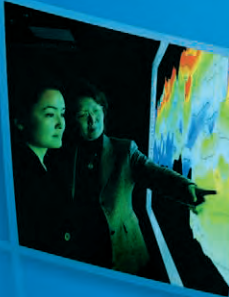




THE WORLD BANK

# Global Economic Prospects



Technology Diffusion in the  
Developing World 2008

# Global Economic Prospects



# Global Economic Prospects

Technology Diffusion in the  
Developing World



2008

© 2008 The International Bank for Reconstruction and Development / The World Bank  
1818 H Street NW  
Washington DC 20433  
Telephone: 202-473-1000  
Internet: [www.worldbank.org](http://www.worldbank.org)  
E-mail: [feedback@worldbank.org](mailto:feedback@worldbank.org)

All rights reserved

1 2 3 4 11 10 09 08

This volume is a product of the staff of the International Bank for Reconstruction and Development / The World Bank. The findings, interpretations, and conclusions expressed in this volume do not necessarily reflect the views of the Executive Directors of The World Bank or the governments they represent.

The World Bank does not guarantee the accuracy of the data included in this work. The boundaries, colors, denominations, and other information shown on any map in this work do not imply any judgement on the part of The World Bank concerning the legal status of any territory or the endorsement or acceptance of such boundaries.

#### **Rights and Permissions**

The material in this publication is copyrighted. Copying and/or transmitting portions or all of this work without permission may be a violation of applicable law. The International Bank for Reconstruction and Development / The World Bank encourages dissemination of its work and will normally grant permission to reproduce portions of the work promptly.

For permission to photocopy or reprint any part of this work, please send a request with complete information to the Copyright Clearance Center Inc., 222 Rosewood Drive, Danvers, MA 01923, USA; telephone: 978-750-8400; fax: 978-750-4470; Internet: [www.copyright.com](http://www.copyright.com).

All other queries on rights and licenses, including subsidiary rights, should be addressed to the Office of the Publisher, The World Bank, 1818 H Street NW, Washington, DC 20433, USA; fax: 202-522-2422; e-mail: [pubrights@worldbank.org](mailto:pubrights@worldbank.org).

ISBN: 978-0-8213-7365-1  
eISBN: 978-0-8213-7366-8  
DOI: 10.1596/978-0-8213-7365-1

ISSN: 1014-8906

Cover photos: Irrigation by Chris Stowers/Panos; Man with Cell Phone by Jacob Silberberg/Panos; Train by Qilai Shen/Panos; Map Projection by Chris Stowers/Panos; and Researcher by Jenny Matthews/Panos.  
Cover design: Critical Stages

<p>The cutoff date for the data used in this report was December 12, 2007. Dollars are current U.S. dollars unless otherwise indicated.</p>
---

---

# Contents

Foreword xi

Acknowledgments xiii

Abbreviations xv

Overview 1

Technological achievement and diffusion in developing countries 2

Some policy directions 13

Note 15

References 15

**Chapter 1 Prospects for Developing Countries 17**

Growth outlook 17

Risks 18

Financial markets: Needed correction or major disruption? 18

Global growth 21

World trade 33

Inflation and commodity markets 36

Risks and uncertainties: Danger of a banking crisis and a U.S. recession 41

Long-term prospects and poverty forecasts 43

Notes 48

References 49

**Chapter 2 Technology and Technological Diffusion in Developing Countries 51**

The role of technology in development 53

Measuring technology in developing countries 58

Evaluating overall technological progress 78

Technological diffusion over the long term 87

Conclusion 92

Technical Annex: Construction of the summary indexes 92

Notes 99

References 101

**Chapter 3 Determinants of Technological Progress: Recent Trends and Prospects 105**

Drivers of technological progress: A framework	107
External transmission channels	109
Nurturing technological adaptive capacity	127
Conclusion	150
Notes	153
References	156

**Appendix: Regional Economic Prospects 165**

East Asia and the Pacific	165
Europe and Central Asia	170
Latin America and the Caribbean	176
Middle East and North Africa	184
South Asia	189
Sub-Saharan Africa	193

**Figures**

1	Robust growth among developing countries should cushion the developed country slowdown	2
2	Scientific innovation and invention is almost exclusively a high-income activity	3
3	Technological achievement: Converging, but the gap remains large	4
4	The penetration of older and more recent technologies depends on more than income	5
5	Technological achievement tends to level off at different income levels in different regions	6
6	Most technologies fail to penetrate deeply into developing economies	7
7	The urban–rural gap in telephone access in India is huge	7
8	Domestic absorptive capacity both conditions and attracts external flows	8
9	Developing countries’ trade in technology goods has risen	10
10	Macroeconomic stability has improved since the early 1990s	11
11	Literacy rates have increased in all regions	12
12	Developing regions have much poorer governance than do OECD countries	13
1.1	The perceived riskiness of high-yield corporate bonds increased more than that of emerging market bonds	19
1.2	Emerging market asset sell-off more severe than during earlier periods of market turbulence	19
1.3	Global equity markets fall, then recover led by emerging markets	20
1.4	A step-down in growth in 2008	21
1.5	Volatile patterns of growth among OECD countries	23
1.6	Tighter credit and weak housing yield slower U.S. growth	23
1.7	Robust growth in developing country industrial production	24
1.8	Developing growth retains strong momentum during the first half of 2007...	26
1.9	...with growth moderating through 2009	26
1.10	East Asia now accounts for one-quarter of China’s imports	27
1.11	External positions vary widely across Europe and Central Asia	27
1.12	Growth eases in 2007 for the Latin America and Caribbean region	28

1.13	Continued oil revenue gains support growth among Middle East and North Africa oil exporters	30
1.14	South Asia growth is slowing as the Indian rupee appreciates	32
1.15	Oil exporters drive 2007 growth results for Sub-Saharan Africa	32
1.16	Weak U.S. growth reduces demand for developing country exports	35
1.17	Export opportunities for high-income countries	35
1.18	U.S. current account narrows over 2007 and is likely to continue doing so	36
1.19	Inflationary pressures are rising in the Middle East and North Africa and Sub-Saharan Africa	37
1.20	Inflation is broadly stable elsewhere, though at high levels	37
1.21	Commodity prices continued gains through 2007 led by metals	38
1.22	Copper, zinc, and aluminum prices sharply affected by China	38
1.23	Growth in the world's demand for oil slows	39
1.24	OPEC reduces output to support prices	39
1.25	Agricultural prices surge over 2006–07	40
1.26	A rise in food prices, led by a ramp-up of the prices of fats, oils, and grains	40
1.27	Long-term growth, 1980–2030	44
1.28	Declining capital-led growth for developed countries, 2002–30	45
1.29	Sustained high productivity growth for developing countries	45
2.1	Patent activity is rising in middle-income countries	61
2.2	Electrical consumption varies markedly even at similar income levels	63
2.3	Rail and road densities rise with income and population density	65
2.4	Telephone densities are highly correlated with income, but air transport is not	66
2.5	The incidence of Internet use varies widely across countries	73
2.6	Logistics performance in the world	77
2.7	Distribution of technological achievement by dimension	80
2.8	Increase in summary technological achievement subindexes, 1990s–2000s	82
2.9	Alternative summary indexes of technological achievement	83
2.10	Technological achievement rises with income levels	84
2.11	Comparison of levels of technological achievement, early 1990s and early 2000s	85
3.1	Domestic absorptive capacity both conditions and attracts external flows	108
3.2	Rising share of high-tech imports	112
3.3	Exports of low-, medium-, and high-technology goods	114
3.4	Share of foreign affiliates in business R&D expenditure	117
3.5	Licensing payments have risen sharply	121
3.6	The brain drain is a severe problem in a number of small countries	123
3.7	Share of Ph.D. students still living in the United States five years after graduation	124
3.8	High-skilled emigrants are disproportionately represented in the diaspora	124
3.9	Most developing countries have increased their exposure to external technology	128
3.10	Number of countries in conflict worldwide	129
3.11	Efficiency of contract enforcement	132
3.12	Developing country governance scores relative to OECD average	132
3.13	Regional averages of six governance indicators	133
3.14	Per capita incomes have accelerated in recent years	134



3.15	Except in Sub-Saharan Africa, life expectancy is improving	134
3.16	Educational expenditures have risen in some regions	137
3.17	Many developing country students fail to meet literacy standards	138
3.18	Levels of intellectual property protection	146
3.19	Level of and recent changes in technological absorptive capacity	149
A1	East Asian growth moves up in 2007	165
A2	Except for China, inflation is now stabilizing across East Asia	166
A3	Performance improves for East Asian countries other than China	169
A4	Mixed growth outturns across Europe and Central Asia	171
A5	External positions vary widely across Europe and Central Asia	171
A6	Growth in Europe and Central Asia eases into 2009	173
A7	Growth outturns were mixed across Latin America in 2007	176
A8	Latin American inflation eases over the last 15 years	177
A9	Latin America and the Caribbean sovereign bond spreads decline, then increase again	177
A10	Growth in Latin America and the Caribbean eases into 2009	179
A11	Financial test: Credit	183
A12	Exchange rate policy dilemmas?	183
A13	Export product (value) concentration is increasing	183
A14	Export market (value) concentration is falling	184
A15	Growth in Middle East and North Africa picks up	184
A16	Hydrocarbon exports continue to rise on higher prices, modest volume gains	186
A17	Tourism and remittances offset widening trade deficits for Maghreb and Mashreq countries	187
A18	Middle East and North Africa equities rebound from the mid-2007 slump	189
A19	South Asian economies ease into 2007	190
A20	Monetary policy is tightened in response to a buildup in inflation	190
A21	Growth in Sub-Saharan Africa has accelerated markedly...	194
A22	...reaching a 35-year high in oil-exporting countries...	198
A23	...and a 10-year high in oil-importing countries	199
A24	Contributions of investment and consumption have increased	199

## Tables

1.1	Gross capital flows to developing countries, 2005–07	20
1.2	The global outlook in summary, 2005–09	22
1.3	Recent economic indicators, developing regions, 2005–07	25
1.4	Developments and prospects for world trade and payments	34
1.5	Poverty in developing countries by region, selected years	46
2.1	Disparity among TFP levels remains wide	54
2.2	Scientific and innovative outputs	61
2.3	Indicators of the diffusion of older technologies	64
2.4	Affordability of fixed-line phones falls rapidly with lower incomes	67
2.5	Immunization rates lag significantly in South Asia and Sub-Saharan Africa	68
2.6	Diffusion of both water and sanitation technology is low in rural areas	69
2.7	Diffusion of recent technologies	72
2.8	Share of high-tech products in total exports	73
2.9	The quality of logistics services in 2005 varies by income	77

2.10	Indicators included in summary indexes of technological achievement	79
2.11	Technological achievement in developing countries relative to that in high-income countries	81
2.12	Increase in technological achievement in developing countries relative to that in high-income countries	81
2.13	Overall technological progress in absolute and relative terms	86
2.14	Successful diffusion has accelerated	88
2.15	The pace at which technology diffuses has picked up among successful adapters	89
2.16	Slow diffusion means that many developing countries never reach the 25 or 50 percent threshold	90
A2.1	Indicators used to calculate the summary indexes and overall index related to technological achievement	95
A2.2	Indicators used to calculate the summary indexes and overall index of technological absorptive capacity	96
A2.3	Share of total variance explained by principal components, technological achievement index	96
A2.4	Share of total variance explained by principal components, technological absorptive capacity index	96
A2.5	Share of total variance explained by principal components for each subgroup of indicators	97
A2.6	Factor loadings and variable weights for technological achievement subgroups	98
A2.7	Factor loadings and variable weights for technological absorptive capacity subgroups	98
A2.8	Share of total variance explained by main principal components of technological achievement and technological absorptive capacity using the sub-indexes	99
A2.9	Factor loadings and variable weights obtained from second-stage principal components analysis (2000–03)	99
3.1	Trade in technology goods has increased in developing countries	111
3.2	Foreign direct investment as a percent of GDP	116
3.3	Foreign direct investment as a percent of fixed capital formation	116
3.4	Selected purchases of high-tech firms by companies in developing countries, early 2000s	121
3.5	Increases in exposure to external technologies index, 1990s to 2000s	129
3.6	Macroeconomic stability has improved in developing countries	130
3.7	The regulatory burden is heavier in developing countries than in the OECD	131
3.8	Educational attainment indicators	135
3.9	Relatively high youth literacy rates	136
3.10	Weak financial intermediation hinders technology in developing countries	139
3.11	R&D intensities have increased	141
3.12	Private-public sector R&D	141
A1	East Asia and Pacific forecast summary	166
A2	East Asia and Pacific country forecasts	168
A3	Europe and Central Asia forecast summary	170
A4	Europe and Central Asia country forecasts	174
A5	Latin America and the Caribbean forecast summary	179
A6	Latin America and the Caribbean country forecasts	180

A7	Middle East and North Africa forecast summary	185
A8	Middle East and North Africa country forecasts	188
A9	South Asia forecast summary	192
A10	South Asia country forecasts	192
A11	Sub-Saharan Africa forecast summary	194
A12	Sub-Saharan Africa country forecasts	195

## Boxes

1	Summary of empirical results	14
1.1	Developing country exports in the wake of the removal of barriers to Chinese exports	31
1.2	Biofuels	41
1.3	Policy responses to rising food prices	42
2.1	Technology can contribute to welfare without affecting measures of short-term output	55
2.2	Technological innovation may spur further innovation in upstream and downstream activities	56
2.3	Promoting appropriate technologies in Rwanda	57
2.4	Shortcomings of available measures of technological achievement	60
2.5	Deepwater petroleum technology in Brazil	62
2.6	The green revolution	68
2.7	Technology and growth in Latin America's natural resource-based economies	71
2.8	Innovative use of communications technology is improving financial access for the poor	75
2.9	The technological divide within India	91
3.1	Technology imports: Different paths for different countries	113
3.2	European call centers in the Maghreb have inspired local entrepreneurs and prompted a specialization in high-value-added services	118
3.3	South African investment in Zambia's retail sector has improved the quality of local produce and farmers' earnings	118
3.4	Wal-Mart's entry in Mexico boosted the Mexican soaps, detergents, and surfactants industry	119
3.5	Technological transfers through the diaspora and return migrants: Some examples	125
3.6	Principal market failures impeding technological progress in developing countries	143
3.7	Government sponsored innovation: Brazilian biofuels	144
3.8	A successful government program of technological development and innovation financing in the Republic of Korea	145
3.9	Technology in 2020	152

---

# Foreword

**E**ACH YEAR, *Global Economic Prospects* explores critical “here and now” economic developments that are relevant to low- and middle-income countries. Past editions have examined the economic implications of international and regional trade liberalization, and migration and remittances. Last year’s report looked at the recent acceleration in growth among developing countries and its sustainability over the longer term.

This year we take a closer look at technology, a critical determinant of sustainable growth and poverty reduction. We do so by directly measuring the extent to which countries use technological inputs (including scientific technologies embodied in goods and services and business processes) and produce technological outputs. The report also examines trends in the major channels through which technology is transmitted internationally, and in the country-specific factors that determine how well it is absorbed domestically.

Encouragingly, this *Global Economic Prospects* finds that, since the early 1990s, technological progress in both low- and middle-income countries has increased more rapidly than in high-income countries. As a result, the level of technology used in developing countries is catching up with high-income countries. However, the technology gap between them remains wide. Globalization has underpinned much of the recent progress by exposing developing countries to foreign technology through imports of high-tech consumption, intermediate and capital goods. Countries

have also benefited from rising levels of foreign direct investment that often brings with it knowledge of important process technologies and foreign markets. Finally, highly skilled international diasporas are exposing developing countries to technology, both through the trade and marketing contacts that they provide to their countrymen and through the return of former émigrés.

Unfortunately, progress in improving the capacity of developing countries to absorb and make use of those technologies throughout their economies has been much weaker. Whether technological progress in developing countries will continue to outpace high-income countries will depend on the improvements in this regard. The main impediments to further progress is not access to technologies, but the weakness of domestic skills and competencies, which prevents many developing countries from exploiting these technologies, and rigidities in the regulatory environment that prevent innovative firms from being created and expanding. The diffusion of technologies within countries is often slow, which means that although some firms may have technologically sophisticated operations, most do not. Moreover, most of the population and most firms operate in a low-tech environment. As a result, despite having technologically sophisticated cities and world-class firms, the economy-wide level of technological achievement in countries like China and India is not very different from that in other countries at similar levels of development.

This report suggests a number of policy directions to bolster technology diffusion and absorption within developing countries. *First*, developing countries should safeguard the principle of openness and actively strengthen skills in the domestic population to ensure that they are able to take advantage of future opportunities. *Second*, to assist diffusion throughout the economy, policy needs to reinforce technological absorptive capacity at the subnational and regional levels and to strengthen dissemination channels within countries, including the outreach, testing, marketing, and dissemination activities of applied R&D agencies. *Third*, authorities should ensure that publicly supplied technological services and technology-enabling infrastructure are widely available, whether they are delivered directly by the state or by private firms. *Fourth*, in low-income countries and in those

middle-income countries with uneven access to quality secondary and tertiary schooling, efforts should concentrate on raising the quality and quantity of schooling.

Finally, governments may need to intervene directly to encourage the rapid diffusion of technology and a domestic culture of “new-to-the-market” innovation. However, caution is required. Although direct interventions have sometimes been associated with some important technology successes, in many instances they have not. Policies that have succeeded have tended to make subsidies conditional on performance and put in place high-quality and independent-of-industry oversight systems.

Alan Gelb  
Acting Senior Vice President and  
Chief Economist  
The World Bank

---

# Acknowledgments

**T**HIS REPORT WAS produced by staff from the World Bank's Development Prospects Group. Andrew Burns was the lead author and manager of the report. The principal authors of chapter 1 were Hans Timmer and Elliot (Mick) Riordan. Chapter 2 was written by Andrew Burns and William Shaw, with written contributions from Antonio David, Yvan Decreux, and Annette De Kleine. Chapter 3 was written by Andrew Burns and William Shaw with written contributions from Dilek Aykut, Antonio David, Yvan Decreux, Annette De Kleine, Mariem Malouche, Sanket Mohapatra, and Olga Sulla. Both Chapters 2 and 3 benefitted from the expert research assistance of Taras Chernetsky, Shuo Tan, and Teng Jiang.

Several people contributed substantively to chapter 1. The Global Trends Team, under the leadership of Hans Timmer, was responsible for the projections, with written contributions from John Baffes, Paul Brenton, Maurizio Bussolo, Betty Dow, Teng Jiang, Annette De Kleine, Donald Mitchell, Denis Medvedev, Gauresh Rajadhyaksha, Elliot (Mick) Riordan, Cristina Savescu, Shane Streifel, and Dominique van der Mensbrugghe. The poverty numbers originated with Shaohua Chen from the Development Research Group.

The accompanying online publication, *Prospects for the Global Economy (PGE)*, was produced by a team led by Cristina Savescu and including Sarah Crow, Teng Jiang, Shunalini Sarkar, and Jennifer Vito, with technical support from Gauresh Rajadhyaksha.

Martha Grotton edited the report, Nigar Farhad Aliyeva and Michael Paul managed the publication process, and Merrell Tuck managed the dissemination activities. Roula Yazigi provided invaluable assistance with the design of some figures. Book production was coordinated by Mary Fisk from the World Bank Office of the Publisher.

The report was produced under the guidance of Uri Dadush, François Bourguignon, and Alan Gelb. Several reviewers offered extensive advice and comments throughout the conceptualization and writing stages. These included Jean-François Arvis, Kevin Barnes, Vandana Chandra, Prof. Carl Dahlman, Mark Dutz, Alan Gelb, Mary Hallward-Dreimeier, Daniel Lederman, Jeffrey Lewis, William Maloney, Claudia Paz Sepulveda, and Alfred Watkins.



---

# Abbreviations

BACI	Banque Analytique de Commerce International (International Trade Analytical Database)
CAGR	compound annual growth rate
CAT scan	computerized axial tomography scan
CEPII	Centre d'Etudes Prospectives et d'Informations Internationales (Institute for Research on the International Economy)
CIS	Commonwealth of Independent States
DAX	Deutsche Aktien Exchange
DJIA	Dow Jones Industrial Average
DPT	diphtheria, pertussis, and tetanus
DSL	digital subscriber ink
EAF	electric arc furnace
EAP	East Asia and the Pacific
ECA	Europe and Central Asia
EMBIG	Emerging Market Bond Index-G
EPO	European Patent Office
EU	European Union
FDI	foreign direct investment
GDP	gross domestic product
GNI	gross national income
HIV/AIDS	human immunodeficiency virus/acquired immune deficiency syndrome
ICB	International Crisis Behavior
IEA	International Energy Agency
IMF	International Monetary Fund
ISO	International Organization for Standardization
LAC	Latin America and the Caribbean
LME	London Mercantile Exchange
MENA	Middle East and North Africa



---

## ABBREVIATIONS

MSCI	Morgan-Stanley Composite Index
NASDAQ	National Association of Securities Dealers Automated Quotations
OECD	Organisation for Economic Co-operation and Development
OHF	open hearth furnace
OPEC	Organization of the Petroleum Exporting Countries
PC	personal computer
PPP	purchasing power parity
R&D	research and development
SAR	South Asia region
SMEs	small and medium enterprises
SSA	Sub-Saharan Africa
TFP	total factor productivity
TOPIX	Tokyo Stock Price Index
UN Comtrade	United Nations Comtrade database
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNIDO	United Nations Industrial Development Organization
USPTO	U.S. Patent and Trademark Office
WTO	World Trade Organization