

INTERNATIONAL
EDITION



Economic Growth

THIRD EDITION

David N. Weil



ALWAYS LEARNING

PEARSON

ECONOMIC GROWTH

THIRD EDITION

DAVID N. WEIL

BROWN UNIVERSITY

INTERNATIONAL EDITION
CONTRIBUTIONS BY ANISHA SHARMA

PEARSON

Boston Columbus Indianapolis New York San Francisco Upper Saddle River
Amsterdam Cape Town Dubai London Madrid Milan Munich Paris Montréal Toronto
Delhi Mexico City São Paulo Sydney Hong Kong Seoul Singapore Taipei Tokyo

AVP/Executive Editor: David Alexander
Senior Editorial Project Manager: Lindsey Sloan
Editorial Assistant: Emily Brodeur
Director of Marketing: Maggie Moylan
Executive Marketing Manager: Lori DeShazo
Marketing Assistant: Kim Lovato
Senior Managing Editor: Nancy H. Fenton
Senior Production Project Manager: Kathryn Dinovo
Publisher, International Edition: Angshuman Chakraborty
Publishing Administrator and Business Analyst, International Edition: Shokhi Shah Khandelwal
Senior Print and Media Editor, International Edition: Ashwitha Jayakumar
Associate Acquisitions Editor, International Edition: Jayashree Arunachalam
Publishing Administrator, International Edition: Hema Mehta

Project Editor, International Edition: Daniel Luiz
Senior Manufacturing Controller, Production, International Editions: Trudy Kimber
Senior Manufacturing Buyer: Carol Melville
Cover Designer: Jodi Notowitz
Cover image: Peter D./Shutterstock.com
Manager, Visual Research: Rachel Youdelman
Photo Researcher: Jorgensen Fernandez
Manager, Rights and Permissions: Michael Joyce
Permissions Specialist, Project Manager: Jill C. Dougan
Media Director: Susan Schoenberg
Executive Media Producer: Melissa Honig
Supplements Editor: Elaine Eusden and Kathryn Dinovo
Full-Service Project Management: Integra
Cover Printer: Courier, Westford

Pearson Education Limited
Edinburgh Gate
Harlow
Essex CM20 2JE
England

and Associated Companies throughout the world

Visit us on the World Wide Web at:

© Pearson Education Limited 2013

The right of David N. Weil to be identified as author of this work has been asserted by him in accordance with the Copyright, Designs and Patents Act 1988.

Authorized adaptation from the United States edition, entitled Economic Growth, 3rd edition, ISBN 978-0-321-79573-1 by David N. Weil published by Pearson Education © 2013.

Microsoft and Windows are registered trademarks of the Microsoft Corporation in the U.S.A. and other countries. This book is not sponsored or endorsed by or affiliated with the Microsoft Corporation.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means, electronic, mechanical, photocopying, recording or otherwise, without either the prior written permission of the publisher or a license permitting restricted copying in the United Kingdom issued by the Copyright Licensing Agency Ltd, Saffron House, 6–10 Kirby Street, London EC1N 8TS.

All trademarks used herein are the property of their respective owners. The use of any trademark in this text does not vest in the author or publisher any trademark ownership rights in such trademarks, nor does the use of such trademarks imply any affiliation with or endorsement of this book by such owners.

Microsoft and/or its respective suppliers make no representations about the suitability of the information contained in the documents and related graphics published as part of the services for any purpose. All such documents and related graphics are provided “as is” without warranty of any kind. Microsoft and/or its respective suppliers hereby disclaim all warranties and conditions with regard to this information, including all warranties and conditions of merchantability, whether express, implied or statutory, fitness for a particular purpose, title and non-infringement. In no event shall Microsoft and/or its respective suppliers be liable for any special, indirect or consequential damages or any damages whatsoever resulting from loss of use, data or profits, whether in an action of contract, negligence or other tortious action, arising out of or in connection with the use or performance of information available from the services.

The documents and related graphics contained herein could include technical inaccuracies or typographical errors. Changes are periodically added to the information herein. Microsoft and/or its respective suppliers may make improvements and/or changes in the product(s) and/or the program(s) described herein at any time. Partial screen shots may be viewed in full within the software version specified.

Microsoft® and Windows® are registered trademarks of the Microsoft Corporation in the U.S.A. and other countries. This book is not sponsored or endorsed by or affiliated with the Microsoft Corporation.

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

10 9 8 7 6 5 4 3 2 1 14 13 12 11 10

Typeset in MinionPro-Regular by Integra.

Printed and bound by Courier Westford in The United States of America

The publisher’s policy is to use paper manufactured from sustainable forests.

PEARSON

ISBN 10: 0-273-76929-4
ISBN 13: 978-0-273-76929-3

To Rachel

BRIEF CONTENTS

Contents 5

Preface 11

About the Author 20

CHAPTER 1	THE FACTS TO BE EXPLAINED	21
CHAPTER 2	A FRAMEWORK FOR ANALYSIS	49
CHAPTER 3	PHYSICAL CAPITAL	68
CHAPTER 4	POPULATION AND ECONOMIC GROWTH	102
CHAPTER 5	FUTURE POPULATION TRENDS	141
CHAPTER 6	HUMAN CAPITAL	170
CHAPTER 7	MEASURING PRODUCTIVITY	199
CHAPTER 8	THE ROLE OF TECHNOLOGY IN GROWTH	221
CHAPTER 9	THE CUTTING EDGE OF TECHNOLOGY	258
CHAPTER 10	EFFICIENCY	288
CHAPTER 11	GROWTH IN THE OPEN ECONOMY	318
CHAPTER 12	GOVERNMENT	350
CHAPTER 13	INCOME INEQUALITY	383
CHAPTER 14	CULTURE	419
CHAPTER 15	GEOGRAPHY, CLIMATE, AND NATURAL RESOURCES	452
CHAPTER 16	RESOURCES AND THE ENVIRONMENT AT THE GLOBAL LEVEL	483
CHAPTER 17	WHAT WE HAVE LEARNED AND WHERE WE ARE HEADED	523

Preface 11
 About the Author 20

CHAPTER 1 THE FACTS TO BE EXPLAINED 21

- 1.1 Differences in the Level of Income among Countries 23
 - BOX: Total GDP versus GDP per Capita 26
- 1.2 Differences in the Rate of Income Growth among Countries 28
 - Growth's Effect on the Level of Income 28
 - BOX: Working with Growth Rates 30
 - Growth during Recent Decades 33
 - BOX: Growth versus Business Cycles 33
 - Growth since 1820 34
 - Growth before 1820 37
 - BOX: Income Inequality between and within Countries 38
 - BOX: Economic Growth as Seen from Outer Space 40
- 1.3 Conclusion 42

APPENDIX Measuring and Comparing GDP Using Purchasing Power Parity 45

CHAPTER 2 A FRAMEWORK FOR ANALYSIS 49

- 2.1 The Economics of Sylvania and Freedonia: A Parable 49
- 2.2 From Parable to Practice 53
 - The Production Function 54
 - From Income Levels to Growth Rates 56
- 2.3 What Can We Learn from Data? 57
 - Scatter Plots and Correlations 58

BOX: Randomized Controlled Trials 62
 BOX: Learning from Historical Data 64

2.4 Conclusion 64

CHAPTER 3 PHYSICAL CAPITAL 68

- 3.1 The Nature of Capital 69
 - 3.2 Capital's Role in Production 71
 - Using a Production Function to Analyze Capital's Role 71
 - BOX: Capital's Share of National Income 74
 - Factor Payments and Factor Shares 74
 - 3.3 The Solow Model 76
 - Determination of Capital per Worker 76
 - BOX: The Rise and Fall of Capital 78
 - BOX: Measuring Change over Time 79
 - Steady States 79
 - BOX: Steady State: A Noneconomic Example 81
 - The Solow Model as a Theory of Income Differences 83
 - The Solow Model as a Theory of Relative Growth Rates 86
 - 3.4 The Relationship between Investment and Saving 88
 - Explaining the Saving Rate: Exogenous versus Endogenous Factors 90
 - The Effect of Income on Saving 91
 - BOX: Government Policy and the Saving Rate 92
 - 3.5 Conclusion 94
 - BOX: The Rise and Fall of Capital Revisited 95
- APPENDIX Further Exploration of the Cobb-Douglas Production Function and the Speed of Convergence in the Solow Model 99

CHAPTER 4
POPULATION AND ECONOMIC
GROWTH 102

- 4.1 Population and Output over the Long Run 104
 - Population over the Long Run 104
 - The Malthusian Model 105
 - BOX: The Power of Population 105
 - The Breakdown of the Malthusian Model 110
 - 4.2 Population Growth in the Solow Model 113
 - Population Growth and Capital Dilution 113
 - A Quantitative Analysis 115
 - 4.3 Explaining Population Growth 117
 - Mortality Transition 118
 - Fertility Transition 120
 - The Interaction of Fertility and Mortality 122
 - 4.4 Explaining the Fertility Transition 125
 - Reduced Fertility: The Means 125
 - BOX: Family-Planning Programs and Their Effects 128
 - Reduced Fertility: The Motives 129
 - 4.5 Conclusion 123
- APPENDIX A More Formal Description of the Total Fertility Rate, Life Expectancy, and Net Rate of Reproduction 127

CHAPTER 5
FUTURE POPULATION
TRENDS 141

- 5.1 Forecasting Population 142
 - Forecasting Mortality 144
 - Forecasting Fertility 145
 - BOX: AIDS in Africa 146
 - BOX: The Tempo Effect 149

- Demographic Momentum 152
- Population in the Very Long Run 153
- BOX: How Many People Can the Earth Support? 154
- 5.2 The Economic Consequences of Demographic Change 156
 - The Slowdown in Population Growth 156
 - Population Aging 158
 - Redrawing the World Map 163
 - BOX: Going for the Gold 165
- 5.3 Conclusion 166

CHAPTER 6
HUMAN CAPITAL 170

- 6.1 Human Capital in the Form of Health 171
 - The Effect of Health Differences on Income 171
 - Modeling the Interaction of Health and Income 174
 - BOX: Health and Income per Capita: Two Views 176
- 6.2 Human Capital in the Form of Education 178
 - Changes in the Level of Education 179
 - BOX: The Economic Effects of Malaria 180
 - Education and Wages 181
 - Human Capital's Share of Wages 183
 - BOX: The College Premium in the United States 184
- 6.3 How Much of the Variation in Income across Countries Does Education Explain? 189
 - A Quantitative Analysis of the Impact of Schooling Differences among Countries 189
- 6.4 Conclusion 196
 - BOX: Human Perfectability and the Growth Slowdown 197

CHAPTER 7 MEASURING PRODUCTIVITY 199

- 7.1 Productivity in the Production Function 200
- 7.2 Differences in the Level of Productivity among Countries 202
 - Measuring Productivity Differences among Countries 203
 - The Contribution of Productivity to Income Differences among Countries 207
 - BOX: Problems with Measuring Capital—and Their Implications for Measuring Productivity 208
- 7.3 Differences in the Growth Rate of Productivity among Countries 212
 - Measuring Countries' Productivity Growth 212
 - The Contribution of Productivity to Growth Differences among Countries 214
- 7.4 Conclusion 216
 - BOX: A Tale of Two Cities 217

CHAPTER 8 THE ROLE OF TECHNOLOGY IN GROWTH 221

- 8.1 The Nature of Technological Progress 222
 - Technology Creation 222
 - Transfer of Technology 223
 - Determinants of R&D Spending 224
- 8.2 Patents and Other Forms of Intellectual Property Protection 226
 - Problems with the Patent System 208
 - Alternatives to Patents 230
- 8.3 Modeling the Relationship between Technology Creation and Growth 231
 - One-Country Model 231
 - Two-Country Model 235
 - BOX: International Technology Transfer 236

- 8.4 Barriers to International Technology Transfer 243
 - Appropriate Technology 244
 - Tacit Knowledge 247
 - BOX: Embodied Technological Progress and Leapfrogging 248
- 8.5 Conclusion 249
- MATHEMATICAL APPENDIX Incorporating Technological Progress into the Solow Model 253

CHAPTER 9 THE CUTTING EDGE OF TECHNOLOGY 258

- 9.1 The Pace of Technological Change 259
 - Technological Progress before the 18th Century 259
 - BOX: Some Milestones of Technological Progress 260
 - The Industrial Revolution 263
 - Technological Progress since the Industrial Revolution 266
- 9.2 The Technology Production Function 268
 - BOX: General-Purpose Technologies 269
 - The Relationship between Technology Level and the Speed of Technological Progress 270
 - BOX: Science and Technology 271
 - Decreasing Returns to Scale in Technology Production 272
 - Implications for the Future of Technological Progress 273
 - BOX: Where Is the Cutting Edge of Technology? 274
- 9.3 Differential Technological Progress 276
 - Differential Technological Progress: Two Theoretical Examples 277
 - Technological Progress in the Real World: Goods versus Services 278
 - Technological Progress in the Real World: Information Technology 279
 - BOX: Predicting Technological Progress 280

9.4 Conclusion 282

MATHEMATICAL APPENDIX An Improved Version of
the Technology Production Function 286

CHAPTER 10
EFFICIENCY 288

10.1 Decomposing Productivity into
Technology and Efficiency 289

Analyzing Cross-Country Data 290

10.2 Differences in Efficiency:
Case Studies 293

Central Planning in the Soviet Union 293

Textiles in 1910 294

Differences in Productivity within an Industry 296

Subsurface Coal Mining in the United States,
1949–1994 298

10.3 Types of Inefficiency 300

Unproductive Activities 300

Idle Resources 301

Misallocation of Factors among Sectors 302

Misallocation of Factors among Firms 308

Technology Blocking 309

BOX: Finance and Growth 310

10.4 Conclusion 314

CHAPTER 11
GROWTH IN THE OPEN
ECONOMY 318

11.1 Autarky versus Openness 318

Measuring Output in an Open Economy 320

Globalization: The Facts 320

Globalization: The Causes 322

BOX: Tariffs, Quotas, and Other Trade
Restrictions 325

11.2 The Effect of Openness on
Economic Growth 326

Growth in Open versus Closed
Economies 327

How Changes in Openness Affect
Growth 328

The Effect of Geographical Barriers to
Trade 330

11.3 Openness and Factor
Accumulation 331

Growth with Capital Mobility 332

Assessing the Free-Capital-Flow
Model 334

11.4 Openness and Productivity 336

Trade as a Form of Technology 337

BOX: The Rise and Fall of Consolidated
Alchemy 338

Openness and Technological
Progress 339

Openness and Efficiency 340

11.5 Opposition to Openness 342

BOX: Anti-Globalization 344

11.6 Conclusion 346

CHAPTER 12
GOVERNMENT 350

12.1 Defining Government's Proper
Role in the Economy 353

The Case for Government Intervention
in the Economy 353

The Case against Government Intervention
in the Economy 355

Swings of the Pendulum 356

12.2 How Government Affects
Growth 357

Rule of Law 357

Taxation, Efficiency, and the Size of
Government 359

Planning and Other Industrial
Policies 363

BOX: The Other Path 364

BOX: Planning Is Not Always a Failure 365

Civil Conflict 366

12.3 Why Governments Do Things That
Are Bad for Growth 368

Some Other Goal 368

Corruption and Kleptocracy 369

Self-Preservation 370

BOX: Government Regulation: Helping Hand
or Grabbing Hand? 372

12.4 Why Poor Countries Have Bad Governments 373

Causation Running from Income to Government Quality 374

BOX: Democracy and Economic Growth 376

Causation Running from Government Quality to Income 378

12.5 Conclusion 379

CHAPTER 13 INCOME INEQUALITY 383

13.1 Income Inequality: The Facts 384

Using the Gini Coefficient to Measure Income Inequality 385

The Kuznets Hypothesis 388

BOX: Is Growth Good for the Poor? 391

13.2 Sources of Income Inequality 393

Explaining the Recent Rise in Income Inequality 398

13.3 Effect of Income Inequality on Economic Growth 400

Effect on the Accumulation of Physical Capital 400

Effect on the Accumulation of Human Capital 401

Income Inequality, Income Redistribution, and Efficiency 404

Sociopolitical Unrest in Response to Income Inequality 408

Empirical Evidence 409

13.4 Beyond Income Distribution: Economic Mobility 412

13.5 Conclusion 416

CHAPTER 14 CULTURE 419

14.1 The Effect of Culture on Economic Growth 420

Openness to New Ideas 420

Hard Work 422

Saving for the Future 423

Trust 424

BOX: What Parking Tickets Say about Culture 425

BOX: Pitfalls of Cultural Explanations for Economic Growth 427

Social Capital 428

BOX: Importance of Social Capital at the Village Level 430

Social Capability 431

BOX: Changes in Appropriate Culture 434

14.2 What Determines Culture? 436

Climate and Natural Resources 436

Cultural Homogeneity and Social Capital 437

Population Density and Social Capability 440

14.3 Cultural Change 442

BOX: Determinants of Cooperation: An Experimental Approach 443

Economic Growth and Cultural Change 444

Government Policy and Cultural Change 445

Media and Cultural Change 447

14.4 Conclusion 448

CHAPTER 15 GEOGRAPHY, CLIMATE, AND NATURAL RESOURCES 452

15.1 Geography 453

Location, Trade, and Growth 454

BOX: Guns, Germs, and Geography 456

Geographic Concentration and Spillovers 458

Geography's Effect on Government 458

15.2 Climate 462

Climate and Agricultural Productivity 464

Climate and Disease 466

Climate and Human Effort 469

15.3 Natural Resources 470

The Relationship between Natural Resources and Growth 470

Explanations for the Resource Curse 473

15.4 Conclusion 478

BOX: Resources and Early Industrial Development: The Case of Coal 480

CHAPTER 16
RESOURCES AND THE
ENVIRONMENT AT THE GLOBAL
LEVEL 483

16.1 Natural Resource Concepts 484

Nonrenewable Resources 484

Renewable Resources 487

Property Rights over Resources 489

Resources and Production 491

16.2 Incorporating Natural Resources
into the Analysis of Economic
Growth 493

BOX: Resource Disasters 494

Revising National Accounts 496

Resource Prices 498

BOX: The Bet 502

Why Resource Limitations Do Not Prevent
Economic Growth 502

BOX: Resource-Saving Technologies 506

16.3 Growth and the Environment 506

The Environmental Kuznets Curve 508

BOX: The Environmental Kuznets Curve in
London 510

Global Warming 512

16.4 Conclusion 516

APPENDIX Technological Improvement versus
Resource Depletion 520

CHAPTER 17
WHAT WE HAVE LEARNED
AND WHERE WE ARE
HEADED 523

17.1 What We Have Learned 523

Factor Accumulation 523

Productivity 524

Fundamentals 526

17.2 What the Future Holds 527

BOX: Will Growth Make Us
Happy? 528

What Will Happen to the World
Income Distribution? 531

Will Technological Progress Continue
Apace? 531

What Is the Future of World
Demographics? 532

Will Global Economic Integration
Continue? 532

Will Shortages of Natural Resources
Constrain Economic Growth? 533

17.3 A Final Thought 533

References 534

Glossary 550

Index 556

Credits 576

NEW TO THIS EDITION

The world economy is evolving rapidly, as is research in the field of economic growth. I have updated the textbook to reflect changes in both dimensions.

- There has been a massive updating of data used throughout the book. Data on gross domestic product (GDP) is now from the Penn World Tables, version 7.0. The period of analysis on which I focus in the first seven chapters of the book is now 1975–2009 (the period was 1960–2000 in the first edition and 1970–2005 in the second edition). Data on human capital, mobility, inequality, and many other variables have been updated by using new or more current sources. Additionally many other historical time series have been extended for additional years.
- Material on randomized controlled trials (RCTs) has been inserted systematically throughout the book, starting with a discussion of RCTs in the context of inference in Chapter 2 and then followed up with examples of the use of RCTs in research in Chapters 4 and 6, as well as discussion of RCTs in several end-of-chapter problems.
- A new section (in Chapter 12) discusses civil violence and its relationship to growth.
- A new section (in Chapter 8) examines patents and other forms of intellectual property protection.
- The discussion of the Easterlin paradox (Chapter 17) has been completely revised to reflect the conclusions from new research.
- New data has been added on intergenerational mobility in the United States, comparisons of mobility across countries, and differing perceptions of mobility.
- New research on the role of media in affecting social capital and cultural attitudes toward fertility and women is presented in Chapter 14.
- New material has been added on government-owned banks, peak oil, natural resource prices, how the correlation of firm productivity with size varies across countries, and the Extractive Industries Transparency Initiative, as well as a new figure on global temperatures.

In addition to these larger additions, there are dozens of other places throughout the book where new research findings are brought to bear as part of the narrative. Innumerable bits of information that appear throughout the text have been updated. Recent events, such as the great recession of the late 2000s, have been incorporated as well.

ECONOMIC GROWTH AS A FIELD OF STUDY

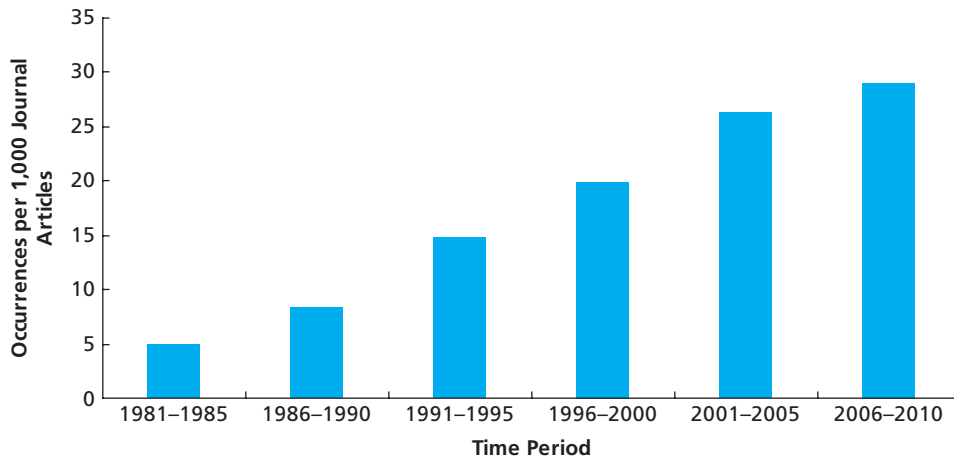
Economic growth is a compelling topic. You cannot read the newspaper or travel to other parts of the world without wondering why differences in standards of living among countries are so large. You cannot help but marvel at how more than a billion people in China are leaping out of poverty within a generation, whereas the incomes of hundreds of millions of others elsewhere in the world have stagnated. It is impossible not to wonder whether our grandchildren will be as rich compared to us as we are compared to our grandparents.

Economists have been thinking about these issues for a long time. The puzzle of why some countries are economically more successful than others is right there in the title of Adam Smith's *Inquiry into the Nature and Causes of the Wealth of Nations* (1776). The questions of why some countries are rich and others poor, and why some countries grow quickly and others slowly, never disappeared as a part of economic investigation, but in the period after World War II, they were divided among several different fields. The formal theory of economic growth became part of macroeconomics; the study of poor countries became the field of economic development; productivity growth was part of industrial organization; and the study of how the currently wealthy countries came to be that way was subsumed in economic history.

Over the past three decades, economic growth has reemerged as an independent field. To see how rapidly the field has expanded, look at the figure on page xiii, which shows how frequently the phrase *economic growth* has appeared in the titles or abstracts of journal articles in the Econlit database from 1981 to 2010. Over that period, the frequency has grown sixfold. This rise in the number of journal articles has been matched by a rise in graduate courses on the topic and by a rise in the number of researchers working in the area. A generation of Ph.D. economists now works on economic growth as a field in its own right rather than as a piece of some other field.

The melding of disparate lines of research into the single field of economic growth has been one of the most exciting intellectual developments in economics over the past three decades. But there has been more than a rearrangement of intellectual cargo. New theoretical tools, new data, and new insights have been brought to bear on the old questions of why some countries are richer than others and why some countries grow more quickly than others. Of particular importance has been the application of new data that put empirical flesh on a skeleton built of both old and new theories.

Frequency of the Phrase “Economic Growth” in Journal Article Titles or Abstracts



GOALS AND INTENDED AUDIENCE

This book is my attempt to synthesize the burgeoning literature in economic growth. Recent research has produced a vast quantity of new examples, data sets, and analytic perspectives. The organization of this new material into a coherent intellectual structure not only makes it easier for students to assimilate but also suggests new avenues for future research.

Beyond synthesizing a wide range of literature, I have sought to present research on economic growth in a form easily accessible to a broad audience. The book requires no more background than a course in principles of economics and uses no calculus in the main body of the text. (However, mathematical chapter appendixes and a series of advanced modules available for download from the Web site allow for a more rigorous presentation for teachers who are so inclined.) The book is optimally suited for the following courses:

- ***An Undergraduate Course in Economic Growth*** Many faculty whose research centers on growth have not been able to teach an undergraduate course in their area of interest because they have been reluctant to undertake all the work necessary to translate professional-level research for an undergraduate audience. Now they can.
- ***An Undergraduate Course in Economic Development*** Many development economists will find that this textbook fits perfectly with their perspective,

including standard models and results that are drawn from single-country microeconomic data sets. Indeed, this sort of development economist might find that the current book better matches his or her perspective than do textbooks that have “Economic Development” in their titles. This third edition of the book moves a step closer to the current trend in development economics by integrating discussion of randomized controlled trials and natural experiments into the text.

- ***Advanced Macroeconomics*** Macroeconomists might want to use the book as part of an Advanced Macroeconomics course that would cover growth as well as other research topics in macroeconomics.
- ***Applied Econometrics*** The book, along with the online data set and the extensive online Lab Exercises by Ann Owen of Hamilton College, can be used as the basis for an Applied Econometrics course using either Stata or Excel.
- ***Development Studies, Development Policy, or Public Policy*** With suitable supplements, the book is appropriate as part of a broader course in development studies, development policy, or public policy at the undergraduate or M.A. level.
- ***Ph.D. Courses*** For Ph.D.-level courses in economic growth, economic development, and macroeconomics, this book can serve as a quick, broad introduction to the literature and key issues. It also provides a coherent framework in which students as well as professors can locate their own research.

CONTENT AND ORGANIZATION

Following the first part’s two introductory chapters, which describe the facts to be explained and define the book’s approach, there are three substantive parts:

- ***Factor Accumulation (Chapters 3–6)***
These chapters examine physical capital, human capital (including both education and health), and population growth and explore the degree to which income variation among countries can be explained by variations in factor accumulation, as well as the determinants of factor accumulation itself. They heavily emphasize quantitative analysis of the role of factors of production in determining output.
- ***Productivity (Chapters 7–11)***
These chapters begin with a development accounting exercise in Chapter 7, showing the importance of variations in the level and growth rate of productivity in explaining cross-country differences in the level and growth rate of income. Chapters 8 and 9 then analyze technology, the former looking

primarily at cross-country differences in the level of technology and the latter focusing on the determinants of progress at the cutting edge of technology. The last two chapters, 10 and 11, examine how institutions and openness to the world economy affect the efficiency with which the economy operates.

- ***Fundamentals (Chapters 12–16)***

These five chapters probe into the deeper determinants that underlie differences in factor accumulation and productivity among countries. Included here are government, income inequality, culture, geography, climate, and natural resources.

This approach of beginning with proximate determinants of income variation and then digging down to see what deeper factors explain these proximate determinants enables undergraduates to assimilate a good deal of information and analysis while retaining a clear structure in their minds. The approach also (not coincidentally) replicates the way in which the field of economic growth has evolved over the past 30 years: Growth economists have shifted their focus from factor accumulation to technology to nontechnological aspects of productivity, and finally to searching for the deeper factors that underlie all of the more proximate determinants of growth.

ALTERNATIVE SYLLABI

Teachers with an interest in the more formal aspects of growth theory might want to skip some or all of the chapters on fundamentals in the last third of the book. They also might want to focus more on the chapter appendixes, as well as the more advanced mathematical modules available on the Web site.

Teachers with a particular interest in development policy will find the Fundamentals chapters of the book, along with components of the Productivity chapters (particularly Chapters 10 and 11, respectively, on efficiency and openness) to be most important. They might want to cover Chapters 3 and 7–9 quickly.

Teachers looking to cut out technical material can excise one or both of the following blocks of material without compromising the structure of the book as a whole: (1) the Solow model and its quantitative implications: all of Chapters 3 and 7, along with Section 4.2, the first part of Section 5.2, and Section 6.3; (2) formal models of technological progress and spillovers: Section 8.3 and all of Chapter 9.


Chapter 5, on future population trends, stands largely on its own and can be skipped without a loss of continuity. Chapter 16, on resources and environment at the world level, is also something of a stand-alone chapter and can be omitted.

Many faculty might want to proceed slowly, giving their students empirical assignments using the data analysis facility on the Web site and the Lab Exercises by Ann Owen as well as the many data sources with links on the Web site.

KEY FEATURES

- **Rich Data** Data from a large cross-section of countries, on attributes ranging from desired fertility to disease environment to rule of law to income inequality, are used to motivate and illustrate the models presented in the book. In addition, extensive use is made of results drawn from household and village-level data, including randomized trials and natural experiments.
- **Robust Theoretical Framework** A simple yet robust theoretical framework helps students to conceptualize how the different factors that affect growth fit together as part of the overall story.
- **Quantitative Orientation** Throughout the text, students are shown how to go beyond thinking, “Does x affect growth?” to ask, “*How much* does x affect growth?”
- **Up-to-Date Content** The text includes the latest research in this rapidly developing field. The data in the tables and figures are the most recent available.

PEDAGOGICAL AIDS

- Chapter 2 lays out the book’s structure in the form of a vivid parable. Chapter introductions remind students of the book’s overall organization.
- Numerous special-topic boxes in each chapter present self-contained examples or discussions of research.
- Several mathematical chapter appendixes provide more rigorous derivations and extensions of material in the book.
- Each chapter ends with Key Terms, Questions for Review, and Problems. Special icons in the margin identify problems requiring a computer or calculator  and those requiring calculus $\int dy/dx$.
- A Glossary at the end of the book defines all the Key Terms and provides handy page references.

ADDITIONAL RESOURCES AVAILABLE ONLINE

The Web site that accompanies this book, www.pearsoninternationaleditions.com/weil, has a number of features to enrich students’ experience of the course. These features include a Data Plotter, Lab Exercises written by Ann Owen of Hamilton College, Further Readings, Web Links, and PowerPoint Slides containing all figures and tables in the text.

For instructors only, an online *Instructor's Solutions Manual* accompanies the text. Written by author David N. Weil, the online *Instructor's Solutions Manual* contains the solutions for all the problems in the text. This new edition of the instructor's manual will include additional problems for professors to assign, as well as their solutions. It is available for download on the Instructor's Resource Center, www.pearsoninternationaleditions.com/weil.

ACKNOWLEDGMENTS

I had a lot of help in writing this book. Colleagues at Brown, notably Oded Galor, Peter Howitt, Ross Levine, Louis Putterman, Herschel Grossman, Enrico Spolaore, Vernon Henderson, Andrew Foster, Toby Page, and Susan Short, were generous with their time and insight. I also received extremely useful input from colleagues elsewhere, including Victor Lavy, Joram Mayshar, Omer Moav, and Avi Simchon (all of Hebrew University), Philippe Aghion (Harvard University), Elise Brezis (Bar Ilan University), Yaakov Khazanov (Ben Gurion University), Jong-Wha Lee (Korea University), Kevin O'Rourke (Trinity College, Dublin), Steve Parente (University of Illinois), Michael Spagat (Royal Holloway University of London), Joakim Stymne, and Chris Weber (Seattle University). Greg Mankiw taught me how to do economic research and served as a model for textbook writing. Several generations of Brown graduate students were drafted as research assistants, reviewers, or both, including Arendam Chanda, Sebnem Kalemli-Ozcan, James Feyrer, Lennart Erickson, Michal Jerzmanowski, Phil Garner, Chad Demarest, Jeff Brown, Malhar Nabar, Adrienne Lucas, Doug Park, Alaka Holla, Ishani Tewari, Joshua Wilde, Isabel Tecu, Momotazur Rahman, and Adam Storeygard. I benefited from the labor of a series of undergraduate research assistants, including Thomas Benson, Susan Gunasti, Nick Advani, Saranga Sangakkara, Nathan Marcus, Khang Nguyen, Gauri Kartini Shastry, Ameya Balsekar, Jessica Yonzon, Jeffrey Kang, and Mary Bryce Millet. Students at Brown, Harvard, and Hebrew universities had the dubious pleasure of seeing me teach this material out of early drafts. In putting together the third edition, I was aided by the superlative team of Fatima Aqeel, Martin Fiszbein, Evan Friedman, and Daniel Prinz.

I also received crucial input from the following reviewers who provided detailed comments:

Daron Acemoglu, *Massachusetts Institute of Technology*
Marcellus Andrews, *Columbia University*
Susanto Basu, *Boston College*
Charles Bischoff, *Binghamton University*
Henning Bohn, *University of California, Santa Barbara*
Patrick Coe, *Carleton University*
Steve Colt, *University of Alaska, Anchorage*
Brad DeLong, *University of California, Berkeley*

Eric Fisher, *California Polytechnic State University*
Terry Fitzgerald, *Federal Reserve Bank of Minneapolis*
Gerhard Glomm, *Indiana University*
Jonathan Houghton, *Suffolk University*
Harvey James, *University of Missouri, Columbia*
Louis D. Johnston, *College of Saint Benedict, St. John's University*
Barry Jones, *Binghamton University*
Garett Jones, *George Mason University*
John Keating, *University of Kansas*
Louise Keely, *University of Wisconsin, Madison*
Peter Klenow, *Stanford University*
Steve Knack, *The World Bank*
Gregory A. Krohn, *Bucknell University*
Jong-Wha Lee, *Korea University*
Ross Levine, *University of California, Berkeley*
Bernard Malamud, *University of Nevada, Las Vegas*
Jenny Minier, *University of Kentucky*
Olivier Morand, *University of Connecticut, Storrs*
Malhar Nabar, *Wellesley College*
Ann Owen, *Hamilton College*
Chris Papageorgiou, *International Monetary Fund*
Pietro Peretto, *Duke University*
Diego Restuccia, *University of Toronto*
James Robinson, *Harvard University*
David Romer, *University of California, Berkeley*
William Seyfried, *Rollins College*
Peter Solar, *Vesalius College*
Kevin Sylwester, *Southern Illinois University, Carbondale*
Robert Tamura, *Clemson University*
John Tang, *Australia National University*
Jonathan Temple, *University of Bristol*
Akila Weerapana, *Wellesley College*
Larry Westphal, *Swarthmore College*
Mark Wright, *University of California, Los Angeles*
Randall Wright, *University of Wisconsin*
Darrell Young, *University of Texas, Austin*
Lester A. Zeager, *East Carolina University*

Beyond these specific people who provided direct input, I also owe a general debt of gratitude to the large group of scholars working on growth. Over the past

25 years, I have been privileged to do my research in an area where (as Alfred Marshall wrote) “good work is rightly appreciated, invention and improvements... have their merits promptly discussed: If one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas.” Many of the ideas presented in this book are distilled from the informal haze that circulates in the air of conferences and seminars. The National Bureau of Economic Research deserves special mention as the location of so many illuminating gatherings.

I am also indebted to several teachers (and their students) who enthusiastically used drafts of the manuscript as the basis for their courses. The reaction of those actively teaching and learning from the material provided unique “from-the-trenches” input that helped me improve the presentation in many ways. I thank Shankha Chakraborty (University of Oregon), Patrick Coe (Carleton University), Terry Fitzgerald (Federal Reserve Bank of Minneapolis), Barry Jones (Binghamton University), Ann Owen (Hamilton College), Peter Solar (Vesalius College), and Robert Tamura (Clemson University).

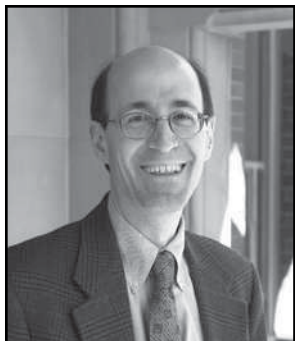
Working with the people at my publisher has been a great experience. I continue to be grateful to those who worked with me on the first edition. Many thanks to my editors Sylvia Mallory and Jane Tufts, Denise Clinton, Nancy Fenton in production, Gina Hagen Kolenda for the design, Melissa Honig for the Web site, and Heather Johnson at Elm Street Publishing Services. For the second edition, there was another great team headed by my editor Noel Seibert. Kathryn Dinovo oversaw the production process that time around, Emily Friel at Elm Street Publishing Services gave the second edition a wonderful design, and Kim Nichols at Elm Street Publishing Services handled production tasks. For the third edition, I’d like to thank Lindsey Loan, my editorial project manager, and Kathryn Dinovo for her management of the production process. I’d also like to thank Kristin Jobe at Integra (formerly Elm Street Publishing Services).

My deepest thanks go to my wife and colleague, Rachel Friedberg. It was Rachel who first encouraged me to produce something beyond the standard output of journal articles. She contributed to every stage of this project, but readers of the book should particularly thank her for the pages of showy technique and pointless diversions that they do *not* see as a result of her comments. More important from my perspective, Rachel built with me a happy marriage and household and also gave birth to our three children during the five years that it took me to gestate this one book.

–D.N.W.

The publishers wish to thank Subhankar Dutta of Amity Global Business School, Kolkata, for reviewing the content of the International Edition.

ABOUT THE AUTHOR



David N. Weil is the James and Merryl Tisch Professor of Economics at Brown University and a Research Associate of the National Bureau of Economic Research and Brown's Population Studies and Training Center. He received his B.A. in History from Brown in 1982 and his Ph.D. in Economics from Harvard in 1990. He has written widely on various aspects of economic growth, including cross-country empirics, accumulation of human and physical capital, appropriate technology, fertility, migration, habit formation, health, and the use of satellite data to measure income, as well as on such nongrowth topics as demographic economics, Social Security, monetary policy, and portfolio allocation. He has held visiting faculty positions at Harvard University and Hebrew University. He is coeditor of the *Journal of Development Economics* and codirector of the NBER project on the Causes of African Development Successes.

THE FACTS TO BE EXPLAINED

We live in a world of rich and poor. The 7 billion people who inhabit the earth exist under a vast range of economic circumstances. In the developing countries, 925 million people do not have enough food to eat, 884 million do not have access to safe drinking water, and 2.5 billion have no access to sanitation. Roughly 5,000 children under the age of five die every day from diseases caused by contaminated water. At the other extreme, among the industrialized countries, diseases caused by too much food have replaced those caused by too little as a major health problem. Life expectancy at birth is 76 years among the 2.1 billion people living in countries classified by the United Nations (UN) as having high human development, 69 years for the 3.6 billion people living in countries with medium human development, and 56 years for the 1.1 billion in countries with a low level of human development.¹

Even when we look beyond these life-and-death matters, the differences in people's living standards are striking. In 2008 there were 687 passenger cars for every 1,000 people in Australia. The corresponding figure for Bangladesh was 2. Sub-Saharan Africa, with 11% of the world's population, accounted for 2.3% of world electricity use in 2003. The United States, with 4.6% of the world's population, accounted for 26%. The fifth of the world that lives in the richest countries receives 60% of the world income. The World Bank estimates that 1.1 billion people survive on incomes of less than one dollar per day, and 2.6 billion live on less than two dollars per day.²

These differences among countries pose a mystery. Why are some countries so rich and others so poor? Does it have to be this way? Are there factors that we can point to (and perhaps change) that lead to these enormous gaps? Does the enjoyment of the rich somehow depend on the continued suffering of the poor?

Science is built up of facts, as a house is with stones. But a collection of facts is no more a science than a heap of stones is a house.

—Henri Poincaré

¹United Nations (2010), <http://www.wfp.org/hunger>; <http://www.unicef.org/wash/>, <http://www.unicef.org/wash/>, <http://www.unep.org/Documents.Multilingual/Default.asp?DocumentID=617&ArticleID=6505&l=en>.

²United Nations (2006).

When we look at how countries have developed over time, a second set of mysteries emerges. Comparing wealthy countries today to their own history, there is once again an immense difference in living standards. A Japanese baby born in 1880 had a life expectancy of 35 years; today life expectancy in Japan is 83 years. In Great Britain, the average height of men rose 9.1 centimeters (3.6 inches) between 1775 and 1975 as a result of better nutrition. In 1958, a worker in the United States earning the average wage had to labor 333 hours to buy a refrigerator; today a worker can earn enough to buy a better product in one-fifth as much time. Since the late 19th century, the fraction of their income that Americans spend on recreation has tripled, while the fraction spent on food has fallen by two-thirds.³

This growth in material wealth has been accompanied by a sharp reduction in the amount of work that people have to do. In the United States in 1870, the average workweek was 61 hours, and the concept of retirement in old age was almost unheard of. Today the average workweek is 34 hours, and the typical worker can expect to experience a decade of leisure in retirement.⁴

Even countries that today are relatively poor enjoy living standards that, prior to the last 100 years, were without precedent anywhere. Egypt, Indonesia, and Brazil currently have higher life expectancy than did members of the British nobility at the beginning of the 20th century. For most of human history, something as simple as a reading light at night was a luxury reserved for the very wealthy. Today, 79% of the world's population has access to electricity at home.⁵ The fraction of the world's population with income of less than one dollar per day fell by half between 1981 and 2002. In China alone, the number of people with income of less than one dollar per day fell by 200 million during this period.⁶

For most of the world, the last half-century has seen an unprecedented rise in living standards. In the richest countries, this rise has been going on for more than a century, leading to the impression that economic circumstances should always be getting better. But what is the source of this growth?

When we compare growth in different countries, more questions emerge. Some countries have grown along largely parallel tracks. For example, Britain and France have had roughly comparable living standards for centuries. Some countries, such as Argentina—which was one of the wealthiest countries in the world at the beginning of the 20th century—have failed to keep up with the pack. Others, such as Japan, were for a long time far poorer than the world's leaders but then experienced great bursts of growth and caught up. In the

³Costa (2000), Federal Reserve Bank of Dallas (1997).

⁴Cox and Alm (1999).

⁵Baumol and Blinder (1997), <http://www.iea.org/weo/electricity.asp>

⁶World Bank (2002).

post-World War II era, these explosions of miraculous growth became increasingly dramatic, with countries such as South Korea making the transition from pauper to industrial power in a single generation. Still other countries have thus far been immune to the contagion of growth and have remained desperately poor. The average African household, for example, consumed 20% less in 1998 than it did 25 years previously. What differences among countries have led to these divergent experiences?

A final question raised by these observations of growth is: Where is this all leading? Will the richest countries in the world continue to grow richer, so that our grandchildren will look back in amazement at the primitive circumstances in which we lived? Will the poor countries continue to trail far behind the richest ones, or will the gaps between rich and poor close? In the face of declining stocks of natural resources, some observers have argued that even the richest countries will have to cut back on their consumption. Will limitations on resources make it impossible for the four-fifths of the world's population still living in relative poverty to catch up? Or will new technologies allow the human race to leave behind the state of want that has been its lot for almost all of history?

This book is an attempt to grapple with the questions of why countries differ in their standards of living and why countries grow richer or fail to grow richer over time. The rest of this chapter lays out in greater detail the scope of the facts to be explained. We first look at differences among countries in their *levels* of income and then examine national differences in the *growth rate* of income. As we will see, there is a close link between these two measures: Countries that are rich today are precisely those that have grown quickly and for a longer period of time in the past.

1.1 DIFFERENCES IN THE LEVEL OF INCOME AMONG COUNTRIES

We begin by examining differences in economic status among countries. Our focus will be on **gross domestic product (GDP)**, which is a measure of the value of all of the goods and services produced in a country in a year. GDP can be calculated as either the value of the output produced in a country or equivalently as the total income, in the form of wages, rents, interest, and profits, earned in a country. GDP is thus also known as *output* or *national income*, and these terms are used as synonyms for GDP throughout this book.

Using GDP to measure a country's well-being is not without its problems. Many aspects of economic well-being are not measured by GDP, and there are serious conceptual and practical problems in measuring and comparing GDP across countries or in a single country over time. Despite these drawbacks, however, GDP remains a rough-and-ready measure of standard of living. Where possible, we



A typical Malian family with their possessions.

will flesh out data on GDP with other measures of economic well-being. Still, the gaps among countries' living standards are so large that even an inexact measure brings them into focus.

In comparing income among countries, one issue we face is how to deal with their different currencies. Similarly, in examining income within a single country over time we face the issue of fluctuations in the price level. This book will express data (GDP and other economic measures) in terms of a common unit of currency—U.S. dollars for the year 2005. To convert amounts from other years and countries, we use a set of artificially constructed factors called **purchasing power parity (PPP)** exchange rates.⁷ The appendix to this chapter presents a more extensive discussion of how PPP exchange rates are calculated and how they affect comparisons of GDP among countries.

The differences in income among countries are enormous—so large that they can be difficult to comprehend. One useful image, suggested by the

⁷Data on GDP and PPP exchange rates are from Heston, Summers, and Aten (2011).



A typical English family with their possessions.

economist Jan Pen, is to think of the people of the world marching by in a parade. Each person's height is proportional to average income in his country, with the average height of all the marchers in the parade being six feet (1.82 meters). You are observing the parade from a reviewing stand, and the parade takes exactly an hour to pass by you. Marchers in the parade proceed at a steady pace, so that after 15 minutes, for example, one-quarter of the people in the world will have passed by. People march by in order of their height, starting with the shortest.

What does the parade look like? For almost all of the time, it is a parade of dwarfs. The first seven minutes are primarily made up of countries from sub-Saharan Africa with heights less than one foot (29 centimeters). Starting in the 13th minute, India passes by, taking up almost 10 1/2 minutes, with marchers 23 inches (59 centimeters) tall. China arrives on roughly the half-hour mark, with marchers 55 inches (1.40 meters), taking 12 minutes to pass. At the 45-minute mark, one sees marchers from Turkey, who have almost exactly the world average height. During the last 15 minutes of the parade, the height of the marchers escalates frighteningly. Nine-foot (2.78-meter) marchers from Croatia pass in the 50th minute and 18-footers (5.51-meter) from Japan in the 52nd minute. Japan is followed by roughly 3 minutes of Western European countries in the 19- to