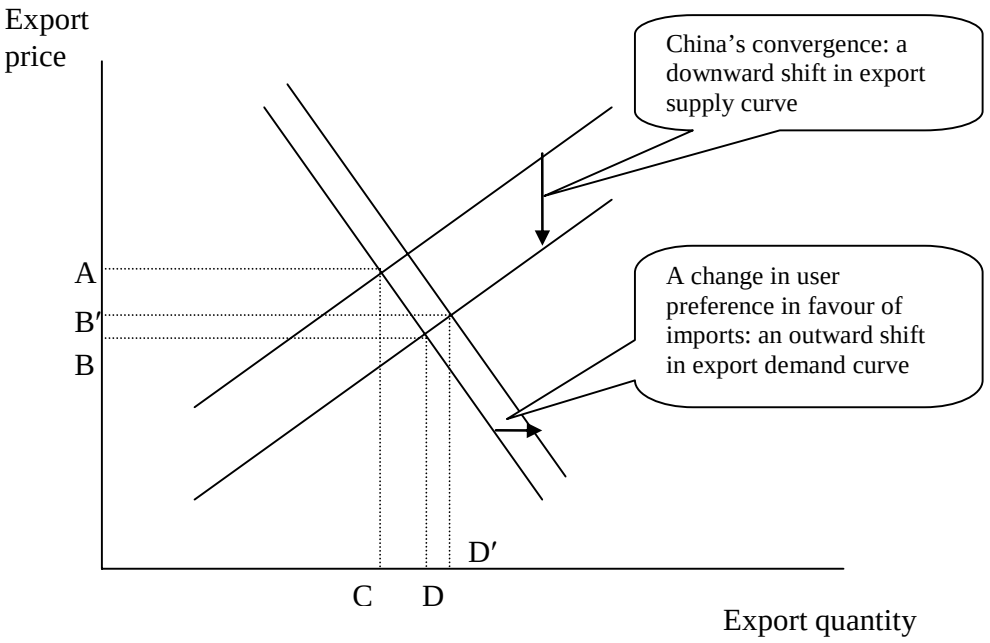
However, the terms of trade for China and the neighbouring countries show a small improvement with the changes in user preferences than without (compare the first and second columns of Table 6.2).

The key factor underlying the small impacts of the convergence on terms of trade is that China is part of a production network. As shown in Chapters 4 and 5, both China and its neighbouring countries’ imports and exports are concentrated on the same product groups such as electronic equipments, machinery and equipment nec, and chemical-rubber-plastic products.

Box 6.1 Effects of China's convergence on its export price and quantity with a shift in user preference in favour of imports

The larger increase in export volume (Table 6.1) and the smaller decrease in export price (Table 6.2) for China can be understood from Figure B6.1. In the standard simulation, China's convergence in technology reduces its production costs leading to an outward shift in its export supply curve. This results in a reduction in export price (A to B) and an increase in export quantity (C to D). With the change in user preference in favour of imports, the demand curve for Chinese exports also shifts outwards. This results in a smaller reduction in export price (A to B′) and a larger increase in export quantity (C to D′).

Figure B6.1. China's convergence with a change in user preference



6.3. Effects on GDP and GNP

With the change in user preference, China's convergence leads to a slightly larger increase (or smaller decrease) in real GDP and GNP for China and the neighbouring countries (Table 6.4). This is due to the slight improvement in terms of trade with than without the change in user preference in favour of imports (Table 6.2).

Overall, changing the consumption about user preference in favour of imports does not alter the key conclusion drawn from the discussion in Chapters 4 to 5. That is the impact of China's convergence on the neighbouring countries' terms of trade, real GDP and real GNP are small due to offsetting factors.

7. China's energy efficiency

In the standard analysis presented in Chapters 2 to 5, prices of oil and its down-stream products emerge as important factors in explaining changes to import and export prices. Therefore, to ensure the robustness of the study, in this chapter we examine the key assumption affecting the model results for oil price: the assumption that China's energy efficiency in current production remain unchanged.

In the standard analysis presented in Chapters 2 to 5, we assume that there are no changes in the efficiency with which energy products are used as inputs into current production. In this Chapter we discuss an alternative scenario of energy efficiency for China (Section 7.1). We then compare the effects of China's convergence on terms of trade and income with and without improvement in energy efficiency (Sections 7.2 and 7.3).

7.1. An alternative scenario of energy efficiency

Table 7.1 presents volumes of energy purchases by firms and households in the Version 6 GTAP energy database. It shows that input purchases by firms account for about 90 per cent of total energy use in China. Households constitute a very small proportion of total energy use. The issue of energy efficiency therefore concerns mainly the efficiency with which energy is used as a production input by firms.

Table 7.2 shows that, compared to Japan, China has considerable scope to improve its energy efficiency in current production. Estimates for the year 2001 shows that, to produce one million US dollar GDP, China uses nearly eight times more electricity and four times more petroleum and coal products than Japan.

As China' rapid growth lends pressure to its energy resources and world oil price, it is only natural for China to think about energy saving policies. In 2004, the government approved an energy conservation plan (Bradley and Yang 2006). In 2005, the government set an energy saving target in its eleventh five-year plan: cutting energy use per unit of GDP by about 20 per cent by 2010. In 2006, although fell short of the target, China's energy consumption per unit of GDP went down by 1.2 per cent (Xinhua 2007).

To understand how improvement in China's energy efficiency might change our view on the impact of China's rapid growth on its neighbouring countries' terms of trade, we simulate China' technological convergence again assuming improved energy efficiency in current production. We assume that firms' input use of electricity and petroleum and coal products grow by *one percentage point* less than output. We assume the improvement in energy efficiency is achieved in a cost neutral way[22] so that there is no net improvement in total factor productivity.

Tables 7.1 to 7.2 present the standard and the new simulation results. The columns labelled "standard" are those presented in Chapters 2 to 5. The columns labelled "with improvement in energy efficiency" are the new simulation results.

7.2. Terms of trade effects

Table 7.3 shows that, with the exception of Indonesia, the worsening in terms of trade due to China's convergence is slightly smaller with the improvement in China's energy efficiency than without. This is mainly due to a smaller increase in the import prices. The convergence leads to a slower growth in demand for oil and its down-stream products with the improvement in energy efficiency than without.

For Indonesia, China's convergence leads to a slightly smaller increase in export price with the improvement in China's energy efficiency than without, leading to a smaller improvement in terms of trade.

Overall, taking the improvement in energy efficiency into account, China's convergence still leads to an overall small change in the neighbouring countries' terms of trade.

7.3. Effects on GDP and GNP

Table 7.4 shows that the improvement in Chian's energy efficiency did not lead to significant changes in the effects of the convergence on China's real GDP. This is because we assume that the improvement in energy efficiency happens in a cost neutral way and therefore does not lead to an improvement in total factor productivity.

[22] The reduction in production cost through improvement in energy efficiency is offset by a proportional increase in the costs of all other inputs.

For the neighbouring countries, the effects of China's convergence on their real GDP and GNP are small with or without the improvement in China's energy efficiency. Thus, taking the improvement in energy efficiency into account, China's convergence still leads to an overall small change in the neighbouring countries' real GDP and GNP (Table 7.4).

8. Concluding summary and policy implication

In this study we first conducted a historical simulation using the MMC model to replicate how the Chinese and its neighbouring economies evolved from 1997 to 2005 based on observed historical data (Chapter 2). Secondly, we conducted a forecast simulation – extending the historical simulation to 2010 assuming the historical trend prevails[23]. The historical and the forecast simulations form the *reality or convergence scenario* where China converges with developed countries in production technology. We then simulate a *baseline scenario* where China does not converge in technology by removing China's faster-than-US technological progress estimated in the historical simulation (Chapter 3). By comparing the baseline with the convergence scenario, we obtain estimates of the effects of China's technological convergence on its own and its neighbouring countries' terms of trade (Figure 3.1).

Since the convergence simulation is based on historical data, it demonstrates observed stylised effects of China's rapid economic growth that have raised terms-of-trade concerns in literature, such as:

- a rapid growth in demand for imports of energy and primary inputs;
- a rapid growth in manufactured exports; and
- limited land and natural resource in China.

The simulations thus enable us to analyse how a rapid growing China with the above characteristics impact on its neighbouring countries' terms of trade.

8.1. Concluding summary

This study shows that China's technological convergence has diverse impacts on the neighbouring countries' terms of trade – positive for Indonesia, Australia, the United States and the Rest of the World region; and negative for India, Thailand, the Philippines, Japan, the Republic of Korea, Singapore and Malaysia. Furthermore, the

[23] For those economies that were affected by the Asian financial crisis of 1997-98, we assume the historical trend for the period 1990-2005 prevails. The period 1990-2005 represents better a long-term trend of growth than 1997-2005 that start with the crisis or 1999-2005 that contains a trend of recovery from the crisis.

magnitude of the terms of trade effects on the neighbouring countries is small, especially for Singapore and Malaysia (Figure 4.1 and Table 4.1).

Among the neighbouring countries, India is most adversely affected in terms of trade due to China's convergence. The level of India's terms of trade (export price index divided by import price index) is estimated to be 3.5 per cent lower due to China's convergence; this is in comparison with the case when China does not experience the technological convergence. Indonesia, on the other hand, has the largest improvement in terms of trade (2.8 per cent).

Due to various reasons depending on the economic structure of the specific neighbouring country (Chapter 4), China's technological convergence brings about factors that generate off-setting effects on the neighbouring countries' terms of trade.

The positive factors are those that increase the overall export price index and reduce the overall import price index of the neighbouring countries:

- **Rise in the prices of services exports**. China's convergence leads to expansion in world trade which, in turn, leads to increased demand for exports of transportation and insurance services. Consequently, China's convergence tends to have a positive impact on export price index for services.
- **Rise in the prices of energy and primary inputs**. China's convergence leads to increased demand for energy and other primary exports. This tends to increase the export price index for exporters of these products.
- **Fall in the prices of manufactured goods**. China's convergence leads to a fall in the price of manufactured goods, especially those China export intensively. This tends to reduce the overall import price index for the neighbouring countries, especially those sourcing a significant share of their manufactured imports from China

These positive effects offset the two negative effects that have raised concern on the terms of trade impact of China's convergence on its neighbouring countries. The two negative effects are:

- **Rise in the prices of energy and primary inputs**. This leads to rise in import price index, especially for those depending on imports for energy and other primary products.

- **Fall in the prices of manufactured goods**. This leads to fall in export price index, especially for those neighbouring countries that export similar manufactured products as China does.

China's neighbouring countries have a diverse range of economic structures. This leads to a diverse terms of trade impacts. For examples:

- Indonesia and Australia have a large share of energy and primary inputs in their total exports. China's convergence therefore leads to a positive impact on their terms of trade (2.8 and 1.4 per cent respectively);
- For Singapore and Malaysia, the positive and negative effects almost completely offset one another resulting in almost zero terms of trade effects (-0.2 and -0.1 per cent respectively);
- Japan depends on imports for energy and primary inputs; but Japan also source a large share of its manufactured imports from China and supply transport and insurance services to trade activities, resulting in a small negative terms of trade effects (-0.8 per cent);
- India depends on imports for energy and primary inputs; furthermore, it exports similar manufactured products as China does. As a result, the negative terms of trade effect for India (-3.5 per cent) is estimated to be the largest among the neighbouring countries (Table 4.1 and Figure 4.1).

The impact of China's convergence on the total exports of the neighbouring countries is also small (Figure 5.1 and Table 5.1). While exports from neighbouring countries to their traditional markets are replaced by Chinese exports, China itself becomes an important market for exports. Because China is part of a production network involving its neighbouring countries, its convergence brings about increased imports into China of not only agricultural and mining products, but also manufactures.

The impact of China's convergence on real GDP and GNP in its close neighbours is small and positive for most of the neighbouring countries (Table 5.10). There are two main reasons for the magnitude of the income effects. The first reason is that the additional capital required to finance the increase in China's real GDP comes mainly from domestic savings. Foreign capital constitutes a very small proportion of China's total capital stock. While rapid growth in China places significant pressure on the

world's supply of natural resources, it places little pressure on the global supply of capital. The second reason is that, as discussed above, the overall terms of trade impact on the neighbouring countries are small (Chapter 5).

However, the small terms of trade and income effects do not mean that China's convergence is not a challenge to its neighbouring countries. The simulation results show large structural changes for both China and its neighbouring countries (Tables 5.2, 5.6 and 5.7). China's convergence makes China a major player in the world market as an importer and a place to invest. Those economies that are building closer trade and investment linkages with China are more likely to gain from China's convergence (Chapters 4 and 5), than those that do not.

Changes of assumptions about user preferences in favour of imports (Chapter 6) and China's energy efficiency (Chapter 7) do not change the main conclusions presented above.

8.2. Further areas of research

There are two sources of precaution about the main conclusions derived from this study. One is the *endogenous* productivity improvement associated with FDI flows and the other is about the third and fourth mode of services trade.

In this study, we assume that the difference between the convergence and no-convergence scenario comes from an exogenous change in China's technological progress. In the convergence scenario, China's technology progresses at a rate coherent with its observed growth in real GDP, employment and capital. In the no-convergence scenario, we assume China's technology progresses at a rate similar to that of the United States. There is no *endogenous* productivity growth associated with any FDI flows. A further investigation on this issue may prove to be important as the main benefit of FDI comes from the associated spill-over effects in productivity.

If endogenous productivity improvement related to increased investment and trade flows are taken into account, China's convergence is likely to lead to significant positive impact on neighbouring countries real GDP. The simulation results indicate that China's convergence leads to increased world trade and investment flows.

The second source of precaution is associated with the nature of services trade. While merchandise trade involves cross-border movements of goods, the third and forth

modes of services trade involve cross-border movements of capital and labour. Services trade is becoming increasingly important, especially for developed countries. The discussion of how China's rapid growth impact on developed countries' terms of trade therefore should not ignore the special nature of services trade.

Last, but not least, the convergence leads to changes in China's and its neighbouring countries' economic structure. While it's possible to estimate costs associated with such structural changes, especially in terms of employment adjustment (Dixon and Rimmer 2003 and 2006), it has not been a focus of this study. Further investigation on this issue would be useful to policy makers in both China and its neighbouring countries.

8.3. Policy implication

This study shows that China's technological convergence and the resulting rapid economic growth does not necessarily leads to negative terms of trade impacts on its neighbouring countries. The very factors that lead to negative terms of trade impacts also have positive effects on terms of trade of the neighbouring countries. While the fall in the price of manufactured products reduces neighbouring countries' export prices, it also reduces neighbouring countries' import prices. While the rise in prices of energy and primary inputs increases in import price index for importing countries, it also increases export price index for exporting countries of these products.

The overall effect of China's convergence on its neighbouring countries' terms of trade depends very much on the economic structure of each of the neighbouring countries. As the neighbouring countries have a diverse range of economic structures as discussed in this report, the terms of trade effects also varies. Due to the offsetting effects on terms of trade generated by China's convergence, the overall impact of the convergence on the neighbouring countries' terms of trade is small.

Furthermore, the neighbouring countries that are negatively affected in terms of trade by China's convergence may be positively affected in real GDP and real GNP. For Malaysia, Singapore, and the Republic of Korea, China's convergence leads to increased real GNP compared to the case when there is no convergence (0.4, 1.0, and 0.5 per cent respectively, see Table 5.10). This is due to:

- China's convergence leads to increased demand for goods and services produced in these countries; and/or
- these countries are important sources of FDI flows into China.

If endogenous productivity improvement due to increased trade and investment flows is taken into account, the positive impact of China's convergence on its neighbouring countries real GDP and GNP should be more significant than those reported in this study[24].

Therefore, China's convergence and the resulting rapid economic growth should not raise alarm in the neighbouring countries as a source of negative welfare impact. On the contrary, China's convergence presents a new market for the neighbouring countries to invest in, to export to and to source imports from[25].

The challenge China's convergence brings to the neighbouring countries is the change in economic structure required to benefit from China's convergence. This is the challenge to shift from traditional markets to new markets that successful firms are alert to. A close investigation of historical data in this study shows that the neighbouring countries are adapting well to this challenge. This is reflected in China taking an increasingly larger share in neighbouring countries trade and investment portfolio (see, for example, Box 5.1 in Chapter 5).

An important change occurred in the past decade or two was that the neighbouring countries have engaged China in the electronic production network in the region. The network greatly expanded regional trade in electronic products that enabled China to become both a good source of manufactured imports, and a good market for manufactured exports. This change has played a significant role in offsetting the negative effects of rising energy price on the neighbouring countries' terms of trade.

[24] Another source of endogenous efficiency change that is not considered in this study is the improvement in energy efficiency due to rising energy prices.

[25] Due to its high level of domestic savings, China has also become a net lender in recent years.

References

Bradley, R., and Yang, M. (2006) 'Raising the Profile of Energy Efficiency in China – Case study of standby power efficiency', *International Energy Agency Working Paper Series* [LTO]/2006/01.

Dimaranan, B. V. and McDougall, R. A. (2002) *Global Trade, Assistance, and Production: The GTAP 5 Data Base*, Centre for Global Trade Analysis, Purdue University.

Dixon, P.B., Parmenter, B.R., Sutton, J., and Vincent, D.P., (1982) *ORANI: A Multisectoral Model of the Australian Economy*, North-Holland, Amsterdam.

Dixon, P.B. and M.T. Rimmer (2002) *Dynamic General Equilibrium Modelling for Forecasting and Policy: a Practical Guide and Documentation of MONASH*, North-Holland Publishing Company, Amsterdam.

Dixon, P.B. and M.T. Rimmer, "A new specification of labour supply in the MONASH model with an illustrative application", *The Australian Economic Review*, Vol. 36(1), March 2003, pp. 22-40.

Dixon, P.B. and Maureen T. Rimmer, "The displacement effect of labour-market programs: MONASH analysis", *Economic Record*, Vol. 82, Supplement, August 2006, S26-S40.

Hertel, Thomas W. (editor) 1997. *Global Trade Analysis: Modeling and Applications*, New York: Cambridge University Press.

Kaplinsky, R. (2006) 'Revisiting the Revised Terms of Trade: Will China Make a Difference?' *World Development* 34(6):981-995.

Mai, Y. (2002) 'The Petroleum Sector After China's Entry Into the WTO' *China Perspectives, No. 41 pp.24-32*.

Mai, Y., Horridge, M. and Perkins, F. (2003) 'Estimating the Effects of China's accession to the World Trade Organisation', paper presented at the 6th Annual Conference on Global Economic Analysis June 12-14 2003, Scheveningen, The Hague, The Netherlands.

Mai, Y. (2004) 'The Monash Multi-Country Model', CoPS working paper, No. G-150, Centre of Policy Studies, Monash University, Melbourne.

Maizels, A., Palaskas, T., and Crowe, T. (1998) 'The Prebisch-Singer hypothesis revisited', in d. Sapsford, and J. Chen (Eds.), *Development economics and policy: The conference volume to celebrate the 85th Birthday of Professor Sir Hans Singer*. Basingstoke: Macmillan.

Phelps, E. S. (2004) 'Effects of China's recent development in the rest of the world with special attention to Latin America', *Journal of Policy Modeling*, 26:903-910.

Prebisch, R. (1950) 'The economic development of Latin America and its principal problems', *Economic Bulletin for Latin America* 7, New York: United Nations.

Singer, H. (1950) 'The distribution of gains between investing and borrowing countries', *American Economic Review* 15:473-485.

Singer, H. (1971) 'The distribution of gains revisited', *The Strategy of International Development*, London: Macmillan, reprinted in Cairncross, A., and Puri, M. (Eds.) 1975.

Weiss, J. (2004) 'People's Republic of China and its Neighbors: Partners or competitors for Trade and Investment?' ADB *Institute Research Paper Series* No. 59. Tokyo.

Xinhua News Agency (2007) "Energy saving, pollution control targets must be met: Premier", *China Daily*, (http://www.chinadaily.com.cn/bizchina/2007-03/05/content 819544.htm) accessed March 2007.

Wood, A. (1997) 'Openness and wage inequality in developing countries: the Latin American challenge to East Asian conventional wisdom', *World Bank Economic Review*, 11(1):33-57.

Yan X. eds. (1998) *Zhong Guo Shi You Da Cong Zu* (Petroleum Overhaul), Shi You Gong Ye Chu Ban She (Petroleum Industry Publishing House), Beijing.

Statistical References

BP, http://www.bp.com, accessed October 2006.

China National Bureau of Statistics, *China Statistical Yearbook*, various years, CD ROM from Monash University Library.

Chinese Ministry of Commerce. Data provided through joint projects.

Food and Agriculture Organisation, http://www.fao.org, accessed August and September 2006.

International Energy Agency, http://www.iea.org, accessed September 2006.

International Labour Organisation, http://www.ilo.org, accessed October 2006.

Singapore Department of Statistics, http://www.singstat.gov.sg, accessed September 2006.

State Information Centre, China. Data provided through joint projects.

United Nation, UNSTATS, http://unstats.un.org/unsd/databases.htm, accessed July to December 2006.

United Nations Conference on Trade and Development (UNCTAD), *World Investment Report 2004, 2005 and 2006.*

United Nation Industrial Development Organisation, *International Yearbook of Industrial Statistics* 2006.

United States Bureau of Economic Analysis, http://www.bea.gov, accessed October 2006.

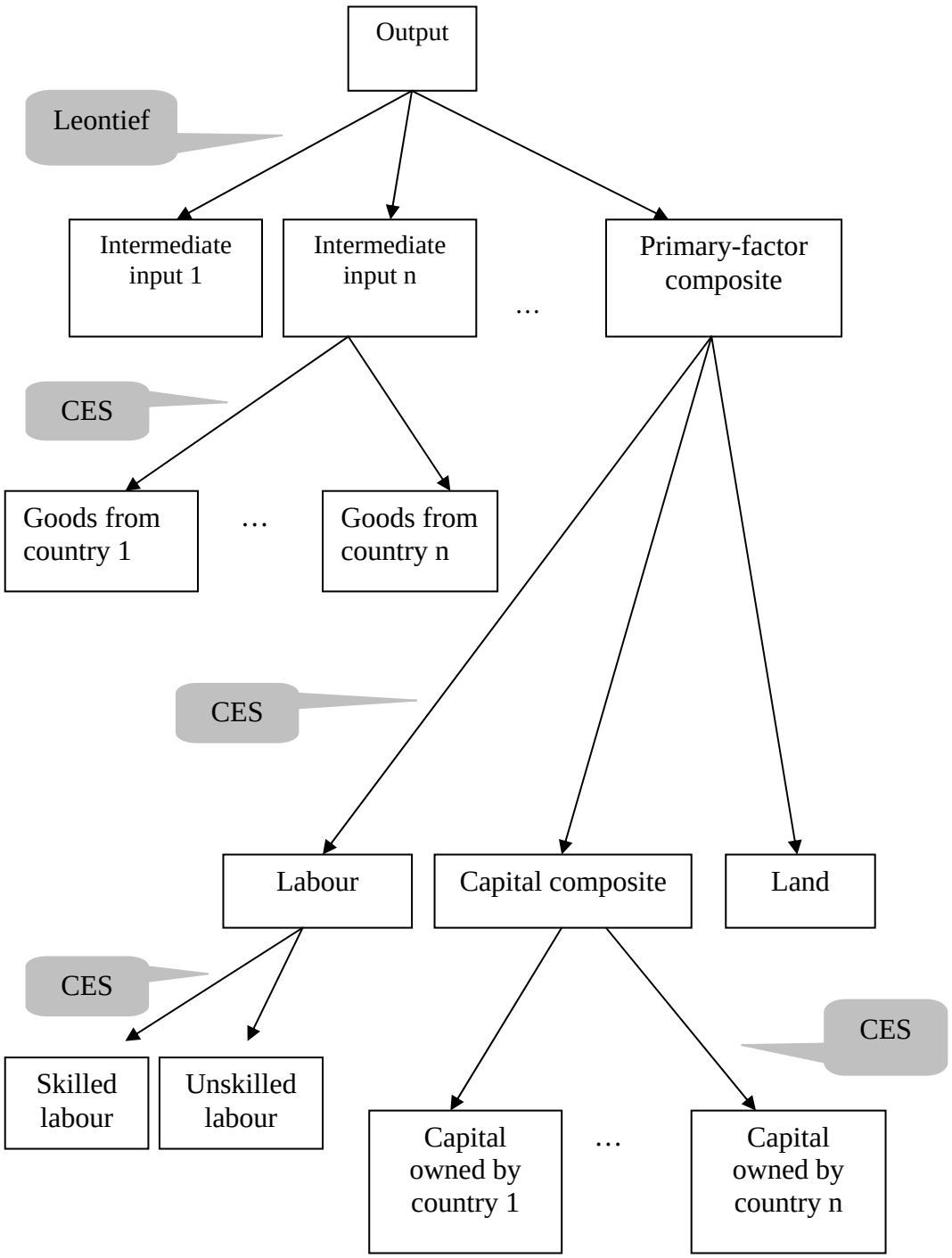
World Bank, WDI, accessed through Monash University Library on-line databases in 2006.

Appendix A The MMC Model

The MMC model is a large system of linearised equations. The equations are a mathematical representation of demand and supply conditions in goods, services and factor markets. The demand and supply equations are derived from the behaviour of various economic agents: producers, consumers, governments, exporters, importers, and investors. Such behaviour (described in more detail below) determines the reaction of the economic agents to changes in relative prices and to their economic environment more generally. The model assumes that all the goods, services and factor markets start from an equilibrium represented in the model database. A change in economic policy (such as a tariff reduction) or in the economic environment (such as a drought) leads to a new equilibrium in which demand equals to supply for all goods, services and factor markets. The model serves to calculate changes to equilibrium quantities and prices of goods, services and factors (and other economic indicators) caused by the change in economic policy or environment.

The model recognises up to 57 industries, each producing a category of goods or services such as textiles, wearing apparel, and construction (Table 2.1). In each industry **producers** use 3 production factors (land, a combination of skilled and unskilled labour, and a combination of capital from different countries/regions) and up to 57 categories of (domestically produced and imported) goods and services as inputs to produce its output (Figure 2.1). In their production, producers mix material inputs and a combination of all production factors in fixed proportions (Box A.1). They determine the combination of production factors according to the relative prices of the production factors. If labour becomes more expensive relative to capital, then producers substitute labour for capital. In determining their demand for material inputs and production factors, producers attempt to minimise costs to produce a certain level of output. Once the level of a material input is determined, producers chose to buy the material input from domestic or foreign sources according to their relative prices. Technological change happens when producers can produce the same level of output using less of one (or all) material input(s) or production factor(s). The output produced by each industry is sold either domestically or exported.

Box A.1 Production technologies



Consumers in the model purchase various categories of goods from different sources (imported or domestically produced). They consume a bundle of necessities and luxury goods. The luxury part of their consumption expands with income. They exhibit optimisation behaviour in choosing their bundle of luxury consumption by maximising utility subject to a budget constraint. Consumers choose between imported and domestically produced goods according to their relative prices.

Governments in the model collect direct and indirect taxes (including tariffs) and have budget expenditures. **Investors** minimise costs when they purchase various goods (imported and domestically produced) and services (mainly construction) for capital creation. Investors exhibit similar behaviours to producers and consumers in their purchasing choice of imported versus domestically produced goods.

The model mechanism capturing **bilateral trade linkages** between economies is similar to that of the GTAP model (see Hertel 1997), except that the producer's decision to supply domestic versus export market is related to the prices in domestic versus export market through a *Constant Elasticity of Transformation* (CET) function.

The demand for composite[26] imports for each category of products is determined by the choice of economic agents (producers, consumers and investors). As discussed above, producers, consumers and investors choose to use domestically produced and imported products according to their relative prices. Once the level of the composite imports for each category of products is determined, importers then choose which country/region to import from according to their relative prices. For example, if Australian wool becomes less expensive relative to wool produced in the ROW region due to a bilateral Free Trade Agreement between China and Australia, importers in China will substitute ROW wool for Australian produced wool.

Linking the export supply and import demand is the international transport sector. The international transport sector provides transport and insurance for bilateral flows of goods between countries/regions, and, thus, adds margins between F.O.B. export prices and C.I.F. import prices. The model mechanism capturing the function of the

[26] The composite imports of a category of products are composed of a bundle of the category of products imported from different countries/regions, such as the total imports of automobile composed of automobile imported from different countries/regions.

international transport sector is based on that of the GTAP model (See Hertel 1997 for more details).

The model has dynamic equations that link the economies from one year to the next. One such equation block models the **accumulation of physical capital** where the capital stock in the following year equals the capital stock in the current year plus investment in the current year minus depreciation. A specific feature of MMC is that it distinguishes capital owned by residence of different countries/regions. Thus, the equation block also allows for the accounting of the accumulation of foreign assets and liabilities through ownership of capitals operating in foreign countries/regions.

On the demand side, the demand for the composite capital is linked to relevant prices through a *Constant Elasticity of Substitution* (CES) function (see Box A.1). This CES function determines the substitution between composite capital, composite labour[27] and land/resource. Composite capital is composed of a bundle of capital owned by residents of different countries/regions. The **capital demand schedule** allows demand for composite capital to respond to changes in relative prices but also to other factors such as technological evolvement that affects capital/labour ratio given a set of relative prices of primary factors.

The bundle of capital owned by different countries/regions is determined by another CES function linking demand for capital owned by a specific country/region to relevant prices. Faster growth in the rental price of capital owned by one country/region relative to the effective price of composite capital leads to a slower growth in the demand for the capital owned by that country/region.

Again, the demand schedule for capital from different sources allows the model to explain or simulate changes in the ratio of foreign versus domestic capital in a particular industry that can not be explained by changes in relative prices. One such change occurred in China's oil industry when the government sold a significant part of its shares to foreigners in 2000. The change itself was part of China's economic reform process and can not be explained only by changes in relative rental prices.

On the supply side, the capital stock available at the end of the year equals to capital stock at the beginning of the year minus depreciation plus investment occurred in the current year. Investment in the current year is determined by an equation linking

[27] The composite labour is composed of skilled and unskilled labour (see Box A.1).

capital growth with expected rate of return on capital. In the **capital supply schedule**, expected rates of return are linked to the growth of capital stocks through *inverse logistic functions* (see Dixon and Rimmer 2002). The current version of the MMC model has static expectation. Under static expectations, investors only take account of current rentals and asset prices when forming current expectations about rates of return (for a more detailed deduction of actual and expected rates of return, see Dixon and Rimmer 2002).

There is a supply curve for capital owned by each country/region that is operating in each industry of each hosting country/region. The accounting of the accumulation of capital stock owned by different countries/regions allows foreign owned capital be counted as foreign liabilities and capital operating in foreign countries/regions be counted as foreign assets. This allows returns on capital operating in foreign countries/regions to be added to the calculation of GNP and returns on foreign-owned capital to be subtracted from GNP.

The model parameters of the MMC database are inherited from the GTAP and MONASH model databases (see Dixon and Rimmer 2002; and Dimaranan and McDougall 2002).

Factor market closure

Given the long-run nature of the analysis, we adopted a typical long-run closure for the labour market in the simulations. This means that aggregate employment is determined by demographic factors rather than production technology. This assumption is plausible because the effects of income rise on fertility rate are very small compared to that of the one-child policy. The latter determined the growth rates of China's working-age population in the past few decades. This is still the case in the coming decade or two, even if China changes its population policy in the near future.

However, our analysis does consider contribution of labour to the convergence of growth by allowing labour to move between sectors. As shown in the simulation results, the Chinese economy saw a rapid industrialisation when it converges with more advanced countries in technology. This greatly facilitated movement of labour from primary sectors to industrial and services sectors. The underemployment in rural China is represented in the model as a much lower labour productivity in the agricultural sectors than the industrial and services sectors. Moving people from

agricultural to industrial and services sectors therefore means a higher effective labour input[28].

In the capital market, capital stock cannot increase in the first year of a simulation. In the subsequent years, capital stock increases/decreases in response to changes in aggregate investment via capital accumulation equations.

[28] This effect is better captured with more detailed representation of rural and urban labour categories which is in our latest dynamic model of China.

1. Appendix B Glossary

Baseline simulation

The baseline simulation is a scenario of how economies in the model evolve without the change in economic policy or environment to be analysed. In this report, the baseline scenario consists of a historical simulation that covers a historical period of time (1997-2005) and a forecast simulation that simulates how economies evolve in a future period (2005-2010).

Convergence scenario

In this study, the convergence scenario is formulated as the "real" scenario in which production technology converges to that of developed countries (see Figure 3.1). For the period of 1997-2005, the convergence scenario is based on historical data. For the period 2005-2010, we assume the continuation of the historical trends. For those countries that were significantly affected by the Asian financial crisis around 1997-1998, we assume that their trend rates of growth during 2005-2010 resemble those of 1990-2005.

Export price index

The export price index is calculated as the weighted sum of FOB prices for individual exports of commodities and services.

Forecast simulation

The forecast simulation is a projection of how the economies in the model evolve during a future period of time. In this study, the forecast simulation for the period 2005-2010 is based on historical trends. In general, a forecast simulation can also be based on forecasts by reputable agencies such as the World Bank and Chinese Academy of Social Sciences.

Four modes of trade in services

According to the World Trade Organisation (WTO), trade in services has four modes: *cross-border supply* – services supplied from one country to another (e.g. international telephone calls); *consumption abroad* – consumers from one country making use of a service in another country (e.g. tourism); *commercial presence* – a company from one country setting up subsidiaries or branches to provide services in another country (e.g. a bank from one country setting up operations in another country); and *movement of natural persons* – individuals travelling from their own country to supply services in another (e.g. an actress or construction worker).

GNP

Nominal GNP is the income which accrues to the persons and organisations that are residents of a country. It can be derived by subtracting from GDP the value of net income paid overseas. *Real* GNP is the value of national income accruing to residents measured in terms of the final quantity of goods and services purchased by residents. It is measured as the value of GNP deflated by the price index of GNE.

GNE

In this study, Gross National Expenditure (GNE) is the sum of private and public consumption plus investment.

Historical simulation

In this study, the historical simulation shows how the economies in the model evolved during the historical period, 1997-2005. In the historical simulation, the model is informed of changes in GDP, consumption, investment, and other observed variables during the historical period. It then calculates the necessary changes in technology and preferences.

Import price index

The import price index is calculated as the weighted sum of the CIF prices for individual imports of commodities and services.

Terms of trade

The terms of trade is calculated as the export price index divided by the import price index.

Total primary factor augmented productivity

An indicator of output per unit of the weighted average of all primary-factor inputs. Total primary factor augmented productivity *improvement* is a larger percentage increase in output than that of the weighted average of all primary-factor inputs.

User preference in favour of imports

An autonomous shift in demand towards imports and away from domestically-produced goods not explained by a change in the price of imports relative to the price of domestic goods.

Table 2.1. List of MMC industries

1	paddy rice	30	wood products
2	wheat	31	paper products, publishing
3	cereal grains nec	32	petroleum, coal products
4	vegetables,fruit,nuts	33	chemical, rubber, plastic prods
5	oil seeds	34	mineral products nec
6	sugar cane, sugar beet	35	ferrous metals
7	plant-based fibers	36	metal nec
8	crops nec	37	metal products
9	cattle,sheep,goats,horses	38	motor vehicles and parts
10	animal products nec	39	transport equiqment nec
11	raw milk	40	electronic equipment
12	wool,silk-worm cocoons	41	machinery and equipment nec
13	forestry	42	miscellaneous manufactures
14	fishing	43	electricity
15	coal	44	gas manufacture, distribution
16	oil	45	water
17	gas	46	construction
18	minerals nec	47	trade
19	meat:cattle,sheep,goats,horse	48	transport nec
20	meat products nec	49	sea transport
21	vegetable oils and fats	50	air transport
22	dairy products	51	communication
23	processed rice	52	financial services nec
24	sugar	53	insurance
25	food products nec	54	business services nec
26	beverages and tobacco products	55	recreation and other services
27	Textiles	56	pubadmin/defence/health/educat
28	wearing apparel	57	dwellings
29	leather products		

Note: The industry classification reported here is identical to the classification used for version 5 of the GTAP database (see Dimaranan and McDougall, 2002). The term “nec” means not elsewhere classified.

Figure 2.1. The structure of the MMC database

		Absorption Matrix					
		1		2	3	4	5
		Prod-ucers	Mixer	Invest-ors	House-holds	Exports	Govern-ment
	Size	← *I* →	←*C*→	← 1 →	← 1 →	←R+1→	← 1 →
Domestic output for domestic market	↑ *C* ↓	V1BAS (dom)		V2BAS (dom)	V3BAS (dom)		V5BAS (dom)
Domestic output for exports	↑ *C* ↓					VXMD	
Composite imports	↑ *R* ↓	V1BAS (imp)		V2BAS (imp)	V3BAS (imp)		V5BAS (imp)
Imports by source	↑ *R* ↓		VXWD				
Margins on imports	↑ *R×M* ↓		VTMFSD				
Tariffs	↑ *R* ↓		V0TARS				
Taxes on domestic products	↑ *C* ↓	V1TAX (dom)		V2TAX (dom)	V3TAX (dom)		
Taxes on exports	↑ *C* ↓					V4TAXD	
Taxes on composite imports	↑ *C* ↓	V1TAX (imp)		V2TAX (imp)	V3TAX (imp)		
Labour	↑ *O* ↓	V1LAB					
Capital	↑ R ↓	V1CAP					
Land	↑ 1 ↓	V1LND					
Other Costs	↑ 1 ↓	V1OCT					

C = Number of commodities
I = Number of industries
S = 2; domestic and imported
R = Number of country/regions
O = Number of occupations
M = Number of margins on imports

Size	Joint Production Matrix ← *I* →
↑ C ↓	MAKE

Table 2.2. The historical simulation: growth of real GDP and components

Average annual growth rates 1997-2005, per cent

	Real GDP	Real Consumption	Real Investment	Government Expenditure	Export Volumes	Import Volumes
China	8.9	5.8	10.1	7.0	16.7	14.8
India	6.4	5.5	7.2	5.9	14.9	12.9
Indonesia	1.8	1.6	0.5	2.5	3.7	2.3
Thailand	2.8	3.0	0.6	4.3	6.3	5.6
Malaysia	3.7	3.9	-0.8	6.4	5.4	4.5
The Philippines	3.8	4.5	-0.7	0.5	3.1	1.9
Singapore	4.4	2.1	-0.5	2.5	4.3	2.5
Australia	3.4	3.8	6.0	2.7	3.5	6.9
Korea, the Rep.	4.1	2.4	1.8	3.3	10.2	7.2
Japan	1.0	0.8	0.1	2.3	2.9	1.6
USA	3.2	3.8	4.6	2.5	3.1	7.1
ROW	2.4	2.4	2.1	2.4	2.1	1.8

Source: Historical simulation.

Table 2.3. The historical simulation: population, employment and price of GDP

Average annual growth rates 1997-2005, per cent

	Population	Employment	GDP price index
China	0.7	0.9	0.9
India	1.6	1.6	1.0
Indonesia	1.4	2.1	-0.5
Thailand	0.9	1.0	-1.7
Malaysia	2.1	2.8	-1.0
The Philippines	1.9	3.0	-1.1
Singapore	1.7	1.4	-1.8
Australia	1.2	2.0	2.8
Korea, the Rep.	0.6	1.0	1.3
Japan	0.2	-0.4	-0.4
USA	1.0	1.1	2.1
ROW	1.4	1.8	-0.1

Source: Historical simulation.

Table 2.4. The historical simulation: output, employment and technology

Average annual growth rates 1997-2005, per cent

	Output		Employment		Technology*	
	China	USA	China	USA	China	USA
Total	**8.9**	**3.2**	**0.9**	**1.1**	**-4.4**	**-1.3**
Agriculture	3.7	4.6	-0.1	-4.8	-3.4	-7.3
Mining	5.4	-0.2	-3.4	-0.2	-7.0	0.3
Manufacturing	10.7	1.6	0.3	-2.8	-5.2	-2.7
Utilities	10.3	2.4	0.5	-2.7	-3.1	-2.5
Construction	10.0	3.7	1.0	3.5	-6.0	0.0
Trade	11.3	4.0	0.7	1.6	-5.5	-1.8
Transport and communication	11.5	5.3	0.3	-2.5	-4.6	-5.7
Other services	8.7	3.3	3.6	2.3	-1.8	-0.4

Sources: The source for technology progress is the historical simulation. See discussion in Section 2.2 and Statistical references for the sources of the output and employment data. The data from various sources were adjusted for data consistency (for a discussion of the data consistency issue see Box 2.2).

Note: * Negative numbers means technological improvement.

Table 3.1. China's convergence: China's technological progress

Average annual growth rates 1999-2010, per cent

	Exogenous shocks applied
TOTAL	**-3.1**
Agriculture	**-2.4**
Mining	**-5.0**
Manufacturing	**-3.7**
meat products	-2.3
meat products nec	-4.5
vegetable oils and fats	-1.4
dairy products	-1.8
processed rice	-2.9
sugar	-1.0
food products nec	-1.7
beverages and tobacco products	-3.1
textiles	-2.6
wearing apparels	-4.4
leather products	-4.2
wood products	-4.0
paper products, publishing	-3.5
petroleum and coal products	-2.4
chemical, rubber, plastic products	-2.6
mineral products nec	-3.7
ferrous metals	-4.2
non-ferrous metals	-4.2
metal products	-3.8
motor vehicles and parts	-2.7
transport equipments nec	-3.5
electronic equipments	-4.5
machinery and equipment nec	-3.5
manufactures nec	-2.8
Services	**-2.7**
utilities	-2.2
construction	-4.3
trade	-4.0
transport and communication	-3.3
other services	-1.3

Source: Historical simulation.

Note: Negative numbers correspond to technological improvements.

Table 3.2. The forecast simulation: growth of real GDP and components

Average annual growth rates 2005-2010, per cent

	Real GDP	Real Consumption	Real Investment	Government Expenditure	Export Volumes	Import Volumes
China	8.9	5.5	9.5	6.6	15.7	13.9
India	6.4	5.2	6.9	5.6	14.3	12.3
Indonesia	3.0	3.0	2.0	2.4	4.8	3.9
Thailand	3.7	3.5	1.0	4.4	6.6	5.5
Malaysia	4.8	4.5	1.6	6.3	6.6	6.0
The Philippines	3.9	4.5	0.8	1.5	4.7	3.9
Singapore	5.3	2.4	1.0	2.8	4.8	3.1
Australia	3.4	3.8	6.1	2.7	3.5	7.0
Korea, the Rep.	4.8	2.4	1.8	3.3	10.0	7.0
Japan	1.2	1.1	0.2	2.4	2.8	1.8
USA	3.2	3.9	4.7	2.5	3.2	7.2
ROW	2.4	2.4	2.1	2.4	2.0	1.8

Source: Simulation results.

Figure 3.1. Historical, forecast and baseline simulations

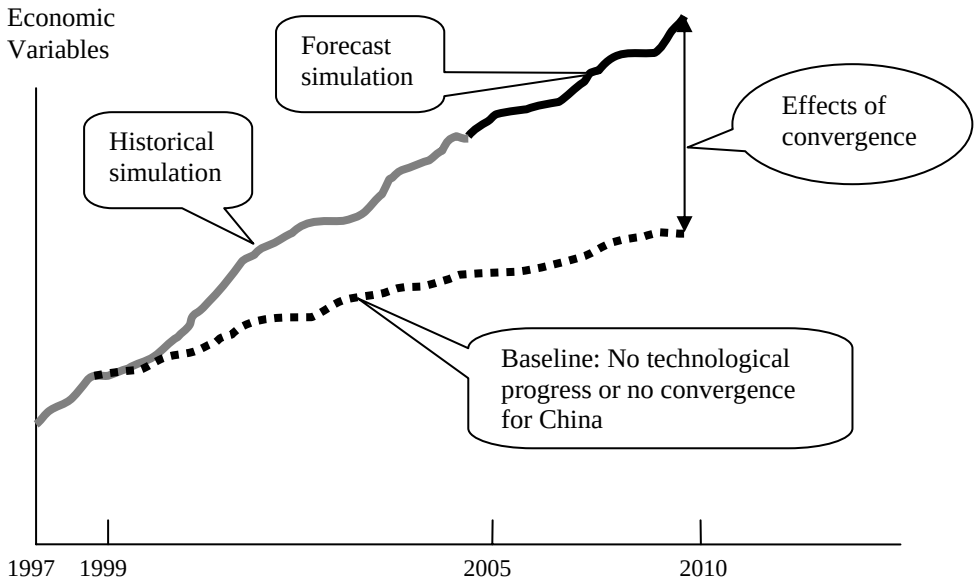


Table 3.3. The baseline: real GDP and components

Average annual growth rates 1999-2010, per cent

	Real GDP	Real Consumption	Real Investment	Government Expenditure	Export Volumes	Import Volumes
China	4.8	2.3	3.9	3.4	11.8	10.1
India	6.5	5.4	7.3	5.8	14.3	12.8
Indonesia	3.0	2.9	1.9	2.3	4.9	3.9
Thailand	3.7	3.6	1.1	4.6	6.7	5.7
Malaysia	4.8	4.5	1.6	6.3	6.7	6.1
The Philippines	3.9	4.6	0.5	1.5	4.9	4.0
Singapore	5.2	2.3	0.8	2.8	4.9	3.1
Australia	3.4	3.8	5.9	2.7	3.5	6.8
Korea, the Rep.	4.7	2.3	1.6	3.2	9.9	6.9
Japan	1.2	1.1	0.1	2.4	2.6	1.5
USA	3.2	3.8	4.5	2.5	3.1	7.0
ROW	2.3	2.3	1.9	2.3	2.0	1.6

Source: Simulation results.

Table 3.4. The baseline: population, employment and GDP price index

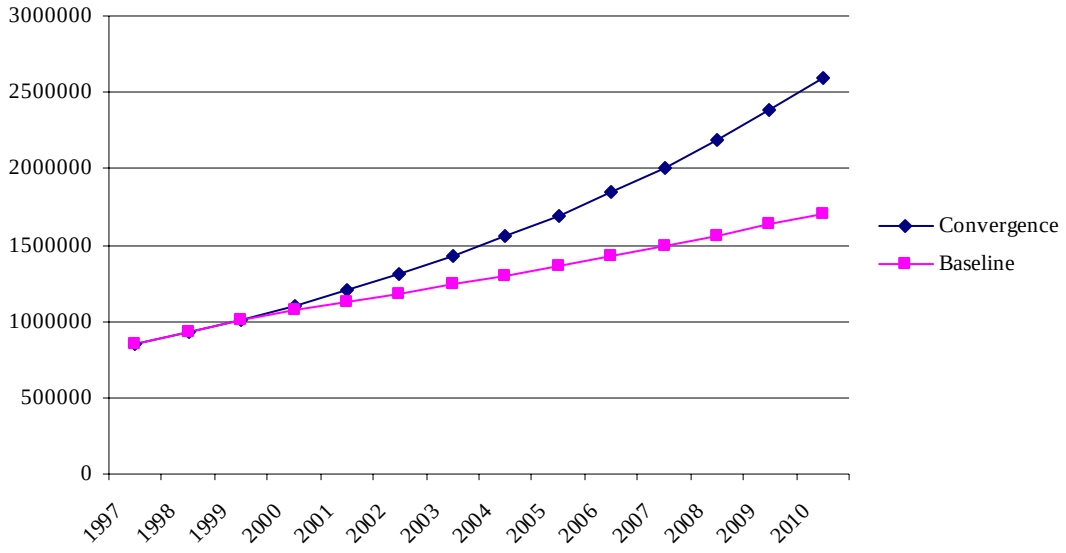
Average annual growth rates 1999-2010, per cent

	Population	Employment	Terms of trade
China	0.7	0.8	0.7
India	1.5	1.8	0.4
Indonesia	1.3	1.8	-0.3
Thailand	0.9	0.9	-1.0
Malaysia	1.9	2.6	-0.2
The Philippines	1.8	2.7	-1.1
Singapore	1.5	1.4	-0.5
Australia	1.1	1.5	2.2
Korea, the Rep.	0.5	0.7	0.3
Japan	0.1	-0.8	-1.0
USA	1.0	0.9	0.2
ROW	1.4	1.6	0.0

Source: Simulation results.

Figure 3.2. China's real GDP: with and without technology convergence

1999-2010, million USD



Source: Simulation results.

Table 3.5. China's convergence: effects on China's macroeconomic indicators

per cent

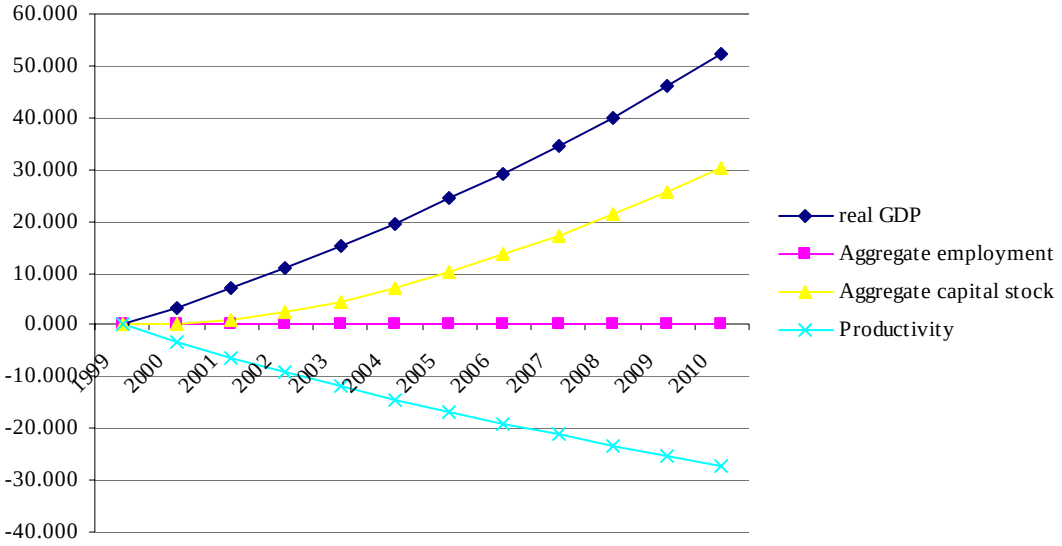
	Baseline: average annual growth rates	China's convergence: average annual growth rates	China's convergence: percentage deviation from baseline
	1999-2010	1999-2010	2010
Real GNP	5.2	8.8	44.2
Real GDP (Y)	4.8	8.9	52.1
Productivity* (A)	-1.3	-4.4	-29.6
Aggregate capital stock (K)	7.6	10.2	30.1
Aggregate employment (L)	0.8	0.8	0.0
Real consumption	2.3	5.5	40.1
Real investment	3.9	9.5	78.4
Export volumes	11.8	15.7	45.8
Import volumes	10.1	13.9	44.6
Real wage	3.2	6.3	38.2
Terms of trade	0.7	-0.3	-10.4
GDP price index (P_g)	1.6	0.9	-7.9
Rental price (Q)	-0.3	0.5	8.6

Source: Simulation results.

* Negative numbers means productivity improvements.

Figure 3.3: China's convergence: GDP, capital, employment, and productivity

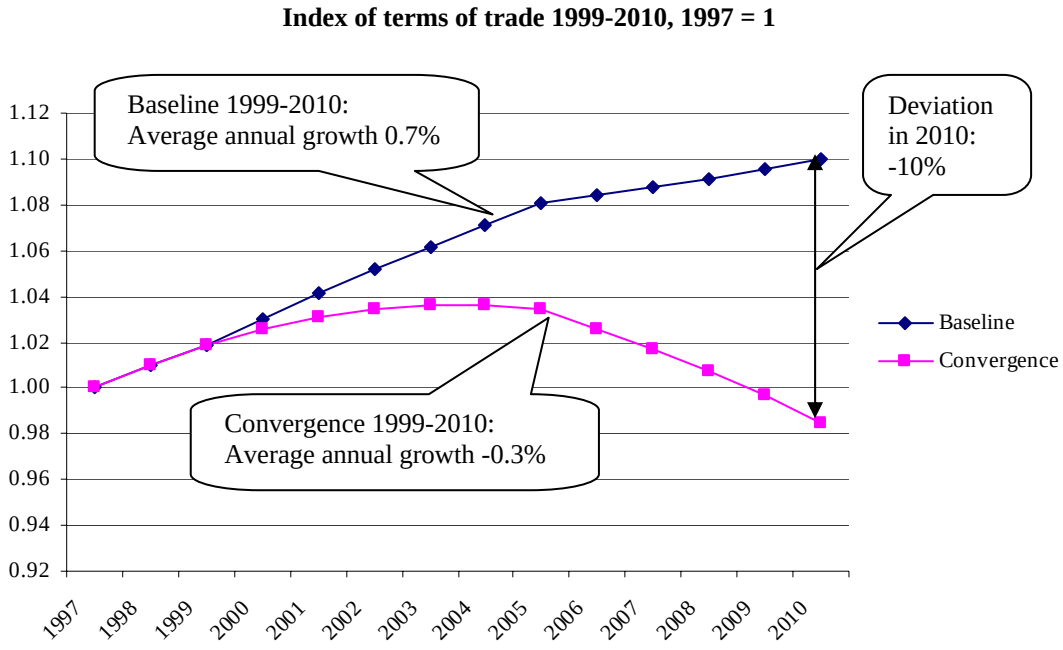
Percentage deviation from baseline 1999-2010, per cent



Source: Simulation results.

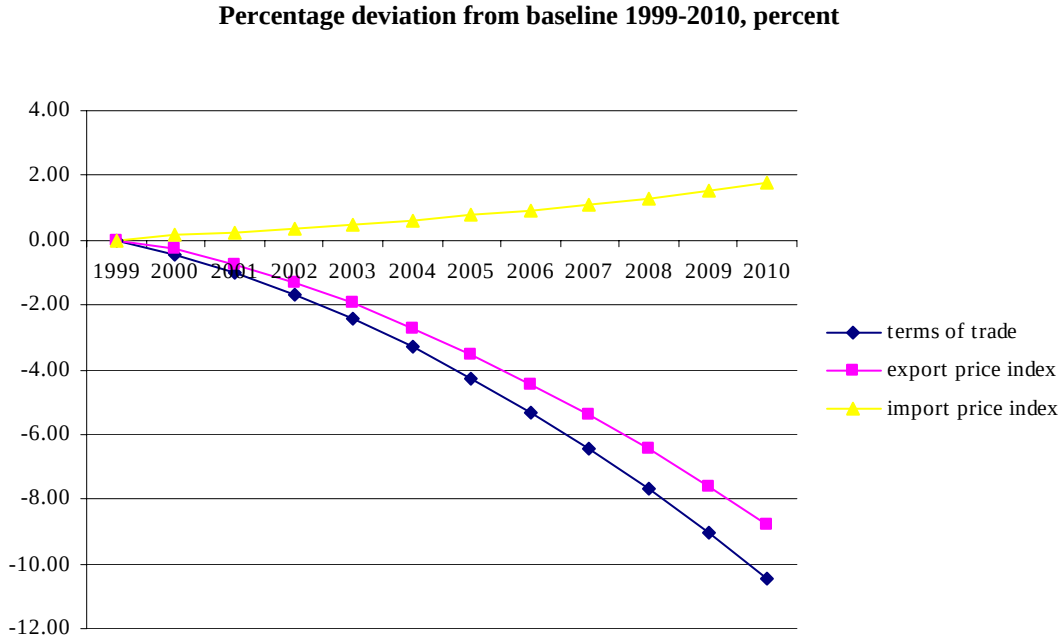
Note: Negative productivity numbers means productivity improvements.

Figure 3.4: China's terms of trade declines due to technological convergence



Source: Simulation results.

Figure 3.5: China's technology convergence: export and import price indices



Source: Simulation results.

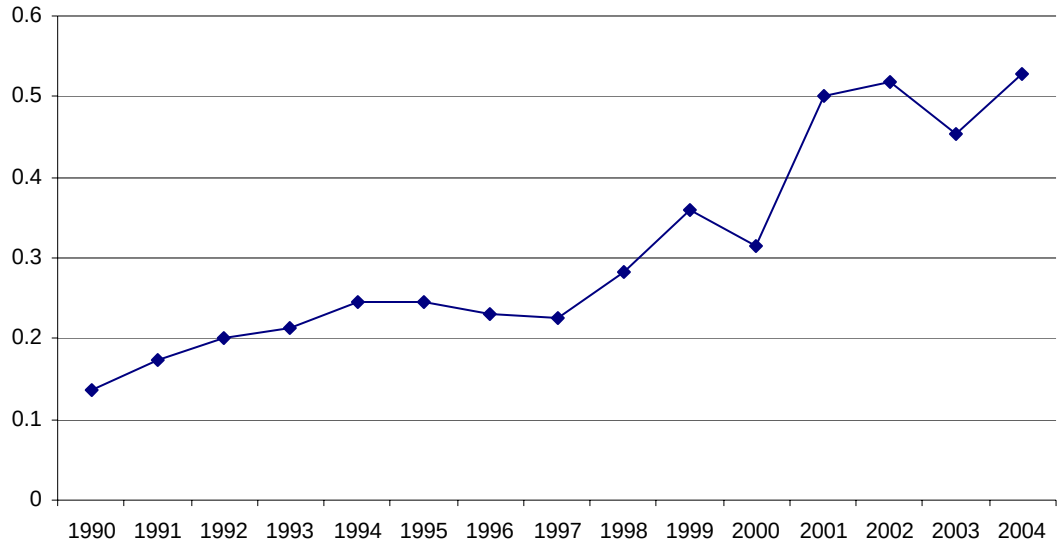
Table 3.6. China's technological convergence: effects on China's exports and imports prices

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**-8.8**
Agriculture	2.5	1.2	-1.2
Mining	1.9	0.5	-4.4
Coal	0.5	0.4	-8.3
Manufacturing	86.1	91.3	-9.0
Wearing apparel	11.0	10.6	-10.5
Electronic equipments	13.0	17.9	-10.9
Manufactures, nec	9.3	9.2	-10.4
Services	9.4	7.0	-7.6
Total imports	**100.0**	**100.0**	**1.8**
Agriculture	2.9	2.7	4.4
Plant-based fibers	0.6	0.4	4.6
Wool, silk-worm cocoons	0.2	0.1	4.2
Mining	3.4	4.0	14.2
Oil	2.1	3.5	16.7
Manufacturing	83.4	77.9	0.6
Petroleum, coal products	2.4	1.6	14.3
Services	10.3	15.4	1.4

Source: Simulation results.

Figure 3.6: Share of coal in total mining exports from China

1990-2004, per cent



Sources: GTAP database; United Nation, COMTRAD.

Table 3.7. China's convergence: effects on China's trade volumes, per cent

	Baseline shares of exports by commodity groups 2010	Percentage deviation of Export volumes from baseline 2010	Baseline shares of imports by commodity groups 2010	Percentage deviation of Import volumes from baseline 2010
Total	**100.0**	**45.8**	**100.0**	**44.6**
Agriculture	**1.2**	**11.0**	**2.7**	**53.1**
Mining	**0.5**	**9.3**	**4.0**	**81.4**
Manufacturing	**91.3**	**47.0**	**77.9**	**43.3**
meat products	0.0	49.7	0.3	7.1
meat products nec	0.2	22.0	0.6	35.4
vegetable oils and fats	0.1	18.0	0.8	39.7
dairy products	0.0	30.2	0.1	27.4
processed rice	0.1	22.6	0.1	14.9
sugar	0.0	7.5	0.1	38.6
food products nec	1.0	13.9	1.1	42.4
beverages and tobacco products	0.4	37.8	0.6	26.3
textiles	5.3	25.0	10.0	36.6
wearing apparels	10.6	38.1	0.7	26.5
leather products	6.3	22.6	1.7	27.4
wood products	2.6	55.5	0.9	30.6
paper products, publishing	0.7	52.1	3.5	37.6
petroleum and coal products	0.3	44.6	1.6	36.2
chemical, rubber, plastic products	6.8	35.4	13.1	46.9
mineral products nec	2.8	66.2	2.1	27.1
ferrous metals	2.3	65.7	4.9	38.2
non-ferrous metals	1.3	63.4	2.9	47.0
metal products	3.7	54.8	1.7	35.3
motor vehicles and parts	0.8	65.4	1.6	45.2
transport equipments nec	1.9	74.2	1.5	38.4
electronic equipments	17.9	58.2	11.7	51.3
machinery and equipment nec	17.0	55.8	15.3	48.9
manufactures nec	9.2	33.4	1.2	43.8
Services	**7.0**	**39.6**	**15.4**	**42.3**

Source: Simulation results.

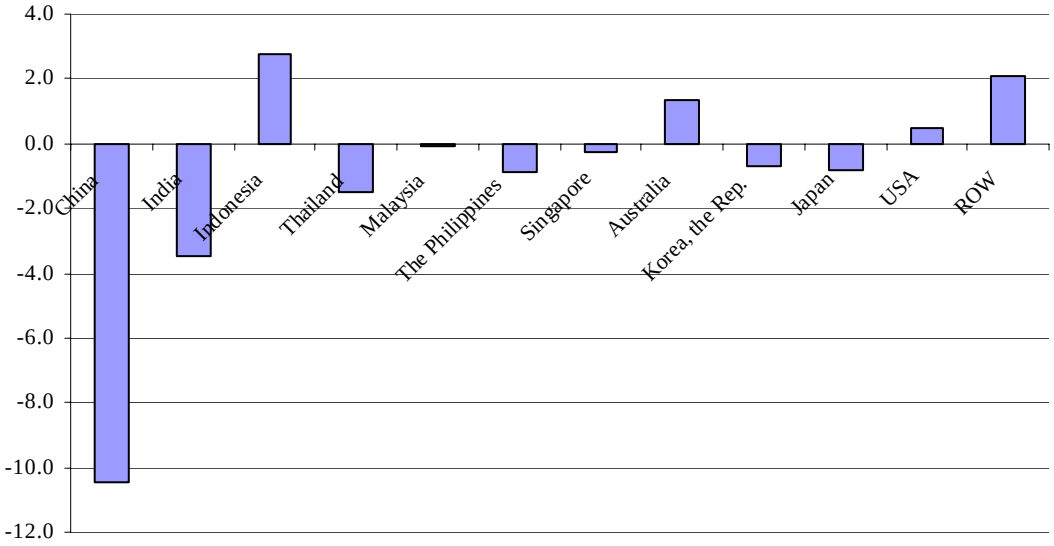
Table 3.8. China's convergence: effects on China's value added by industries

	GTAP database: shares of value added by industries Per cent	Baseline simulation: shares of value added by industries Per cent	China's convergence: percentage deviation from baseline Per cent
	1997	2010	2010
Total	**100.0**	**100.0**	**52.1**
Agriculture	**20.9**	**16.3**	**36.2**
Mining	**4.4**	**0.9**	**39.9**
Manufacturing	**37.5**	**39.6**	**57.2**
meat products	0.1	0.0	39.5
meat products nec	0.2	0.1	40.5
vegetable oils and fats	0.1	0.0	35.6
dairy products	0.0	0.0	38.4
processed rice	1.5	0.9	27.3
sugar	0.0	0.0	21.9
food products nec	0.7	0.4	31.5
beverages and tobacco products	0.9	0.6	47.5
textiles	3.3	2.5	40.6
wearing apparels	2.0	3.0	41.9
leather products	1.0	1.2	27.6
wood products	0.7	1.0	61.2
paper products, publishing	1.5	1.1	66.7
petroleum and coal products	0.6	0.5	55.8
chemical, rubber, plastic products	4.2	3.3	51.1
mineral products nec	4.1	3.8	75.0
ferrous metals	1.7	1.7	81.1
non-ferrous metals	0.5	0.6	76.3
metal products	1.5	1.7	65.1
motor vehicles and parts	0.9	0.7	75.7
transport equipments nec	0.8	0.8	77.9
electronic equipments	1.9	4.4	63.9
machinery and equipment nec	6.4	7.2	67.7
manufactures nec	2.8	4.0	43.5
Services	**37.3**	**43.1**	**58.3**

Sources: GTAP database and simulation results.

Figure 4.1: China's technological convergence: terms of trade effects

Percentage deviation from baseline 2010, per cent



Source: Simulation results.

Table 4.1. China's technological convergence: impact on other countries

Percentage deviation from baseline in 2010, per cent

	Terms of trade	Export price index	Import price index
China	-10.4	-8.8	1.8
India	-3.5	-1.2	2.3
Indonesia	2.8	4.4	1.6
Thailand	-1.5	-0.3	1.2
Malaysia	-0.1	-0.2	-0.1
The Philippines	-0.9	0.0	0.9
Singapore	-0.2	1.1	1.3
Australia	1.4	1.7	0.4
Korea, the Rep.	-0.7	1.1	1.8
Japan	-0.8	0.1	0.9
USA	0.5	0.7	0.3
ROW	2.1	2.9	0.8

Source: Simulation results.

Table 4.2. China's technological convergence: effects on Japan's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**0.1**
Agriculture	0.1	0.1	3.1
Mining	0.0	0.0	n.a.
Manufacturing	84.3	81.6	-0.3
Petroleum, coal products	0.2	0.5	13.3
Services	15.6	18.2	1.6
Total imports	**100.0**	**100.0**	**0.9**
Agriculture	5.1	3.5	2.0
Mining	12.0	15.4	11.2
Oil	7.12	11.0	16.3
Manufacturing	58.9	59.5	-2.2
Petroleum, coal products	2.0	2.3	14.1
Electronic equipments	9.7	11.4	-5.1
Services	24.0	21.6	1.7

Sources: GTAP database and simulation results.

n.a. not applicable.

Table 4.3. China's technological convergence: effects on Japan's import prices

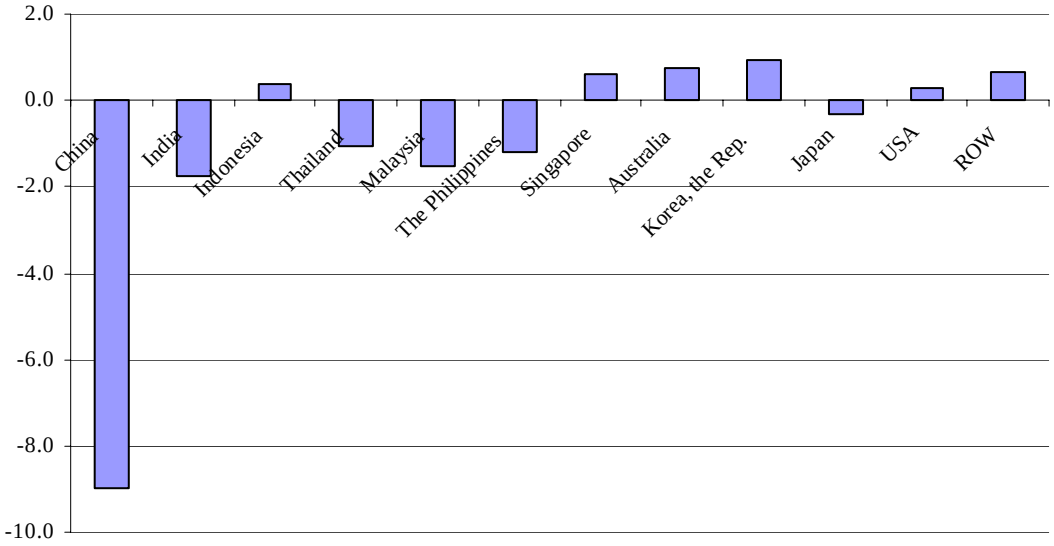
Contribution by commodity groups to the deviation of import price index 2010

	Baseline shares in total imports by commodity groups (a)	Percentage deviation in import prices by commodity groups (b)	Contribution to the percentage deviation in the total import price index by commodity groups (c) = (a)*(b)/100
Total imports	**100.0**	**0.9**	**0.9**
Agriculture	3.5	2.0	0.1
Mining	15.5	11.2	1.7
Manufacturing	59.4	-2.2	-1.3
Services	21.6	1.7	0.4

Source: Simulation results.

Figure 4.2: China's convergence: effects on the export price for manufactures

Percentage deviation from baseline 2010, per cent



Source: Simulation results.

Table 4.4. China's technological convergence: effects on Korea's trade

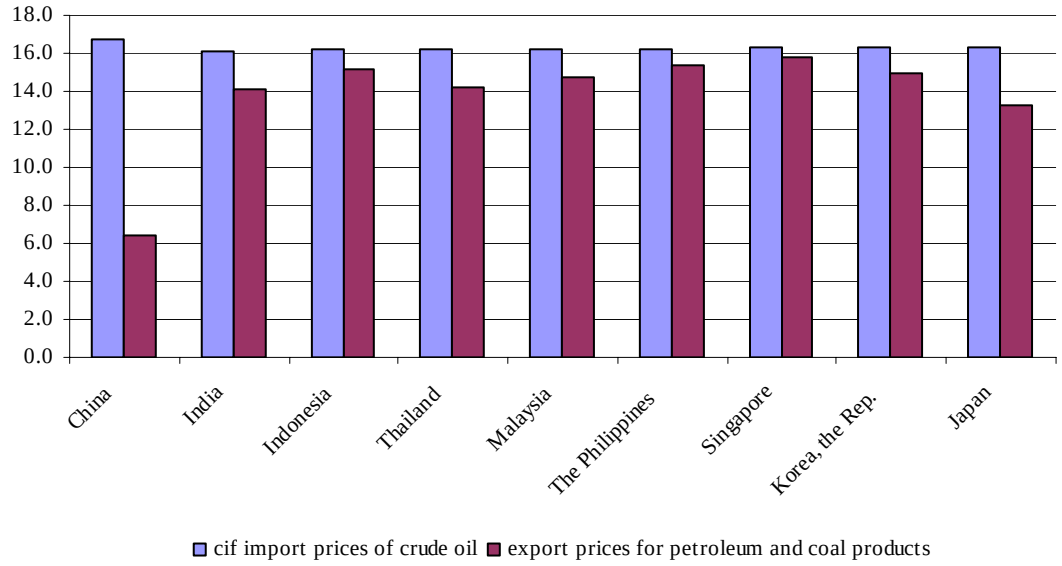
	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**1.1**
Agriculture	0.4	0.3	2.3
Mining	0.0	0.0	n.a.
Manufacturing	80.5	87.4	0.9
Petroleum, coal products	2.5	3.6	14.9
Services	19.1	12.3	2.3
Total imports	**100.0**	**100.0**	**1.8**
Agriculture	3.6	2.2	2.5
Mining	13.6	14.8	13.0
Manufacturing	67.9	69.6	-0.8
Services	14.8	13.4	1.3

Sources: GTAP database and simulation results.

n.a. not applicable.

Figure 4.3: China's convergence: effects on import prices for oil and export prices for petroleum and coal products

Percentage deviation from baseline 2010, per cent

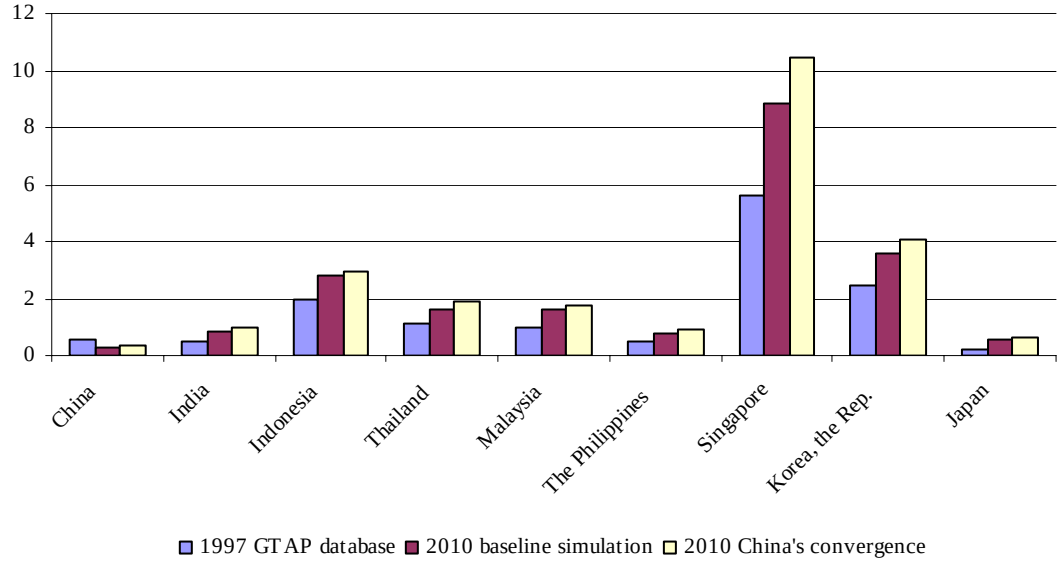


Source: Simulation results.

Note: Petroleum and coal products are part of manufactured exports.

Figure 4.4: Shares of petroleum and coal products in total exports

1997 and 2010, per cent

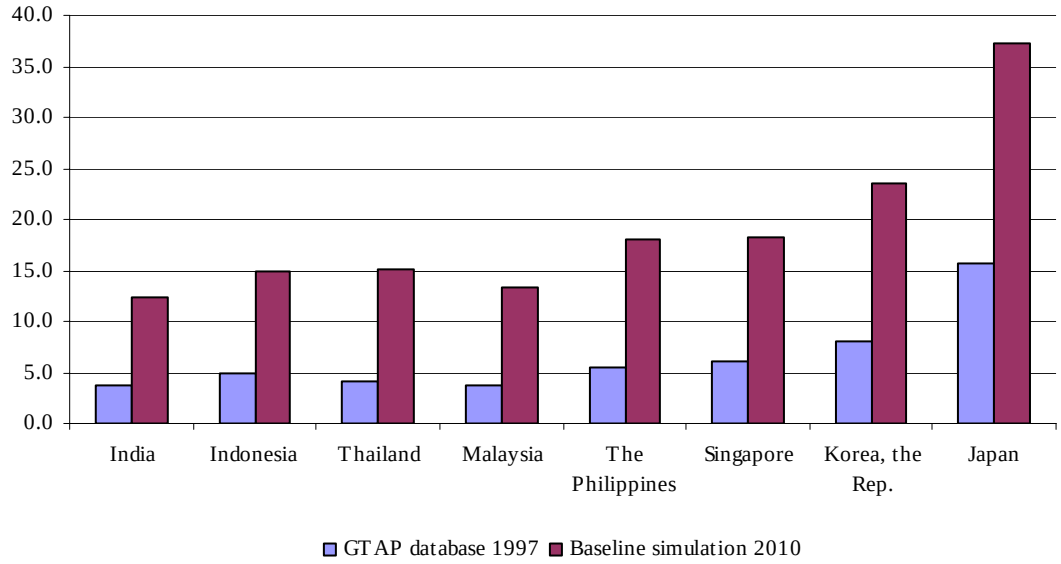


Sources: GTAP database and simulation results.

Note: See Box 3 for the historical trend of the exports of petroleum products for Korea.

Figure 4.5: Share of manufactured imports from China in total manufactured imports

1997 and 2010, per cent



Sources: GTAP database and simulation results.

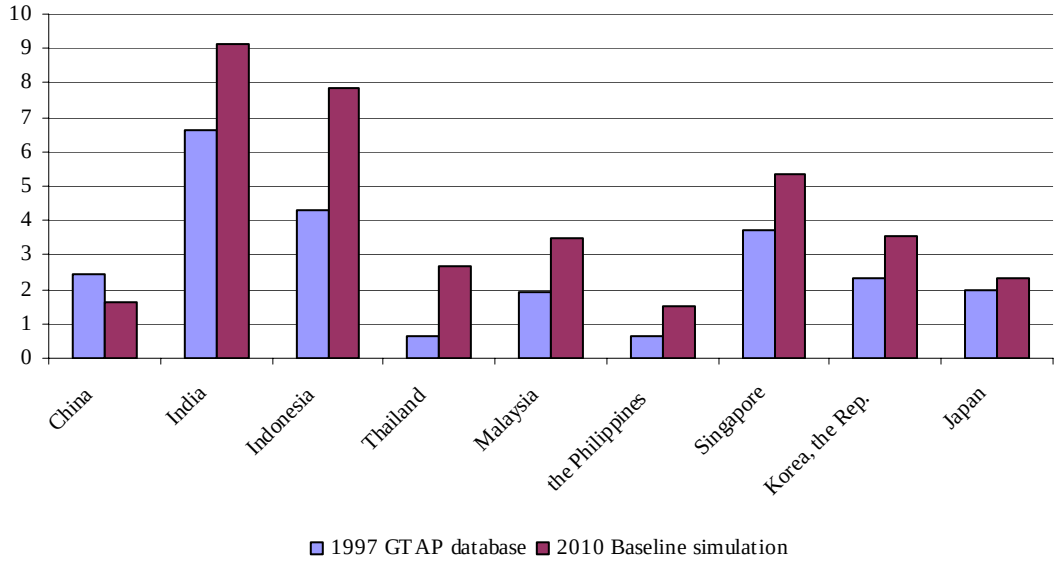
Table 4.5. China's technological convergence: effects on India's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**-1.2**
Agriculture	6.4	2.8	0.6
Mining	2.4	0.8	4.8
Manufacturing	70.6	80.5	-1.8
Services	20.5	15.9	0.7
Total imports	**100.0**	**100.0**	**2.3**
Agriculture	3.6	6.4	2.7
Mining	10.4	7.0	12.2
Manufacturing	69.4	70.7	1.3
Services	16.5	15.9	0.9

Source: Simulation results.

Figure 4.6: Shares of petroleum and coal products in total imports

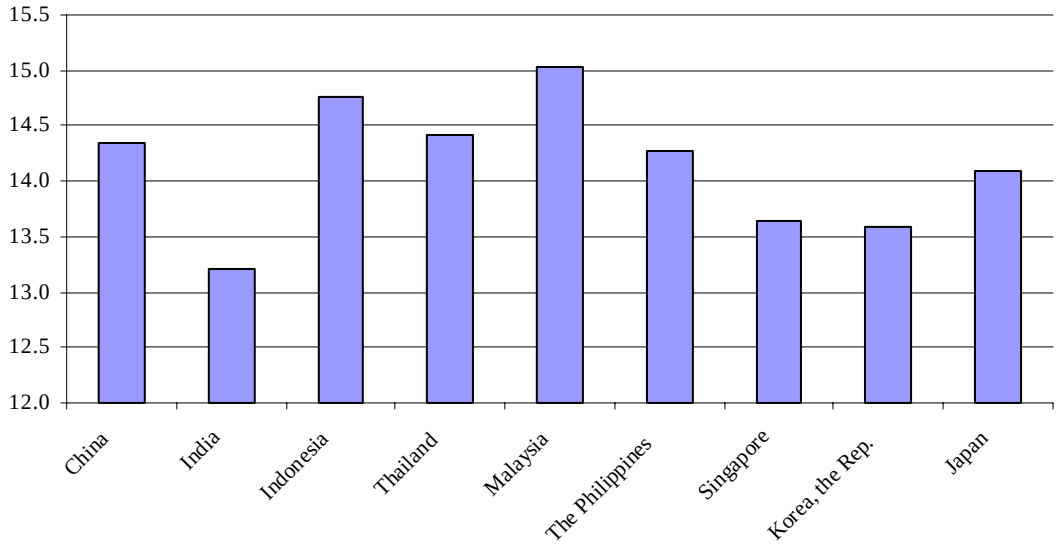
1997 and 2010, per cent



Sources: GTAP database and simulation results.

Figure 4.7: China's convergence: effects on the import prices for petroleum and coal products

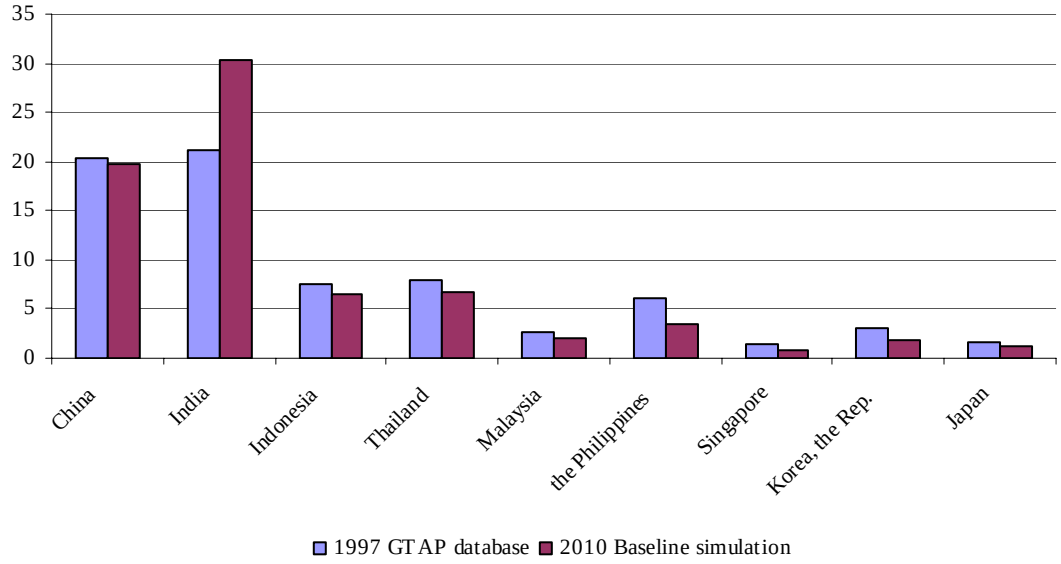
Percentage deviation from baseline 2010, per cent



Source: Simulation results.

Figure 4.8: Shares of wearing apparels and manufactures nec in total exports

1997 and 2010, per cent



Sources: GTAP database and simulation results.
nec not elsewhere classified.

Table 4.6. China's convergence: effects on export prices for China and India

	GTAP database: shares in total exports by commodities		Baseline simulation: shares in total exports by commodities		China's convergence: percentage deviation of export prices from baseline	
	1997		2010		2010	
	China	India	China	India	China	India
manufactures	86.1	70.6	91.3	80.5	-8.8	-1.2
meat products	0.0	0.4	0.0	0.1	-9.2	-3.1
meat products nec	0.5	0.0	0.2	0.0	-4.3	-0.7
vegetable oils and fats	0.2	2.3	0.1	1.0	-2.9	0.1
dairy products	0.0	0.0	0.0	0.0	-5.8	-0.5
processed rice	0.1	1.8	0.1	1.1	-5.9	-2.6
sugar	0.1	0.5	0.0	0.3	-1.0	-0.5
food products nec	1.8	4.0	1.0	2.3	-3.0	-1.1
beverages and tobacco products	0.4	0.1	0.4	0.1	-6.1	-1.0
textiles	8.6	13.4	5.3	9.5	-6.6	-1.1
wearing apparels	11.0	8.9	10.6	15.5	-10.5	-4.4
leather products	8.8	2.9	6.3	4.4	-8.8	-3.2
wood products	1.7	0.4	2.6	0.6	-7.9	-1.3
paper products, publishing	0.7	0.3	0.7	0.3	-8.3	-0.3
petroleum and coal products	0.5	0.5	0.3	0.8	6.4	14.1
chemical, rubber, plastic products	6.8	8.6	6.8	7.1	-4.9	1.1
mineral products nec	2.2	1.4	2.8	2.4	-9.3	-1.5
ferrous metals	1.8	2.2	2.3	3.5	-9.2	-1.1
non-ferrous metals	1.0	0.8	1.3	0.9	-7.2	-0.2
metal products	2.9	2.2	3.7	5.9	-8.7	-2.7
motor vehicles and parts	0.5	1.2	0.8	2.2	-5.4	-0.8
transport equipments nec	1.4	0.9	1.9	1.2	-7.2	-1.6
electronic equipments	13.0	1.4	17.9	1.3	-10.9	-3.4
machinery and equipment nec	12.9	4.3	17.0	5.1	-9.0	-2.0
manufactures nec	9.3	12.1	9.2	14.9	-10.4	-3.9

Sources: GTAP database and simulation results.

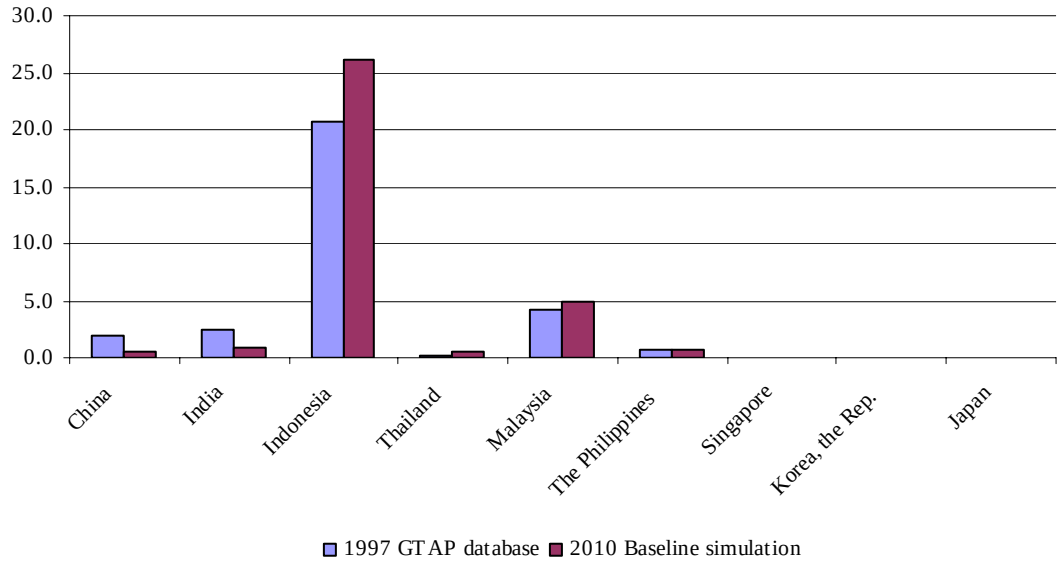
Table 4.7. China's technological convergence: effects on Indonesia's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**4.4**
Agriculture	3.9	2.6	2.0
Mining	20.7	26.2	12.6
Manufacturing	63.8	59.0	0.4
Services	11.6	12.3	2.5
Total imports	**100.0**	**100.0**	**1.6**
Agriculture	5.3	6.3	2.1
Mining	2.6	4.9	13.5
Manufacturing	70.7	65.5	1.1
Services	21.4	23.3	0.6

Source: Simulation results.

Figure 4.9: Shares of mining products in total exports

1997 and 2010, per cent



Sources: GTAP database and simulation results.

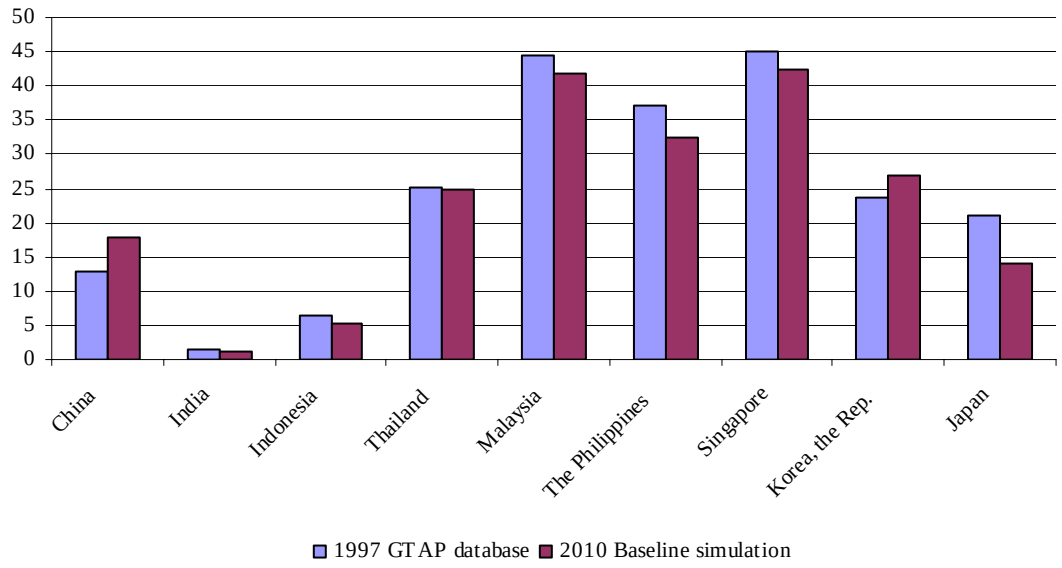
Table 4.8. China's technological convergence: effects on Malaysia's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**-0.2**
Agriculture	1.8	1.7	5.3
Mining	4.3	4.9	12.5
Manufacturing	78.6	77.7	-1.5
Services	15.3	15.7	0.4
Total imports	**100.0**	**100.0**	**-0.1**
Agriculture	2.2	2.5	1.8
Mining	0.9	1.7	10.6
Manufacturing	81.6	70.8	-0.5
Services	15.3	24.9	0.1

Source: Simulation results.

Figure 4.10: Shares of electronic equipments in total exports

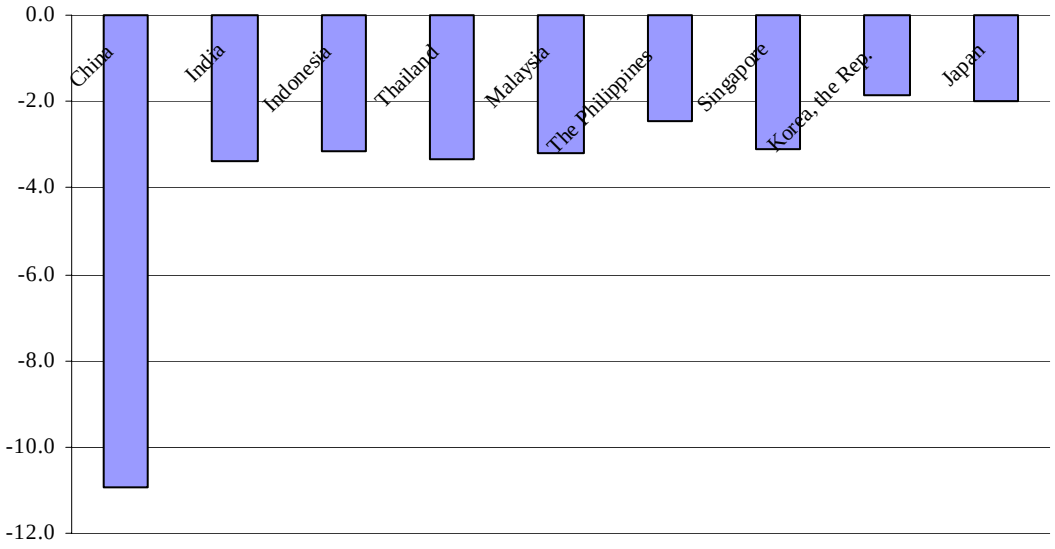
1997 and 2010, per cent



Sources: GTAP database and simulation results.

Figure 4.11: China's convergence: effects on export prices for electronic equipments

Percentage deviation from baseline 2010, per cent



Sources: Simulation results.

Table 4.9. China's technological convergence: effects on Singapore's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**1.1**
Agriculture	0.5	0.4	1.3
Mining	0.0	0.0	1.8
Manufacturing	75.4	76.6	0.6
petroleum and coal products	5.6	8.8	15.8
electronic equipments	44.9	42.4	-3.1
Services	24.0	22.9	2.1
Total imports	**100.0**	**100.0**	**1.3**
Agriculture	1.3	1.0	1.4
Mining	5.5	9.5	16.1
Manufacturing	82.7	74.4	-0.8
petroleum and coal products	3.7	5.3	13.6
electronic equipments	33.2	29.4	-3.7
Services	10.5	15.1	0.7

Source: Simulation results.

n.a. not applicable.

Table 4.10. China's technological convergence: effects on Thailand's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**-0.3**
Agriculture	1.9	1.5	3.8
Mining	0.3	0.5	16.3
Manufacturing	77.4	76.7	-1.1
electronic equipments	25.1	25.0	-3.3
machinery and equipment nec	10.5	13.4	-1.9
Services	20.5	21.3	1.5
Total imports	**100.0**	**100.0**	**1.2**
Agriculture	2.2	2.5	2.7
Mining	7.1	7.4	15.0
Manufacturing	75.5	64.9	-0.6
electronic equipments	16.6	12.9	-3.3
machinery and equipment nec	20.5	13.3	-1.4
Services	15.2	25.2	0.7

Source: Simulation results.

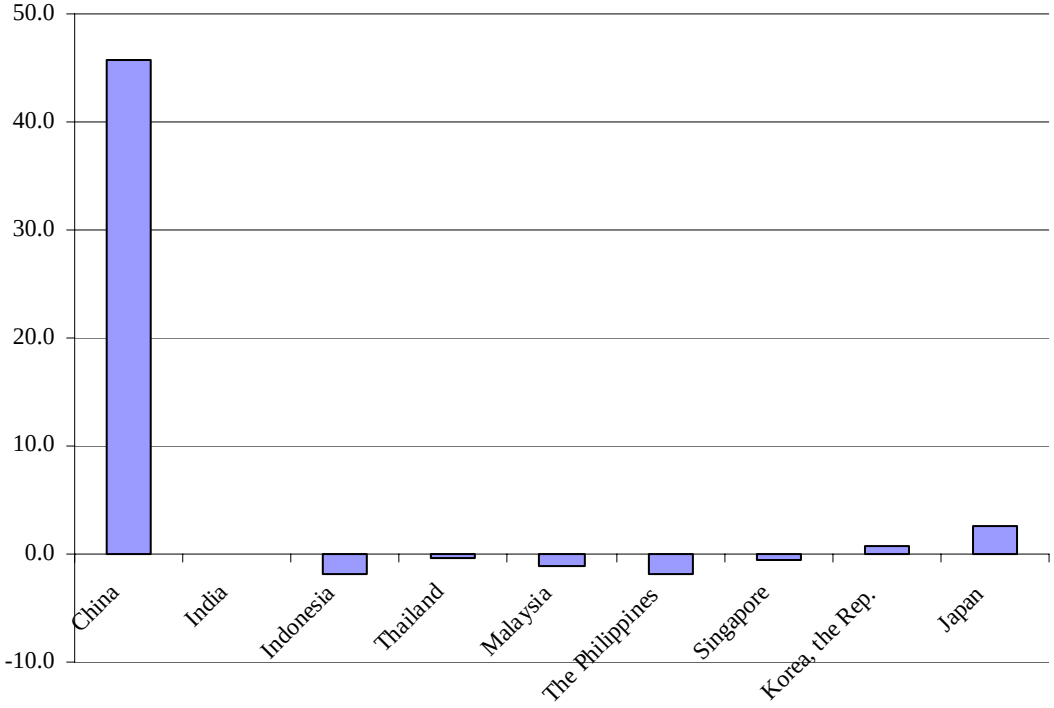
Table 4.11. China's technological convergence: effects on the Philippine's trade

	GTAP database: shares of exports or imports by commodity groups Per cent	Baseline simulation: shares of exports or imports by commodity groups Per cent	China's convergence: percentage deviation of export or import prices from baseline Per cent
	1997	2010	2010
Total exports	**100.0**	**100.0**	**0.0**
Agriculture	1.6	1.5	4.7
Mining	0.8	0.7	3.1
Manufacturing	62.2	56.6	-1.2
electronic equipments	37.2	32.6	-2.4
Services	35.5	41.3	1.1
Total imports	**100.0**	**100.0**	**0.9**
Agriculture	2.4	2.6	1.8
Mining	5.6	7.6	13.9
Manufacturing	69.7	60.3	-1.1
electronic equipments	23.9	18.6	-3.0
Services	22.4	29.5	0.7

Source: Simulation results.

Figure 5.1. China's convergence: effects on the volumes of total export

Percentage deviation from baseline 2010, per cent



Source: Simulation results.

Table 5.1. China's convergence: effects on the volumes of total export

	GTAP database: values of total exports in 1997	Baseline: volumes of total exports in 2010	Deviation of export volumes from the baseline in 2010	
	In 1997 US$ million	In 2005 US$ million	In 2005 US$ million	Percentage deviation %
World total	**6409115**	**12068108**	**605593**	**5.0**
China	241436	1341357	614244	45.8
India	47347	322613	49	0.0
Indonesia	56926	122641	-2169	-1.8
Thailand	71757	195022	-570	-0.3
Malaysia	96875	261860	-2851	-1.1
The Philippines	41550	87900	-1589	-1.8
Singapore	131528	286194	-1558	-0.5
Australia	71901	132464	361	0.3
Korea, the Rep.	162527	676609	4635	0.7
Japan	506296	834830	21708	2.6
USA	872658	1528886	11126	0.7
ROW	4108313	6277732	-37795	-0.6

Source: GTAP database and simulation results.

Table 5.2. China's convergence: effects on imports into USA, Japan, ROW and China

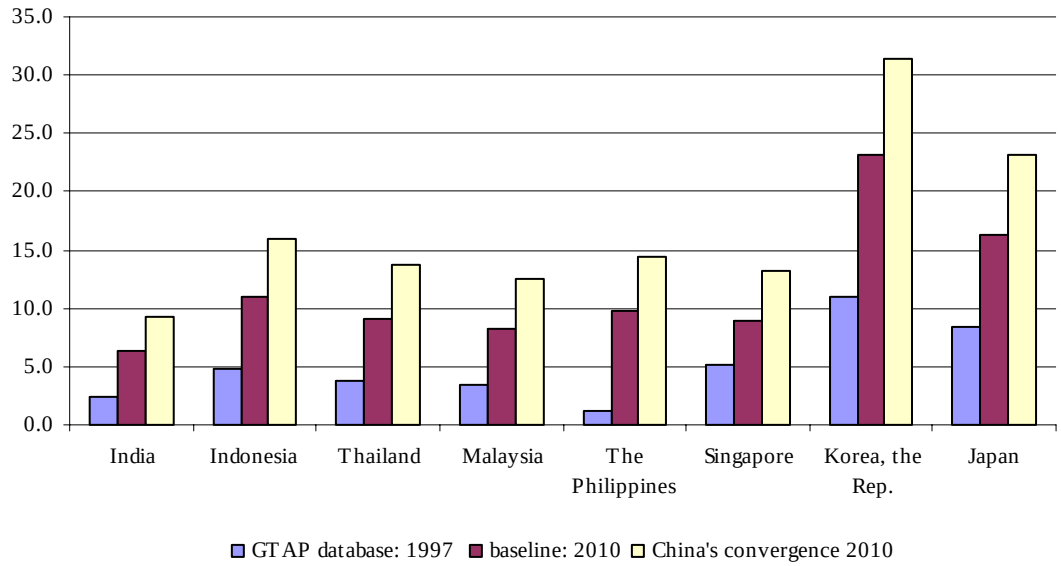
Percentage deviation from the baseline 2010, per cent

	Import volumes into			
	USA	Japan	ROW	China
Total (from all sources)	**1.8**	**3.2**	**1.4**	**44.6**
China	42.7	39.0	51.2	n.a.
India	-6.6	-6.2	-1.6	47.6
Indonesia	-10.7	-8.8	-6.1	42.9
Thailand	-7.5	-9.9	-2.3	49.1
Malaysia	-8.8	-9.5	-2.0	51.1
The Philippines	-9.7	-15.8	-4.1	42.6
Singapore	-10.1	-12.5	-4.4	46.8
Korea, the Rep.	-14.1	-17.5	-9.0	36.7
Japan	-7.0	n.a.	-3.8	44.7

Source: Simulation results.

Figure 5.2. The shares of exports to China in total exports

1997 and 2010, per cent



Source: GTAP database and simulation results.

Note: See Box 5.1 for historical trend.

Table 5.3. China's convergence: effects on export volumes by commodity groups

Percentage deviation from baseline 2010, per cent

	India	Indonesia	Thailand	Malaysia	The Philippines	Singapore	Korea, the Rep.	Japan
Total exports	**0.0**	**-1.8**	**-0.3**	**-1.1**	**-1.8**	**-0.5**	**0.7**	**2.6**
Agriculture	6.2	2.6	2.8	6.8	9.4	0.4	2.8	7.7
Mining	8.5	2.5	3.3	2.0	3.4	n.a.	n.a.	n.a
Manufactures	-1.7	-4.1	-1.8	-3.1	-6.3	-2.0	0.0	1.2
Services	7.3	2.0	4.9	8.2	3.6	4.8	6.0	8.6

Source: Simulation results.

n.a. not applicable.

Table 5.4. China's convergence: effects on imports of manufactures into USA, Japan, ROW and China

Percentage deviation from the baseline 2010, per cent

	Import volumes of manufactures into			
	USA	Japan	ROW	China
Total (from all sources)	**3.6**	**8.0**	**2.5**	**44.3**
China	43.0	40.2	52.8	n.a.
India	-7.8	-8.7	-2.6	48.4
Indonesia	-12.1	-13.0	-7.2	38.0
Thailand	-9.3	-11.6	-3.5	51.5
Malaysia	-11.0	-12.9	-3.6	51.6
The Philippines	-14.3	-18.0	-9.8	41.2
Singapore	-12.4	-13.7	-5.3	49.2
Korea, the Rep.	-15.5	-18.6	-9.7	36.7
Japan	-7.9	n.a.	-5.8	44.5

Source: Simulation results.

Table 5.5. China's convergence: effects on China's trade in manufactures

Per cent

	GTAP database: shares of exports by commodity groups 1997	Baseline: shares of exports by commodity groups 2010	China's convergence: Percentage deviation of exports from the baseline 2010
Total exports of manufactures	**86.1**	**91.3**	**47.0**
wearing apparels	11.0	10.6	38.1
manufactures nec	6.8	6.8	35.4
chemical rubber plastic products	13.0	17.9	58.2
electronic equipments	12.9	17.0	55.8
machinery and equipments nec	9.3	9.2	33.4
	GTAP database: shares of total imports by commodity groups 1997	Baseline: shares of total imports by commodity groups 2010	China's convergence: Percentage deviation of imports from the baseline 2010
Total imports of manufactures	**83.4**	**77.9**	**43.3**
wearing apparels	0.9	0.7	26.5
manufactures nec	14.4	13.1	46.9
chemical rubber plastic products	13.3	11.7	51.3
electronic equipments	19.5	15.3	48.9
machinery and equipments nec	1.1	1.2	43.8

Source: GTAP database and simulation results.

Table 5.6. China's convergence: effects on the exports of manufactures

Percentage deviation from the baseline 2010, per cent

	Electronic equipments		Machinery and equipment nec		Chemical, rubber and plastic products	
	Exports to the world	Exports to China	Exports to the world	Exports to China	Exports to the world	Exports to China
China	58.2	n.a.	55.8	n.a.	35.4	n.a.
India	-6.6	62.7	0.8	61.3	5.0	57.8
Indonesia	-10.4	64.5	-1.9	61.7	2.1	53.7
Thailand	-5.3	66.7	0.4	59.5	8.1	50.9
Malaysia	-7.6	63.5	1.8	61.0	8.0	59.2
The Philippines	-9.4	52.8	-2.2	53.0	6.4	43.9
Singapore	-5.0	62.5	-0.8	53.9	4.7	52.4
Korea, the Rep.	-8.3	47.1	0.1	44.0	8.2	35.5
Japan	-3.7	48.5	0.7	49.4	4.9	48.6

Source: Simulation results.

Table 5.7. China's convergence: effects on the imports of manufactures

Percentage deviation from the baseline 2010, per cent

	Electronic equipments		Machinery and equipment nec		Chemical, rubber and plastic products	
	Imports from the world	Imports from China	Imports from the world	Imports from China	Imports from the world	Imports from China
China	51.3	n.a.	48.9	n.a.	46.9	n.a.
India	-1.8	57.0	-4.3	56.4	-2.1	33.7
Indonesia	3.3	58.8	0.1	65.4	-1.4	36.1
Thailand	-3.6	56.3	-0.7	60.7	-0.3	38.4
Malaysia	-3.5	62.3	-0.1	57.8	-0.6	38.3
The Philippines	-5.8	61.8	1.1	51.1	-1.8	34.8
Singapore	-3.4	53.1	-0.3	51.4	0.8	39.0
Korea, the Rep.	-1.7	51.7	-2.5	61.0	4.4	41.4
Japan	13.0	57.2	8.5	45.8	0.2	32.8

Source: Simulation results.

Table 5.8. China's convergence: effects on value added by sectors

Percentage deviation from baseline 2010, per cent

	India	Indonesia	Thailand	Malaysia	The Philippines	Singapore	Korea, the Rep.	Japan
GDP	**-1.1**	**0.0**	**-0.2**	**0.2**	**0.0**	**0.6**	**0.5**	**0.0**
Agriculture	0.2	0.2	0.8	1.5	0.0	0.5	0.1	0.1
Mining	1.9	0.6	0.4	1.4	0.7	n.a.	-0.2	0.1
Manufactures	-1.9	-1.9	-2.1	-3.2	-2.5	-2.4	-0.4	-0.8
Services	-0.9	0.5	0.1	3.2	0.6	1.4	0.4	0.2

Source: Simulation results.

n.a. not applicable.

Table 5.9. China's convergence: effects on GDP and capital stock

Percentage deviation from baseline 2010, per cent

	India	Indonesia	Thailand	Malaysia	The Philippines	Singapore	Korea, the Rep.	Japan
Real GDP	-1.1	0.0	-0.2	0.2	0.0	0.6	0.5	0.0
Capital stock	-1.5	0.0	-0.7	-0.4	0.1	0.1	0.2	-0.1
Employment	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GDP price index	-2.8	1.6	-2.0	-1.1	-0.6	-1.2	-0.1	-0.9
Capital rental	-3.6	-0.9	-2.2	-1.8	-0.7	-1.0	0.2	-1.1
Real wage	-3.0	-2.1	-2.5	-2.5	0.1	0.7	0.0	-0.5
Terms of trade	-3.5	2.8	-1.5	-0.1	-0.9	-0.2	-0.7	-0.8
Rates of return	-0.8	-0.1	-0.4	0.4	0.2	0.7	0.9	0.1

Source: Simulation results.

Table 5.10. China's convergence: effects on real GNP

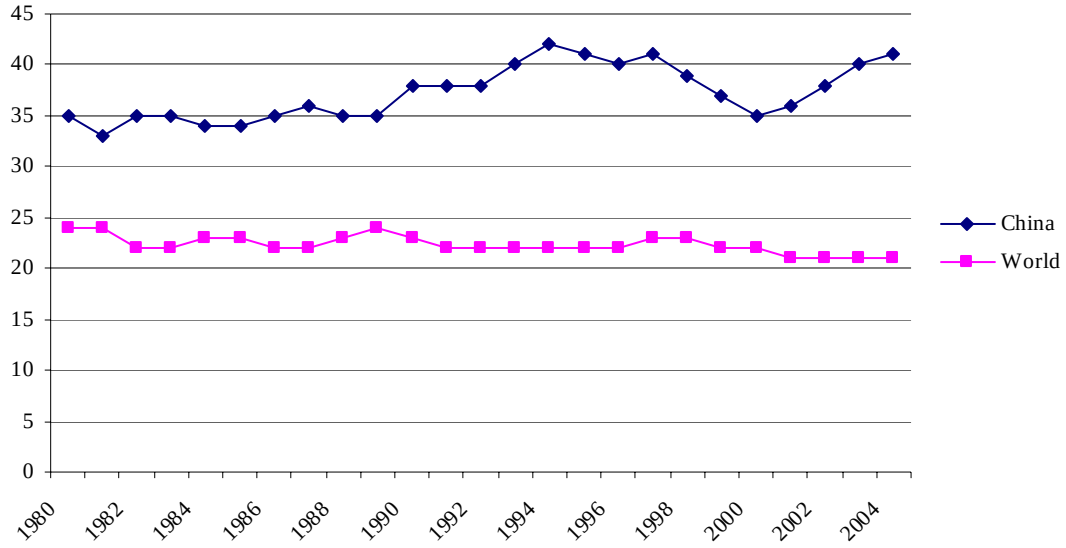
Percentage deviation from baseline 2010, per cent

	Real GDP	Real GNP	Terms of trade
China	52.1	44.2	-10.4
India	-1.1	-1.7	-3.5
Indonesia	0.0	1.1	2.8
Thailand	-0.2	-1.1	-1.5
Malaysia	0.2	0.4	-0.1
The Philippines	0.0	-0.6	-0.9
Singapore	0.6	1.0	-0.2
Australia	0.1	0.4	1.4
Korea, the Rep.	0.5	0.5	-0.7
Japan	0.0	-0.1	-0.8
USA	0.2	0.3	0.5
ROW	0.2	0.9	2.1

Source: Simulation results.

Figure 5.3. China's high gross domestic savings

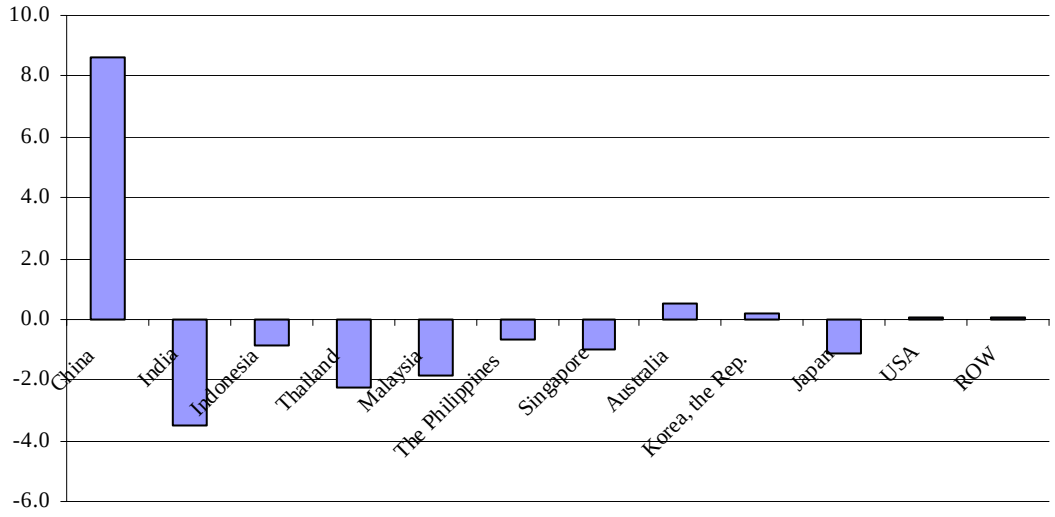
1980-2004 Percent of GDP, per cent



Source: World Bank, *World Development Indicators*.

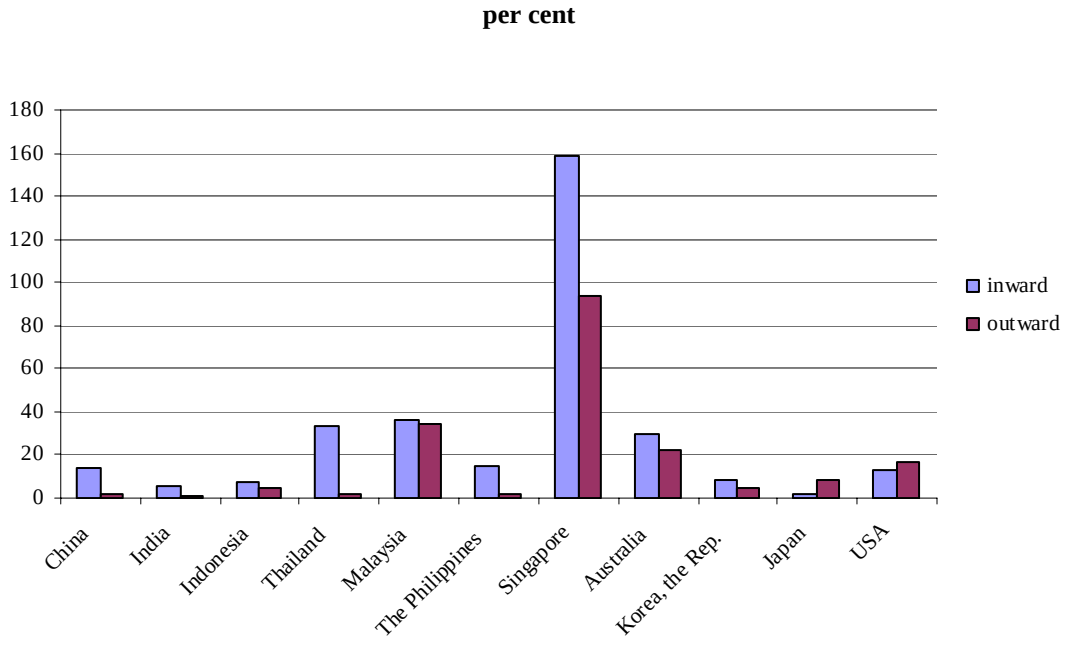
Figure 5.4. China's convergence: effects on rental prices for capital

Percentage deviation from baseline 2010, per cent



Source: Simulation results.

Figure 5.5. Foreign Direct Investment stocks as a percentage of GDP



Source: UNCAD, *World Investment Report*.

Table 6.1. China's convergence with and without changes in user preferences: effects on export volumes

Percentage deviation from the baseline 2010, per cent

	Total volumes of exports		Volumes of exports of manufactures	
	Standard	With a change in user preference	Standard	With a change in user preference
China	45.8	48.1	47.0	49.6
India	0.0	1.1	-1.7	-0.3
Indonesia	-1.8	-0.8	-4.1	-2.5
Thailand	-0.3	0.5	-1.8	-0.6
Malaysia	-1.1	-0.6	-3.1	-2.3
The Philippines	-1.8	-0.8	-6.3	-4.2
Singapore	-0.5	0.2	-2.0	-0.9
Korea, the Rep.	0.7	1.8	0.0	1.2
Japan	2.6	4.1	1.2	3.1

Source: Simulation results.

Table 6.2. China's convergence with and without changes in user preferences: effects on terms of trade

Percentage deviation from the baseline 2010, per cent

	Terms of trade		Export prices		Import prices	
	Standard	With a change in user preference	Standard	With a change in user preference	Standard	With a change in user preference
China	-10.4	-10.2	-8.8	-7.6	1.8	2.8
India	-3.5	-3.2	-1.2	0.0	2.3	3.2
Indonesia	2.8	2.8	4.4	5.4	1.6	2.6
Thailand	-1.5	-1.3	-0.3	0.9	1.2	2.1
Malaysia	-0.1	0.1	-0.2	1.0	-0.1	0.9
The Philippines	-0.9	-0.9	0.0	0.8	0.9	1.8
Singapore	-0.2	-0.2	1.1	2.1	1.3	2.3
Korea, the Rep.	-0.7	-0.3	1.1	2.4	1.8	2.7
Japan	-0.8	-0.4	0.1	1.3	0.9	1.6

Source: Simulation results.

Table 6.3. China's convergence with and without changes in user preferences: effects on export and import prices for manufactures

Percentage deviation from the baseline 2010, per cent

	Export prices for manufactures		Import prices for manufactures	
	Standard	With a change in user preference	Standard	With a change in user preference
China	-9.0	-7.8	0.6	1.8
India	-1.8	-0.5	1.3	2.4
Indonesia	0.4	1.8	1.1	2.2
Thailand	-1.1	0.2	-0.6	0.6
Malaysia	-1.5	-0.2	-0.5	0.7
The Philippines	-1.2	-0.1	-1.1	0.1
Singapore	0.6	1.8	-0.8	0.4
Korea, the Rep.	0.9	2.2	-0.8	0.3
Japan	-0.3	1.0	-2.2	-1.2

Source: Simulation results.

Table 6.4. China's convergence with and without changes in user preferences: effects on real GDP, GNP and terms of trade

Percentage deviation from the baseline 2010, per cent

	Real GDP		Real GNP		Terms of trade	
	Standard	With a change in user preference	Standard	With a change in user preference	Standard	With a change in user preference
China	52.1	52.7	44.2	44.9	-10.4	-10.2
India	-1.1	-0.8	-1.7	-1.5	-3.5	-3.2
Indonesia	0.0	0.1	1.1	1.3	2.8	2.8
Thailand	-0.2	0.1	-1.1	-0.7	-1.5	-1.3
Malaysia	0.2	0.4	0.4	0.8	-0.1	0.1
The Philippines	0.0	0.2	-0.6	-0.5	-0.9	-0.9
Singapore	0.6	0.9	1.0	1.2	-0.2	-0.2
Korea, the Rep.	0.5	0.7	0.5	0.9	-0.7	-0.3
Japan	0.0	0.1	-0.1	0.1	-0.8	-0.4

Source: Simulation results.

Table 7.1. Energy purchases by firms and households in China and Japan

2001, MTOE

	Energy purchases by firms MTOE		Energy purchases by households MTOE		Share of firm purchase in total energy use Per cent	
	China	Japan	China	Japan	China	Japan
coal mining	607.3	100.0	40.6	0.0	93.7	100.0
oil mining	209.5	202.6	0.0	0.0	100.0	100.0
gas mining	11.6	61.6	0.6	4.0	95.1	93.9
petroleum and coal products	266.0	239.5	36.2	50.1	88.0	82.7
electricity generation, distribution	139.9	66.1	22.4	23.1	86.2	74.1
gas manufacture, distribution	18.0	1.6	6.0	3.3	75.0	32.7
total	**1252.3**	**671.3**	**105.8**	**80.4**	**92.2**	**89.3**

Source: GTAP version 6 database.

Table 7.2. Energy purchases by firms per million US dollar GDP

China and Japan, 2001

	Firm's input purchases of energy per million US dollar GDP TOE/US million		Ratio: China to Japan Per cent
	China	Japan	China
coal mining	524.0	23.9	21.9
oil mining	180.8	48.5	3.7
gas mining	10.0	14.7	0.7
petroleum and coal products	229.5	57.3	4.0
electricity generation, distribution	120.7	15.8	7.6
gas manufacture, distribution	15.5	0.4	40.5
total	**1080.5**	**160.7**	**6.7**

Source: GTAP version 6 database.

Table 7.3. China's convergence with and without improvement in input efficiency: effects on terms of trade

Percentage deviation from the baseline 2010, per cent

	Terms of trade		Export prices		Import prices	
	Standard	With improve-ment in input efficiency	Standard	With improve-ment in input efficiency	Standard	With improve-ment in input efficiency
China	-10.4	-10.0	-8.8	-8.7	1.8	1.4
India	-3.5	-3.1	-1.2	-1.2	2.3	1.9
Indonesia	2.8	2.4	4.4	3.7	1.6	1.3
Thailand	-1.5	-1.3	-0.3	-0.4	1.2	0.9
Malaysia	-0.1	-0.1	-0.2	-0.3	-0.1	-0.2
The Philippines	-0.9	-0.7	0.0	-0.1	0.9	0.6
Singapore	-0.2	-0.1	1.1	0.8	1.3	0.9
Korea, the Rep.	-0.7	-0.4	1.1	1.0	1.8	1.4
Japan	-0.8	-0.5	0.1	0.0	0.9	0.5

Source: Simulation results.

Table 7.4. China's convergence with and without improvement in input efficiency: effects on real GDP and GNP

Percentage deviation from the baseline 2010, per cent

	Real GDP		Real GNP		Terms of trade	
	Standard	With improve-ment in input efficiency	Standard	With improve-ment in input efficiency	Standard	With improve-ment in input efficiency
China	52.1	51.9	44.2	44.2	-10.4	-10.0
India	-1.1	-1.0	-1.7	-1.6	-3.5	-3.1
Indonesia	0.0	0.0	1.1	1.0	2.8	2.4
Thailand	-0.2	-0.1	-1.1	-0.9	-1.5	-1.3
Malaysia	0.2	0.2	0.4	0.4	-0.1	-0.1
The Philippines	0.0	0.0	-0.6	-0.4	-0.9	-0.7
Singapore	0.6	0.6	1.0	1.1	-0.2	-0.1
Korea, the Rep.	0.5	0.5	0.5	0.6	-0.7	-0.4
Japan	0.0	0.0	-0.1	0.0	-0.8	-0.5

Source: Simulation results.