Explorations in World History

Why Europe?

The Rise of the West in World History, 1500–1850

Jack Goldstone

WHY EUROPE?

THE RISE OF THE WEST IN WORLD HISTORY, 1500–1850

JACK A. GOLDSTONE

George Mason University

Higher Education

Boston Burr Ridge, IL Dubuque, IA New York San Francisco St. Louis
Bangkok Bogotá Caracas Kuala Lumpur Lisbon London Madrid Mexico City
Milan Montreal New Delhi Santiago Seoul Singapore Sydney Taipei Toronto

The McGraw-Hill Companies

Higher Education

A Division of The McGraw-Hill Companies

This book is printed on acid-free paper.

1 2 3 4 5 6 7 8 9 0 DOC/DOC 1 0 9 8
ISBN: 978-0-07-284801-4
MHID: 0-07-284801-4

Editor in Chief: *Michael Ryan*
Publisher: *Lisa Moore*
Senior Sponsoring Editor: *Jon-David Hague*
Editorial Coordinator: *Sora Kim*
Executive Marketing Manager: *Pamela Cooper*
Production Editor: *Karol Jurado*
Production Service: *Anne Draus, Scratchgravel Publishing Services*
Manuscript Editor: *Carol Lombardi*
Design Manager: *Margarite Reynolds*
Cover Design: *Asylum Studios*
Production Supervisor: *Tandra Jorgensen*
Composition: *10/13 Palatino by Laserwords*
Printing: *45# New Era Matte Plus, R.R. Donnelley & Sons*

Library of Congress Cataloging-in-Publication

Goldstone, Jack A.
Why Europe? The Rise of the West in World History, 1500-1850 / Jack Goldstone. — 1st ed.
p. cm.
Includes bibliographical references and index.
ISBN-13: 978-0-07-284801-4 (alk. paper)
ISBN-10: 0-07-284801-4 (alk. paper)
1. Europe—Social conditions. 2. Europe—Civilization. 3. Asia—Social conditions. 4. Asia—Civilization. 5. East and West. I. Title.
HN373.G65 2008
909.08—dc22

2007039922

The Internet addresses listed in the text were accurate at the time of publication. The inclusion of a Web site does not indicate an endorsement by the authors or McGraw-Hill, and McGraw-Hill does not guarantee the accuracy of the information presented at these sites.

Credits
Page 28: © Jan Adkins/Jan Adkins Studio. Page 124: DAJ/Getty Images.
Page 138: © 1959 by Cambridge University Press. Reprinted with permission.

www.mhhe.com

Dedicated to my children,
Alexander and Simone,
world travelers.

TABLE OF CONTENTS

Preface

The one thing that is constant in history is change. Twenty years ago, the focus of world politics was the conflict between communism and capitalism. That conflict largely ended in 1989–1991 with the collapse of communism in the Soviet Union and Eastern Europe and seems a distant memory to high school and college students today.

Today's concerns are with the rise of Islam as a mobilizing force, the emergence of China and India as new economic powerhouses, and possibly dramatic changes in the world's climate and its diverse environments.

The study of history has changed as well. For most of the nineteenth and twentieth centuries, students learned about world history by studying Western Civilization, which was told as the story of the "rise of the West." This story started with the emergence of democracy and philosophy in ancient Greece and Rome; continued with the rule of Europe's kings and knights in the Middle Ages; moved on to the arts and explorations of the Renaissance; and concluded with the military, economic, and political domination of the world by the nations of Western Europe and North America. The peoples of Africa, Latin America, and Asia were mentioned only when they encountered European explorers or colonizers—their "history" thus beginning with European contact and conquest.

In the last half-century, however, the study of World History has focused far more attention on the areas outside of Europe and on the centuries-old patterns of exchange and interaction among all the world's civilizations. It is certainly true that the modern world owes much to the political and philosophical inventions of the Greeks. However, it is also true that the modern world obtained its religions, its systems of numbers and counting, much of its fundamental principles of mathematics and chemistry, and its most common consumer goods (cotton clothing, fine china, paper, printed books) from Asia and north Africa. While politicians worry today about a clash of civilizations, historians are trying to achieve a better understanding of how the modern world developed from the contributions of many civilizations. Historians today are also trying to understand how people's responses to varying climates and environments shaped history in different times and places. Finally, the histories

Note from the Series Editors

World History has come of age. No longer regarded as a task simply for amateurs or philosophers, it has become an integral part of the historical profession and one of its most exciting and innovative fields of study. At the level of scholarship, a growing tide of books, articles, and conferences continues to enlarge our understanding of the many and intersecting journeys of humankind framed in global terms. At the level of teaching, more and more secondary schools as well as colleges and universities now offer, and sometimes require, World History. One of the prominent features of the World History movement has been the unusually close association between its scholarly and its teaching wings. Teachers at all levels have participated with university-based scholars in the development of this new field.

The McGraw-Hill series Explorations in World History operates at this intersection of scholarship and teaching. It seeks to convey the results of recent research in World History in a form wholly accessible to beginning students. It also provides a pedagogical alternative to or supplement for the large and inclusive core textbooks that are features of so many World History courses. Each volume in the series focuses briefly on a particular theme, set in a global and comparative context. And each of them is "open-ended," raising questions and drawing students into the larger issues that animate World History.

The issue this book addresses has been perhaps the most widely discussed and contentious within World History circles over the past several decades. It is an attempt to explain the transformation of Europe from a peripheral and relatively backward region to a place of great innovation, wealth, power, and something approaching global dominance by the nineteenth century. Was the rise of the West the product of some unique feature of European life? Was it the outcome of Europe's changing relationship with the rest of the world? How different was it from other periods of efflorescence in human history?

Few historians are better equipped to address these questions than Jack Goldstone, for he has been a major participant in this scholarly debate for decades. Now in *Why Europe? The Rise of the West in World History, 1500–1850,* he offers his mature reflections to a general audience in a language that is accessible to beginning undergraduates. His thorough presentation draws upon the most recent research on the topic. Here then is a thoughtful, readable, and exciting introduction to what is probably the central question of modern World History.

Robert Strayer
Kevin Reilly

of religion, of law, and of science and technology—once somewhat separated as specialized studies—are now all deemed essential to understanding the larger story of World History.

In the last dozen years, a group of young economic and social historians has made some new and surprising arguments about World History. Instead of seeing the rise of the West as a long process of gradual advances in Europe while the rest of the world stood still, they have turned this story around. They argue that societies in Asia and the Middle East were the world leaders in economics; in science and technology; and in shipping, trade, and exploration until about AD 1500. At the time Europe emerged from the Middle Ages and entered its Renaissance, these scholars contend, Europe was well behind many of the advanced civilizations elsewhere in the world and did not catch up with and surpass the leading Asian societies until about AD 1800. The rise of the West was thus relatively recent and sudden and rested to a large degree on the achievements of other civilizations and not merely on what happened in Europe. Indeed some of these scholars suggest that the rise of the West may have been a relatively short and perhaps temporary phenomenon, as other societies are now catching up to or even surpassing Western societies in their economic growth.[1]

This little book presents an introduction to these new approaches to World History. It offers some of the latest findings and most recent arguments about the achievements of civilizations outside the West, their relations with Europe, and their importance to the creation of the modern world. It also points out what might have been special about Europe and what factors account for the dominant position of Europe and North America in the nineteenth and twentieth centuries.

At a time when peoples throughout the world are seeking to understand how their diverse civilizations can grow and prosper, this fresh look at the past might offer some useful insights for the future.

[1]These historians include Kenneth Pomeranz, R. Bin Wong, Jack Goldstone, James Lee, Dennis Flynn, Robert Marks, the late Andre Gunder Frank, the late James Blaut, John Hobson, and Jack Goody, among many others. They are sometimes called the "California School," because many of these scholars worked at universities in California.

INTRODUCTION

EARTH: A GLOBAL VIEW

From outer space Earth shines like a jewel, brilliant green and blue against a black velvet background. Moving closer in, one sees that most of the globe is covered with shimmering oceans and a few irregularly shaped continents. Life of all kinds flourishes.

This view from space would have been unchanging for millions of years, even for the last 5,000 years of recorded history. Yet in just the last 100 years, the view has dramatically changed. If we looked at Earth with a special instrument that only measures the electrical energy produced by particular regions, the continents would look very different. In fact, if we mapped the total electrical energy produced in various regions of the world, we would find a very puzzling situation.

Some areas of the Earth produce far more energy than others. For example, the area of North America covered by Canada and the United States produces four times as much electrical energy as the rest of North America and South America combined. The relatively small peninsula of Europe produces nearly seven times as much electrical energy as all of Africa, even though Africa is much larger (see Figure I.1).

If we were interstellar explorers looking at Earth from outer space, how might we explain this oddity? We might suspect that more energy is produced and consumed where more people live. We could check this by using other instruments to estimate how many people live in various areas. But we would be shocked to learn that most of the energy production is occurring where relatively *few* people live. The 521 million people in the European peninsula produce 3,300 billion kilowatt-hours of electrical energy each year, while Africa, with 869 million people, produces only 480 billion kilowatt-hours. Two-thirds of the population of North and South America lies south of the U.S.–Mexico border, but the area north of the border produces 80 percent of the electrical energy generated in the Americas. The 120 million people in Japan produce 10 times as much electricity per year as do the 220 million people of Indonesia.[1]

Even observers from outer space would thus notice perhaps the most striking fact about the Earth at the beginning of the twenty-first century: A

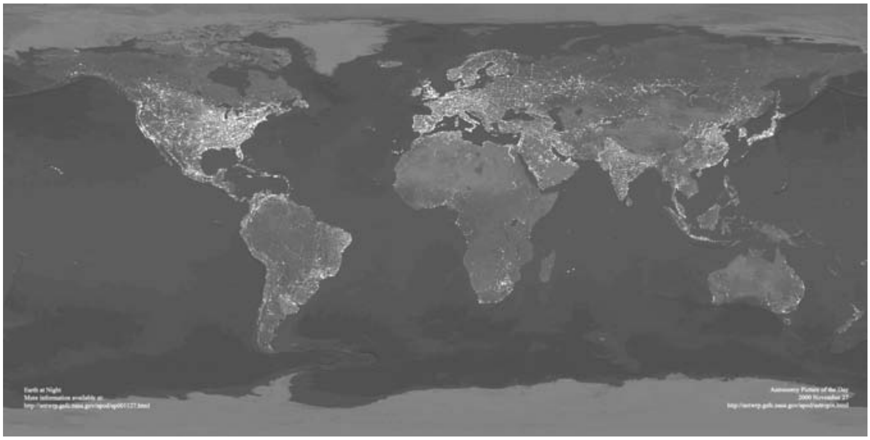


Figure I.1 The Earth at Night as Seen from Space
Note the differences in how various regions are lit up at night. North America is much brighter than South America, western Europe is much brighter than Africa, and Japan is much brighter than China or Indonesia. Although India shows a fair number of lights, you would not think that its population is almost five times as large as that of the eastern half of the United States. *(Source: C. Mayhew & R. Simmon (NASA/GSFC), NOAA/NGDC, DMSP Digital Archive)*

relatively small portion of the Earth's population is producing and consuming most of the electrical energy. In short, a relatively few people living in certain regions are rich, and many more people, living in other regions, are—when compared with the first group—poor.

How might one of our space observers try to explain this? Much as most people today, she might think that perhaps the rich people stole resources from the poor or prevented the poor from having equal access. Yet this turns out not to be quite right—the poor regions actually have more natural and energy resources, and they either voluntarily exchange them for other things (cars, movies, radios, machinery) or waste them (many countries burn off their natural gas, have unused hydroelectric generating capacity, or do not use the resources they grow, mine, or pump from the ground).

The observer might guess that people in the richer regions were exceptionally talented or clever and therefore mastered certain skills in producing energy. Yet this, too, is not quite correct—many of the peoples in the poor regions have long histories of high civilization, with extraordinary craftsmanship, intricate systems of philosophy, and brilliant literature.

Perhaps the richer areas just stumbled upon some great magical knowledge that allowed them to produce and use this energy, which was kept from other areas? Even that guess can't be quite right—books and education and electronic communications carry knowledge all over the world. Yet some regions seem to make much better use of this information than other regions.

To solve the puzzle, the best way is to come down to Earth and study the history of its peoples, their societies, and their interactions over time. Of course, our poor space observer would be even more befuddled by her first discoveries in history, for she would find out that for thousands of years, the earliest civilizations and the most advanced societies were in precisely those areas that were *not* the big energy producers and consumers of the early twenty-first century. That is, for thousands of years, the leading civilizations, the richest and most technologically advanced societies on Earth, lay in northern Africa, in eastern Asia, in southern Asia, and in the areas of the Americas south of the United States. In other words, something dramatic happened relatively recently that led to a striking inequality across different world regions and reversed the older patterns.

This book examines various ideas that try to explain what happened—and when, and how—to produce this striking inequality. We would like to know how it arose, what caused it, and whether it will likely increase or diminish. Unfortunately, even the finest of Earth's scholars of economic and social history have disagreed over this issue. But scholars from all over the world are now producing new insights that help us come closer to answering this puzzle. This book presents the argument as it stands in the most up-to-date research, so that readers can better decide for themselves where they think these processes of long-term economic change are taking us.

CHAPTER ONE

THE WORLD CIRCA 1500: WHEN RICHES WERE IN THE EAST

CHAPTER PREVIEW: In 1500, Europe was not the richest part of the world. Although Europeans had mastered some technologies and borrowed others—including clocks, gunpowder weapons, and oceanic sailing vessels—they were dazzled by the wealth, commerce, and productive skills that they encountered when visiting other centers of civilization, whether in the Middle East, southern and eastern Asia, or even in the New World. At this time, Asia generally had greater agricultural productivity and more refined craftsmanship than Europe and offered a wide variety of products, such as silk and cotton fabrics, porcelains, coffee, tea, and spices that Europeans desired. The voyages of discovery by Columbus and other seafarers—although motivated partly by a surge of curious exploration and partly by a burst of missionary zeal—were mainly attempts to help Europeans improve their access to the riches of India and China.

When Christopher Columbus sailed from Spain across the Atlantic in 1492 and returned the following year, his voyage opened a new era in the history of the world. In 1497, the Portuguese mariner Vasco da Gama made a similarly long-distance voyage and returned, this time from India, which he reached by sailing first westward into the Atlantic and then turning south to round the southern tip of Africa. These voyages opened the Atlantic Ocean to Europeans as a portal through which they could reach Asia and the Americas. From that point on, an increasingly dense web of maritime trade links, missionary activity, and colonization would connect Europe to the rest of the world.

Previously, European seafarers had been relatively limited in their reach. Prior to 1400, European ships generally traveled no farther than the Black Sea to the east, the Mediterranean Sea to the south, the English Channel and North Sea to the west, and the Baltic Sea to the north (see Figure 1.1). Hemmed in

FIGURE 1.1 EUROPE IN 1500

Before 1492, most European seafaring was limited to the surrounding seas.

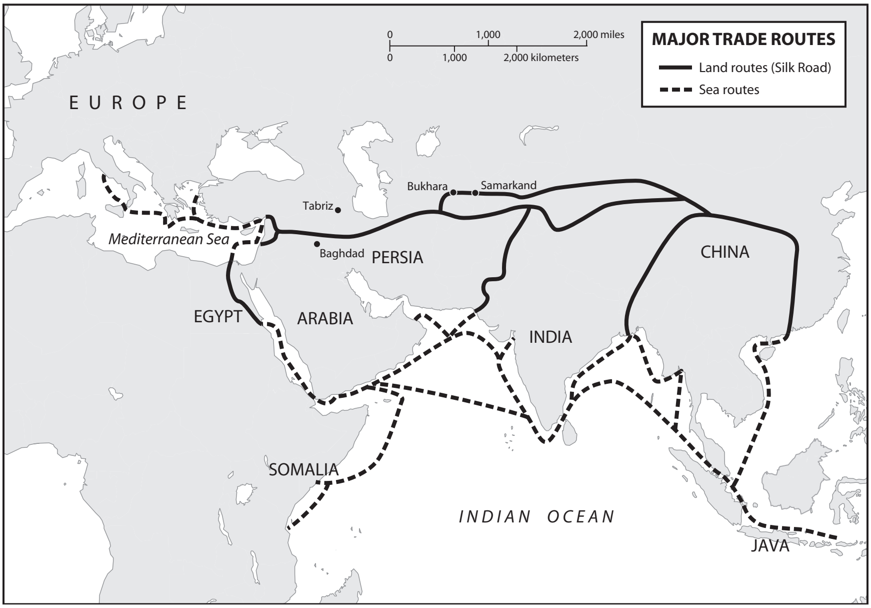


Figure 1.2 Europe and Asia Showing the Silk Road and the Sea Trade Routes

Important trade routes, including the fabled Silk Road, linked eastern, southern, and central Asia and the Middle East. Europe was on the western fringes of these networks of trade.

by the seas, as it were, European vessels usually stayed within easy reach of their own lands.[1] Prior to 1492, European ships remained confined to the far western fringes of the great Eurasian trade routes (see Figure 1.2 above).

Before 1488, when the Portuguese captain Bartolomeu Dias became the first to pilot his ship around the Cape of Good Hope at the southern tip of Africa—thereby showing that it was possible to sail from the Atlantic into the Indian Ocean—most Europeans believed there was no sea route to the east. European maps showed the Indian Ocean as fully enclosed by the east coast of Africa and the shores of Arabia, India, and southeast Asia; it appeared to be a basin of Asian trade that was closed to seafarers from Europe.

Although individual European merchants, like Marco Polo, had traveled to India and Asia in the Middle Ages, by 1500 neither European rulers nor merchants were able to project any substantial presence outside of Europe itself. South of the Mediterranean lay the Muslim kingdoms and sultanates of North Africa, whose residents fiercely resisted European intrusions. In the eastern Mediterranean, the Ottoman Turks, who claimed the great Byzantine city of Constantinople as their capital and called it Istanbul, continued to sweep forward into the Balkan Peninsula. By 1500, they had taken all of Greece and most of the Balkans and, within another 60 years, extended their reach deep into Hungary and almost to Vienna.

The greatest seafarers in Europe before the Portuguese and the Spanish were the Vikings in the north and the Italians in the Mediterranean. Although the Vikings skipped and jumped their way from the northern islands of Scotland to Iceland to Greenland and even to North America, they never crossed the belly of the Atlantic.

Meanwhile, the Venetians and Genoese, setting out from their city-states in northern Italy, sailed, traded, and settled widely throughout the eastern Mediterranean, even passing through the straits near Constantinople to the eastern shores of the Black Sea. Their ships transported the riches of Asia—silks and spices, jade and jewels—back to Europe. But the Italians rarely ventured beyond the Black Sea or the Ottoman-controlled coasts of the Mediterranean. Western Europe was thus locked in, surrounded by the open ocean to the west and the powerful Ottoman Empire to the east.

Yet the civilizations of the Middle East and Asia were not so limited. Arab merchants not only traveled all across North Africa and into Spain but also sailed along the Red Sea and down the eastern coast of Africa as far as Zanzibar, around the Arabian Peninsula, out of the Persian Gulf, and across the Indian Ocean to lands rich in pepper, rare gems, and other treasures. Arab, Persian, and Armenian merchants also traveled by caravan all the way to the borders of China on the overland routes known as the Silk Road, stopping at the wealthy cities of Baghdad, Tabriz, Bukhara, and Samarkand. Indian merchants traveled west around the Indian Ocean to Arabia and Africa and east around the Bay of Bengal to southeast Asia; they even established trading communities in Russia.

Almost a century before Columbus's voyages, the Chinese had built huge sailing fleets, dwarfing Columbus's tiny caravels, and sailed them from China around Southeast Asia, to India, and beyond the Indian Ocean to Africa. In short, while Europeans remained bottled up behind a wall of Islamic states, other traders moved freely across the entire Asian world (see Figure 1.2).

This explains why Columbus took his daring journey across the Atlantic, and why the Portuguese kept pushing down the coast of Africa until they sailed east and north into the heart of the Indian Ocean. Both sought a direct route to the riches of the East—a way for the Spanish, Portuguese, and other Europeans to participate in the thriving trade beyond the Ottoman border.

By sailing across the open ocean to the west, Columbus hoped to go around the world and arrive in China or India, the fabulously wealthy lands known to Europeans as the Orient. Columbus hoped to enrich himself and to find and claim the fabled "spice islands" of the East for his king, queen, and Christian god. Yet the most important result of his voyage, and of those of other Atlantic explorers, was to end the relative isolation of Europeans and connect them directly with the flourishing trade of the Asian civilizations lying beyond the Ottoman lands.

Columbus's voyage did just that, although in ways he could not possibly have expected. For in between Europe and Asia lay another entire continent—North and South America, joined at the narrow tail of Central America. (Not knowing this, and believing he had landed in India, Columbus labeled the Native Americans of the Carib tribe that he encountered "Indians"; the misnaming has stuck ever since.)

Columbus's discovery of the Americas got Europeans into the trading circuits of Asia. Before their contact with the New World, Europeans had relatively few things of value to offer for global trade. Although gold and ivory from Africa and furs and glass objects from Europe were valued in Asia, the Europeans had little of their own to trade for the costly spices, silks, and other Asian goods that they desired. But thanks to Columbus, they found their fortune.

The Americas held huge mines and storehouses of silver and gold, enough to allow Europeans to expand their trade with Asia greatly. Such riches had to be separated from their Native American owners, but the Europeans had no scruples about doing so. Through conquest, slavery, and the spread of diseases that decimated the native population, Europeans took control of the wealth of the Americas.

Why did the Europeans go through all that trouble? Why was it that India and China appeared to Europeans as the lands of riches at the time of Columbus?

The answer is that these regions *were* richer, in almost every way. The fields of India and China were more fertile and productive, and their technology for production was superior. China was the first region in the world to manufacture a host of products, including paper, gunpowder, oceangoing ships with sternpost rudders and multicompartmented hulls, the compass, the lateen sail, cast-iron tools, and high-quality porcelains. India led the world in the production of luxurious and brilliantly colored cotton textiles, and China and Persia were world leaders in the production of silk. The people of India and China clothed themselves in soft cotton, while Europeans wore coarser garments of linen and wool.

How did this come about?

Climate, Soil, and Agricultural Zones in Eurasia: Agricultural Productivity as the First Key to Wealth

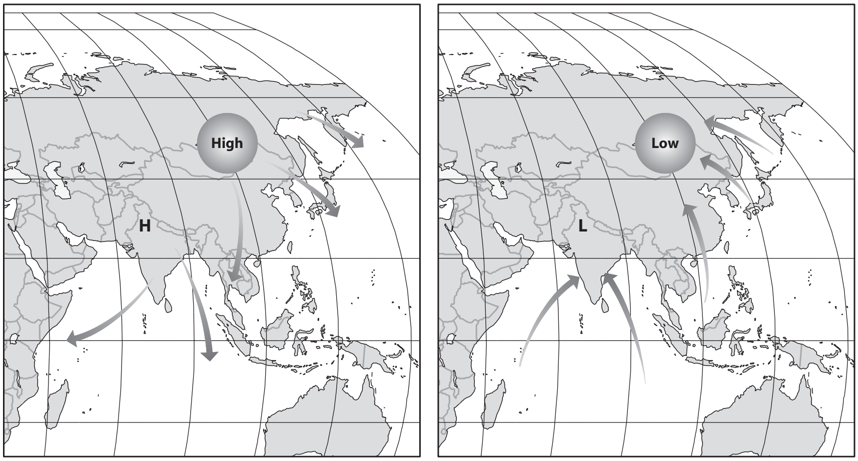
We can get some insights by thinking of the vast Eurasian continent as divided into zones—zones of different climate, soils, and crops. The first zone is Europe. The weather over the Atlantic Ocean blows into Europe, carrying cold winds and rain in the winter, but milder and dryer air in the summer. The southern or Mediterranean region tends to be hotter, dryer, and more dependent on mountain-fed rivers for irrigation, while the northern region from Britain to Russia gets heavier rains and is cooler. Yet all of Europe enjoys a climate with sufficient moisture in the winter and sufficient dryness and warmth in the summer to support an agriculture based on growing dry cereals (wheat, barley, oats, or rye) as well as fruit and vegetable crops.

The second zone is the huge mass of central Asia and the Middle East, roughly from the Ural Mountains to the borders of China. In this region, not enough rain falls in most places to sustain forests or settled agriculture, so much of central Asia is grassland, providing a home to nomads who graze their herds of horses, sheep, camels, goats, and oxen. The main exceptions are the areas subject to seasonal flooding from great rivers, such as the Nile River in Egypt and the Tigris and Euphrates rivers in Mesopotamia or the areas in high plateaus or near mountains that catch enough snowfall to provide summer water for irrigation, as in northern Persia. In these places the concentration of water and extensive irrigation has allowed for rich agriculture and the support of great civilizations.

Farther to the south and east, in India, China, Korea, Japan, and Southeast Asia, a third climate zone prevails. This is the monsoon zone of strong seasonal winds, dry winters, and rainy summers. Winter winds come from central Asia, bringing dry cool air. However, in summer the winds change direction, coming from over the warm waters of the western Pacific and the Indian oceans. The winds pick up moisture from the oceans and drop heavy rains over the monsoon zone. The result is a warm summer with heavy rains for India, China, Korea, Japan, Southeast Asia, and parts of Africa (see Figure 1.3).

To sum up, Europe's weather comes mainly from air patterns over the Atlantic, giving it cool wet winters and dry summers. Most of central Asia and the Middle East get little rain from the oceans and thus form a dry zone of deserts and grasslands, except for the rich irrigated lands along major rivers, and the mountain valleys and plateaus that catch more rain and snow. In eastern and southern Asia, by contrast, the weather is driven by seasonally shifting winds. The most striking feature of the latter is the monsoon season, when summer winds coming from the Pacific and Indian Oceans drop warm, heavy rains throughout the region.

This difference in seasonal rainfall patterns has large implications for agriculture, especially when combined with regional differences in soils. In Europe, much of the soil is thin and chalky, or sandy, or rocky, or covered with immense hardwood forests. To produce food, the land must be heavily worked to be cleared and fertilized. This means large numbers of



WINTER PATTERN
In winter, dry winds flow south and east from central Asia.

SUMMER PATTERN
In summer, winds bringing moisture and heavy rains flow north and west from the Indian and western Pacific Oceans.

FIGURE 1.3 THE ASIAN MONSOON WIND PATTERNS
In winter, dry winds flow south and east from central Asia. In summer, winds bringing moisture and heavy rains flow north and west from the Indian and western Pacific oceans.

farm animals are essential, both for their work effort and their manure. The heavy soils of the forest regions could not be worked until the Middle Ages (from about the tenth century), when the use of new iron-tipped, heavy plows allowed farmers to churn up the old forest roots and bring fresh topsoil to the surface. But even these plows were fairly primitive, because iron was scarce and hard to shape; plows therefore had simple iron cutting shares lashed at a right angle to flat wooden (or sometimes iron) moldboards. The plowshare would cut through the soil, and the moldboard would lift a ridge of soil and turn it over, creating a furrow. This cleared the soil of weeds and aerated it, allowing nitrogen to re-enter the soil. But dragging that moldboard through heavy soil was enormous work, requiring large teams of animals and often a driver to encourage the animals as well as a plowman to guide the plow.

Because most rain in Europe falls in the winter, not in the summer growing season, farmers need to plant crops that are hardy. Europeans thus planted crops like barley and wheat, oats and beans and millet, as their main food source. But because the soils were poor and animals needed to be fed, almost two-thirds of the available land had to be left unplanted to provide grazing or held in a fallow or "resting" period for a year between plantings to improve soil fertility.

By contrast, farmers in the eastern monsoon zone had superior soils and got their wet weather in the summers. They thus organized their agriculture quite differently. The northern Chinese plain was covered by a very light and fertile loess soil, which could be easily worked, and during the summer the high flow of the Yellow River and its tributaries provided plentiful water for irrigation.

Chinese farmers could work this soil using a lighter plow, and indeed China's technology produced a far more efficient one. The Chinese had developed a fairly sophisticated iron technology at an early date. By the fourth century AD, they were already using ceramic-coated ovens to generate high enough temperatures to melt iron for casting into a variety of shapes—something that Europeans would not master for centuries to come. Instead of a simple iron tip lashed to a moldboard, the Chinese would cast the plowshare and moldboard as a single smooth curve of metal with a sharpened leading edge and flanged sides. The result was a plow that cut through the soft loess soils like a knife through butter and allowed plowing by only a single worker and an animal or two.

Chinese farmers thus did not need to devote much land to grazing, nor did they need to rest any land in fallows, because irrigation and light manuring (usually from pigs) carried the needed nutrients into the light but deep soils. Even though the northern Chinese plain grew crops similar to those of Europe—wheat, millet, and beans—the Chinese were able to produce more food per acre and per farmer, to feed more craft and urban workers, and to support more and larger cities than Europeans could.

In India, southern China, southeastern Asia, and the southern parts of Japan and Korea, the monsoons dropped so much water that farmers could flood their fields in the growing season and grow the more productive and water-tolerant crop of rice. Rice plants have many more seeds or kernels per plant than wheat; thus much less of the crop had to be kept for seeding the next harvest, and more edible food could be harvested per acre. In addition, because flooding the fields helped fertilize the soil and keep down weeds, and far less animal power was needed for plowing, rice cultivation needed no fallow period and required little land for grazing. The methods of rice farming and the properties of rice thus allowed for higher productivity than did European farming, leading to greater output per person and per acre in Asia. This greater output allowed Asian societies to support a larger class of cultured and leisured elites, and to engage more craftspeople to produce specialized products for consumption and trade.

There was a downside to monsoon farming, however. Every so often, the rains would fail. This periodic effect is called the El Niño-Southern Oscillation (ENSO) and occurs when the normally warm waters that supply the monsoon rains in the western Pacific and Indian Oceans move away to the eastern Pacific instead. These shifting ocean currents affect the air currents, greatly weakening the southeasterly monsoon winds and resulting in a terrible drought in eastern or southern Asia. Crops wither and millions starve. Conversely, in some years the monsoon rains fall earlier and much more heavily than usual. Fields and homes are swept away as rivers overflow their banks. The great agricultural productivity and wealth of Asia thus was always punctuated by occasional periods of drought or flood, leading to extremes of poverty and misery.

Climate and soil made a huge difference, but as we have seen with the comparison of Asian and European plows, Asian peoples also developed superior technologies that let them take the best advantage of what nature offered. In fact, because nature was often cruel—bringing ruinous floods and droughts when the monsoons came too soon, too harsh, or not at all—the Chinese and other Asian peoples developed a variety of technologies to diversify their economies and to control their essential water supplies.

Technologies to Shape the Environment and Create Marketable Products

Throughout Asia, agricultural societies developed elaborate networks of canals, ditches, and levees to divert river water to their farms. Although it was once believed that these water-control projects could only have been built by harshly dictatorial states, we now know that most of the irrigation projects that created wonderfully fertile fields from Iran to Bali and that operated all across India and China were built and maintained under the supervision of local elites and their communities.

Where the government was involved, it focused mainly on creating water projects to improve trade and travel, such as China's Grand Canal, built to take tribute grain from the rice-growing area of the Yangzi River delta to the northern capital of Beijing. Stretching over 1,000 miles from north to south, linking numerous bodies of water and crossing rivers and mountains, it remains the world's longest canal, and its main sections were largely completed by the seventh century AD. In the tenth century, the Chinese invented canal locks to float barges over uneven terrain, eliminating the need to remove, carry, and reload cargoes when traversing hills. (This was 400 years before canal locks were used in Europe.) Yet this was just one of many projects that the Chinese and other Asian nations built to control flooding, channel irrigation waters, and maintain port facilities in coastal trading centers.

In addition to their prowess in agriculture and water control, the peoples of Asia also produced a variety of valuable materials unavailable in Europe. From the time of the Roman Empire, the Chinese had been producing silk: raising silkworms, steaming the cocoons to kill the worms and prevent them from breaking out as moths, and then skillfully unreeling the cocoon into threads. Woven silk textiles were one of the main luxury items traded across Asia for centuries, giving their name to the Silk Road trade route. Silk production spread to Persia and the Middle East in the early Middle Ages, and Europeans had learned to produce silk by the thirteenth century. But the demand for fine silks was so great that local production in Europe and the Middle East could not keep up with it, and Chinese (and other Asian countries') silk continued to be exported to the West through modern times.

By the time of Columbus, China and India were also beginning to produce another luxury fabric unavailable in the West: fine cotton. It may be hard to believe today, but until the eighteenth century, the cotton that Europeans now rely on for their shirts, undergarments, and jeans was only available from Asia. The British imported huge amounts of woven cotton cloth to Europe. Even in the late 1700s, as the British were developing their own machine-driven cotton-spinning industry, they feared they would never be able to produce such fine cotton cloths as were produced in India.

In addition to higher agricultural productivity and superior textiles, eastern Asia also had great advantages in what we would today call materials engineering. The Chinese mastered heavy bronze casting almost as soon as they developed writing and became skilled in casting iron utensils 1,000 years before the Europeans. The Chinese (and Koreans and Japanese as well) also developed the magnificent ceramics—ornately glazed and almost translucent—that we admire today as fine china. Indeed Chinese ceramics were in such demand throughout Asia that, as early as the seventeenth century, the Chinese developed coal-fired factories with thousands of workers to turn out pieces with designs carefully tailored to appeal to Middle Eastern or European customers.

The Chinese also developed inexpensive paper and woodblock printing and hence had vast libraries of books centuries before large-scale book printing and libraries developed in Europe. Even paper money (also made possible by cheap paper and printing) was used in China long before it was used in Europe. Europeans used expensive animal skins (vellum or parchment) for most writing in the Middle Ages. Arab middlemen sold Asian paper to Europeans for roughly 400 years, from AD 800 to 1200, before Europeans learned to manufacture it themselves. Costly pigments (for dyeing cloths and creating paints), gunpowder, and matches all came from various parts of Asia.

Finally, Asian lands were also the source of precious spices, ointments, and perfumes—mainly pepper, but also cinnamon, cloves, cardamom, myrrh, and frankincense. Somewhat later, Arabia, India, and China became the source of Europeans' daily tea and coffee, but that trade only developed over 100 years after Columbus's voyage.

Having enjoyed a more productive agriculture and more advanced technology for many centuries before 1500, most Asian societies appeared fabulously wealthy to Europeans. The volume of shipping on Chinese rivers is said to have stunned Marco Polo, himself a Venetian trader, who visited China in the thirteenth century. Through 1750, Europeans marveled at the riches, technological skills, and beautifully crafted products of the East.

The Puzzling Rise of Europe

How then is it possible that by 1850, perceptions had reversed, and Asians began to seem poor and backward to Europeans? By 1911, when the Chinese Empire collapsed, Europeans considered China a land of wretchedness and dulling tradition, not an advanced civilization. Europe had spread its political and economic domination around the world, colonizing some regions, dictating terms of trade to others, and enjoying technological superiority and material wealth that seemed beyond the reach of non-Europeans. Given where the world stood in 1492, how did all of this come about?

For most of the last 200 years, Europeans justified their sudden rise to global domination in terms of their own superior virtues. Singling out elements in their history borrowed from ancient Greece and Rome and proceeding through the Renaissance, Europeans prided themselves on having achieved special insights into nature. They congratulated themselves on having greatly developed their cities and their trade, sometimes forgetting that when they joined the global trading circuits, great cities and immense trade already existed in Asia.

Sometimes Europeans explained their success in terms of their religion, arguing that Christianity provided a superior foundation for economic activity. At other times, Europeans pointed to their system of government—the competition among diverse states in early modern Europe—as the reason for their success.

Some explanations are more humble, suggesting that Europeans did not deserve their greater riches, but had stolen them. Starting with Columbus's construction of forts in the Caribbean, Europeans became global invaders, stealing wealth and resources from native peoples wherever they went.

Finally, some explanations suggest that Europe was just fortunate in having certain resources—coal and iron for industry in Europe, or the depopulated lands of the Americas—in places where Europeans could put them to good use and thus gain an advantage over other world regions.

All these and other ideas are worthy of consideration. Yet they must also be carefully examined and tested. We should not assume so easily that any factors we think made Europe special were in fact absent in Asia or Africa. We may just have to look a bit harder. Nor should we assume that, just because Europe was different in some way from other places, such differences produced a better outcome. Such differences could just as easily have produced worse outcomes, so we have to trace cause and effect very carefully to be sure a given factor did indeed produce a particular outcome.

The following chapters thus undertake a study in comparisons—what really were the important differences that led to Europe's great and sudden rise to world domination? And will they last?

Additional Reading

Fagan, Brian. *The Long Summer: How Climate Changed Civilization.* New York: Basic Books, 2004.

Pomeranz, Kenneth. *The Great Divergence.* Princeton, NJ: Princeton University Press, 2001.

CHAPTER TWO

Patterns of Change in World History

CHAPTER PREVIEW: We tend to think of change in history as always moving forward: people getting richer and learning more, and cities and countries growing. But that has not always been the case. Changes in world history often move in up-and-down cycles. Bursts of progress are followed by reversals or long periods of stagnation. This was true in both Europe and other major civilizations for most of history.

Some scholars have pointed to episodes of progress in Europe before 1700 in the areas of social change, or technology, or population control as responsible for the rise of the West. However, when placed in broader context, these are often seen to be part of longer up-and-down cycles and very similar to episodes that took place at roughly the same time in other civilizations.

When we think about long-term social change, our natural tendency is to think of change as something that is always with us—prices go up, populations grow, cities expand, technology improves. If we think of modern times as different from what went before, we mainly see the rate of change as different, with changes in the modern world coming much faster.

Yet the reality is considerably more complicated. Long before modern times, history saw episodes of rapid advances in population, in prices, in urbanization, and in technology. Most of the great empires of history started with a "bang" of rapid expansion and social change. However, the total effect of such changes was limited because they were not sustained. Instead, they were interrupted by sudden reversals, in which plagues, harvest failures, wars, revolutions, and other disasters sharply reduced population. Urbanization and trade usually declined as well, and prior technological advances were sometimes lost. These declines were often followed by long periods of relative stability in which population, prices, cities, and technology hardly changed for centuries.

To take just one example, we now think that the population of England reached over 4 million during the late Roman Empire (around AD 300), was over 4 million again around AD 1300, and was over 4 million again in 1600.[1] But this does not mean that the population of England was constant for over 1,000 years. Rather, the population went through several periods of increase, then decline and stagnation, followed by slow recovery. England's population probably plunged to around 2 million by AD 500 and reached that level again around AD 1400. Nor was England alone—in Italy, Germany, Turkey, and China, from ancient times until the nineteenth century, records tell of periods when disease, war, and famine carried off one-quarter to one-third of the population within a generation.

What makes the modern world different, in other words, is much more than merely the pace of change. Before the nineteenth and twentieth centuries, the typical pattern of economic change was cyclical: There were periods in which population, prices, urbanization, and technical growth all rose, but also long periods when they fell or remained unchanged. By contrast, since 1800 in Europe (and since 1900 in most of the rest of the world), the pattern of economic change has been one of accelerating growth, in which populations, cities, and technological inventions have generally increased more rapidly in every succeeding decade than they had ever done before. Population and technology have advanced faster and still faster, interrupted only by relatively mild downturns or brief periods of stability.

Two centuries of accelerating change have meant that the advance of prices, population, urbanization, and technology since 1800 has dwarfed anything that came before. In 1800, the population of the world had grown to a total of about 1 billion people. It had taken tens of thousands of years for the world's population to reach that number. Then, in merely the next century, the world gained almost that many people once again, with global population nearly doubling to reach 1.7 billion people by 1900. In the century after that, global population grew so fast that the number of people more than tripled, reaching 6 billion by the year 2000. In fact, by the late twentieth century, in every 20 years the number of people being born was greater than the entire population of the world 200 years before.

Other social factors also changed rapidly. In the world before 1800, in most large societies no more than 10 to 15 percent of the population lived in big cities. Methods of farming, manufacturing, and transportation underwent major changes only every century or two. Farmers in Europe and America in 1760 used pretty much the same equipment that had been used since the introduction of the horse collar and the iron-tipped heavy plow in 1300. As late as 1800, people all around the world who traveled on land either walked or rode horses or were carried in horse-drawn carriages, as they had been for thousands of years.

In the past 200 years, things have changed dramatically. Today in most large societies more than half the population live in big cities. New methods of manufacturing and transport have appeared every decade. Changes in just the past 50 years have been enormous. Before 1950 there was no public jet travel, and no man-made object, much less a human being, had ever left earth's atmosphere to enter outer space. Before 1975, there were no personal computers, no cell phones, no Internet, no cable or satellite TV.

When and where did this shift from premodern cyclical change to modern accelerating change begin? This is another way of asking how the rise of the modern world began. To understand how the world became modern, we need to inquire into the kinds and patterns of social change that occurred in different parts of the world.

Was Change Different in Asia and Europe?

Some scholars have suggested that the patterns of social change in Europe diverged from those elsewhere in the world long ago, perhaps as long ago as the Middle Ages, and certainly by the end of the Renaissance, or about AD 1600.

Karl Marx, for example, argued that Western European society moved through a series of distinct social formations, which he called patterns of class relations, over the last 2,000 years.[2] Marx observed that in ancient Greece and Rome, society was led by a small elite of citizens who ruled over slaves. In the Middle Ages, society was led by feudal nobles and lords who ruled over peasants. By the Renaissance, an urban elite of bureaucrats, financiers, and traders emerged to challenge the feudal lords. By the nineteenth century, wealthy capitalists were firmly in control of an industrial society in which most people were wage-earning workers. By contrast, according to Marx, as late as the 1800s major Asian societies such as China and India were large but stagnant empires, never progressing beyond the ancient or feudal stage of development, with their class relations remaining unchanged across the centuries.

Other scholars have made similar arguments based not on class relations, but on changes in technology. David Levine, for example, has argued that technological changes began to intensify in Europe from about AD 1000, when water mills, windmills, and new heavy iron plows began to spread widely in northern Europe. Alfred Crosby has argued that a uniquely European mania for precise counting spread from the thirteenth century and led to improvements in clocks, music, artwork, and eventually navigation, science, and manufacturing. Jan de Vries and Ad van der Woude looked to the sixteenth century, focusing on the Netherlands (also known as "Holland" after its largest province), and suggested that its highly commercialized agriculture; high rates of urbanization (with roughly 25 percent of its people living in cities); and large number of dominant manufacturing, transport, and financial activities (including fishing, shipping, warehousing, insurance, brewing, glassmaking, and printing) made it the first modern nation. By contrast, these authors have presumed that any technical changes in Asia were relatively smaller and unimportant.[3]

Finally, still another set of authors have suggested that the pattern of growth in European populations was different than the pattern elsewhere. John Hajnal, E. A. Wrigley, and Roger Schofield have suggested that northern European populations were better able to conserve and accumulate resources than other populations because they were better at restraining population growth.[4] Europeans accomplished this by making it the custom that women not marry until they reached their early to mid-20s, and that they not marry at all in hard economic times. By contrast, these scholars observed that in most Asian societies, marriages occurred when women were much younger (in their mid-to late teens), and that nearly all women married. They assumed that this pattern of early universal marriage would naturally lead to larger families and more rapid population growth in Asia, so that fast-rising populations would literally eat up any economic growth. Therefore no accumulation of resources could take place, and the standard of living would remain stuck at a low level while population grew and grew.

All of these suggestions are plausible. The problem is that they are all mistaken. Each of these approaches has exaggerated the ways in which European class relations, or technology, or population growth were different from the richer Asian societies before 1800.

Some of the errors come simply from comparing a fairly detailed and learned understanding of change in Europe with a rather vague and oversimplified understanding of change in Asia. In fact, Chinese history over the last 2,000 years shows many periods of crisis and changes in social relations, government structure, and technology, as we will show in the chapters to come.

Other mistakes come from isolating and examining a single dramatic period of change in Europe. Focusing on a particular time period—such as the early Middle Ages, or the sixteenth century—that formed an upswing in a long cycle of population, urbanization, and technical growth can make it appear that Europe was dynamic and advancing from an early date. But this overlooks the downswings that almost always followed. A longer-term perspective shows that none of the countries in Europe—or anywhere else for that matter—managed to escape from the cyclic character of long-term social change that prevailed everywhere before 1800. The same European societies that flourished in the eleventh and twelfth centuries faltered in the thirteenth century and collapsed in the fourteenth century. Even the wonderfully prosperous society of sixteenth and seventeenth century Holland underwent a sharp reduction in living standards and economic decline in the eighteenth century.

Similarly, pointing to specific changes in European technology can make Europe appear more inventive, when in fact different but equally powerful changes in Asian technology were occurring at the same time, if only we are open to seeing them. From the sixteenth to the eighteenth centuries, for example, China developed new farming techniques that gave higher output of a wide variety of crops, including millet and soy, rice and beans, wheat and cotton. China also developed new technologies for the production of ceramics, cotton, and silk textiles and expanded its coal mining and its overseas trade. These new developments raised the standard of living in China beyond European levels.

Finally, although it is true that in northern Europe women married later, this did not mean that only European populations controlled their growth during difficult times. Asian populations used other methods: In hard times, men would leave their families for many years to look for work in distant cities or regions; widows would be discouraged from remarrying; and infants would be starved or killed. The result was that even though Asian women married earlier, in the end they had no more surviving adult children than did European women. Completed family sizes in China were hardly different from those in Europe throughout the seventeenth and eighteenth centuries.[5]

In short, many of the supposedly critical distinctions between European and non-European societies melt away when longer-term trends are considered and when one looks with equal care at Western and non-Western societies. Until 1750, changes in population, agriculture, technology, and living standards were not fundamentally different in eastern Asia from those in western Europe.

This should, after all, not be surprising. Until very recently, long-term cycles of social change were caused mainly by factors that no society could escape and that worked equally on all populations of the world: climate and disease. All societies depended upon the food they could grow and on the same basic materials (animal skins, plant fibers, mud, wood, and stones) for clothing and shelter. This meant that harsh winters—with heavy snows, floods, or hail—or harsh summers with withering droughts could reduce the output of the vital plant and animal products on which people everywhere depended for food and shelter.

All societies kept some domestic animals for food and other products and relied on some long-distance trade to supply them with materials or products that they could not produce for themselves. This meant that almost all societies (except for those living in relatively isolated lands, such as Australia or the Americas before Columbus) also were subject to infection from animal- or human-borne disease.

Understanding the patterns of climate and disease and how these affected human societies is therefore the first step in understanding broader patterns of social change.

Climate Change, Disease, and Long-Term Cycles of History

We all know, of course, that the Ice Ages made life much tougher for our ancestors. Wrapped in furs and hunting large animals with spears, they struggled through brutal winters that kept large areas of the world covered with ice and snow. It was only with the end of the most recent Ice Age, about 8,000 to 10,000 years ago, that agriculture and farming developed.

We are now gaining knowledge—from the study of tree rings and ice cores drilled from glaciers—that the end of the Ice Ages did not simply mean that global climate had improved. Rather, it seems that eras of harsh winters have periodically returned, even in the last few thousand years, and again made life tougher for our recent ancestors. We are still not exactly certain why noticeable climate shifts have occurred every few hundred years. What is increasingly clear, however, is that every three to four centuries for the last few thousand years, the world has undergone a period of marked cooling. These cooling periods have generally shortened growing seasons; produced more disastrous floods, frosts, and hailstorms; and made it impossible to farm marginal lands that had previously been successfully brought under cultivation.

More hostile weather and less certain food supplies would likely make societies more vulnerable to disease. And indeed, each of the cooling periods appears to have been associated with outbreaks of ravaging epidemics. In the second and third centuries AD, massive plagues wreaked havoc on the early Roman Empire. Three centuries later, the Justinian plague of the sixth century killed perhaps one-third of the population of the eastern Roman Empire. In the ninth century, records are sparse in Europe, where the collapse of the Roman Empire had left civilization in chaos. However, records from China and Japan note epidemics—probably plague—that are reputed to have killed half the population of coastal China and Japan.

The four centuries from 900 to 1300 were a period of great prosperity and population growth all across Eurasia. However, from the early 1300s the plague spread from China across Asia and Europe all the way to

England, where it became known as the Black Death. From one-quarter to one-third of the population of Europe and Asia died. The Middle East and North Africa, especially Egypt, were equally affected. Recovery began only after 1450.

From about 1500 to the early or mid-1600s, population grew rapidly all over Europe, in the Middle East, and in China. Then once again—about three centuries after the first appearance of the Black Death, in the early and mid-1600s—new epidemics returned to Europe. This time smallpox and typhus joined a resurgence of the plague. Nonetheless, European death rates were not as high as before. In some war-ravaged areas, such as Germany (which was the main battleground in the Thirty Years' War [1618–1648]), combined war and disease deaths may have reached one-third of the population. But for most of Europe, not more than 10 to 15 percent of the population died, still a massive toll.

However, the lightness of disease mortality in Europe was more than offset by the devastating effects that European diseases had when they were introduced into the Americas. Before the arrival of Columbus, the temperate regions of North and South America appear to have been heavily settled. From the huge numbers of arrowheads and fishing hooks scattered across coastal regions of the United States to the impressive earthen mounds—many hundreds of feet across—raised by the Mississippi River Valley civilizations, there is evidence of large Native American populations who were never seen by subsequent explorers. And we know from direct observation by Cortés and Pizarro that the highlands and valleys of Mexico and Peru were teeming with people. Yet within a century of Europeans' arrival on the mainland of the Americas, these lands appeared nearly empty to later settlers. In the sixteenth and seventeenth centuries perhaps 80 to 90 percent of the pre-Columbian population perished by exposure to toxic germs—plague, smallpox, and others—introduced by Europeans and Africans to a population with no prior exposure, and hence no resistance, to these scourges.

Whether it was mainly the weather or just independent cycles of disease evolution that became worse during periods of harsh climate, few parts of the world were exempt from bouts of depopulation that occurred every three or four centuries and were generally followed by periods of stagnation or slow recovery. The result was a pattern of rise and fall of populations all across the globe.

What we do know, to sum up, is that all across Eurasia, from England to Japan, the last few thousand years have seen repeated, regular changes in climate and disease patterns, which in turn have produced cyclical changes in population. These changes in population in turn had visible effects on other aspects of society. Population cycles were linked to long-term changes in prices, urbanization, and incomes.

Patterns in Prices, Population, Urbanization, and Incomes

Figure 2.1, taken from *The Great Wave* by David Hackett Fischer, shows the long-term change in the price of items consumed in English households from the thirteenth to early twentieth century.[6] There are long periods in which prices rose considerably, and long periods in which they stagnated or fell. Similar patterns can be found in the prices of consumables in other countries in Europe and even in the Ottoman Empire and in China.

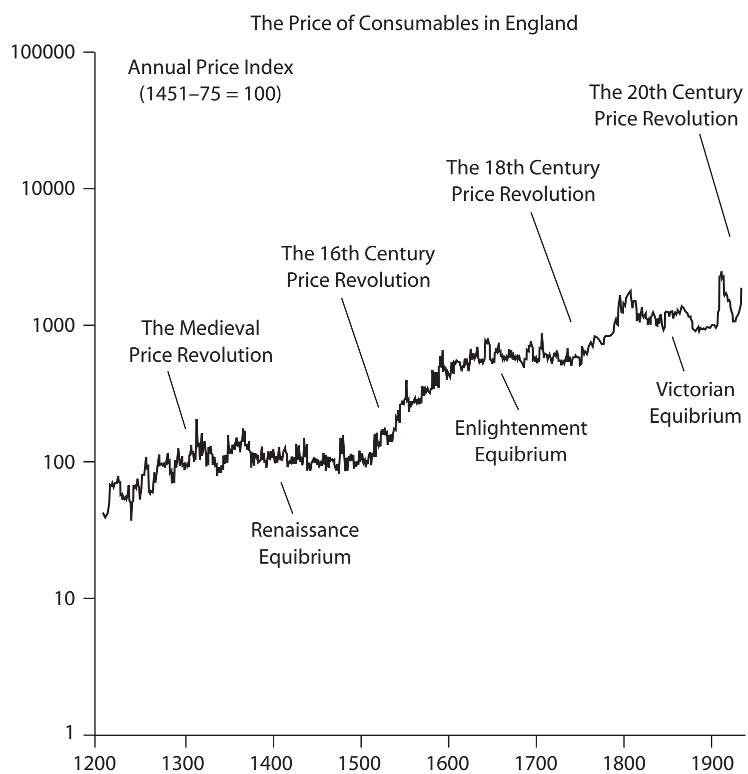


Figure 2.1 The Long Waves of Price Advance and Stagnation in England, 1200–1900

Since 1200, England has had 150- to 200-year periods of population growth and price inflation alternating with equally long periods of population decline or stability and price stagnation.

Generally speaking, periods when prices were rising were also times of economic and population booms, when population grew steadily, trade increased, and urban centers expanded. In England, during the sixteenth century Price Revolution (roughly from 1550 to 1650), the population rose from 3 million to 5.2 million, increasing by about 70 percent. But during the Enlightenment Equilibrium (roughly from 1650 to 1730), population first fell to less than 5 million, then stagnated; it was only 5.3 million at the end of this period—essentially no change at all. Then growth resumed, and during the eighteenth century Price Revolution (roughly from 1730 to 1850), England's population tripled to almost 17 million.[7] The growth rate of major cities followed a similar pattern: The population of England's five largest cities more than doubled between 1600 and 1675, but increased by only 50 percent in the following 75 years.[8]

Similar patterns hold all across Eurasia. Throughout Europe, in the Ottoman Empire, and in China, the sixteenth century was a time of growth in total population; of very rapid expansion of cities; and of rising prices for land, grains, and animal products. The later seventeenth century, however, was a period of stagnation and decline for these same factors.

These factors moved together because they were all closely linked through people's activities. If better weather or less disease allowed the population in an area to grow, that generally pushed up the price of food; people would then produce more food or more goods to trade for it, and trade would increase. Urban centers—where merchants met to make those trades—would increase in size. And people who could not find work or land in the countryside came to the city as well, to try their hand at manufacture or trade. Adding their products meant more things to trade, which kept the cycle going.

These cycles went into reverse during times of bad weather or disease that suppressed population growth for decades at a time. During these downswings, trade was often disrupted, merchants went bankrupt, not as many people moved from the country to cities, and prices of foodstuffs stabilized or even fell.

Oddly, the one thing that was good during these downswings was that the real wages of ordinary workers generally went up—as food prices went down, people could often afford more food (provided that they could find work). As Figure 2.2 shows, during the latter part of the long Renaissance price equilibrium (from 1450 to 1500), real average earnings rose to their highest level before the 1900s. In many ways, it was the worst of times—population had been devastated by the Black Death and its terrible mortality, and the Hundred Years' War (from 1337 to 1453) had raged across western Europe. But the result was that labor was scarce, and earnings for those who survived were relatively high.

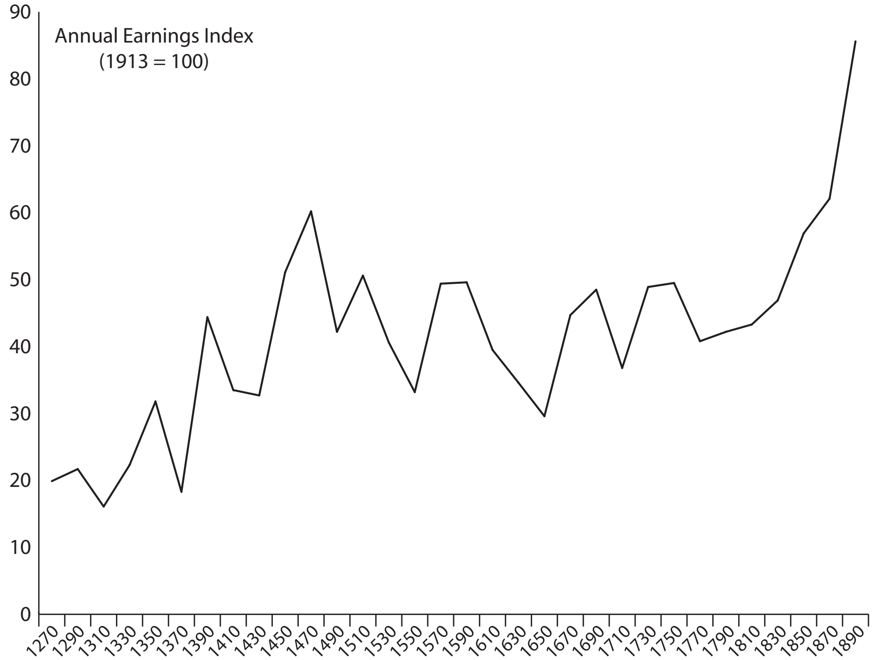


FIGURE 2.2 AVERAGE EARNINGS IN THE LONG RUN IN ENGLAND, 1270–1890 (INDEXED TO AVERAGE EARNINGS IN 1913 = 100)

After a rise following the Black Death (1350–1410), English workers' earnings remained basically unchanged for four centuries, to 1830. Only then did earnings suddenly start to rise, so that by 1890 workers' earnings had grown to double the level that had prevailed for the period from 1410 to 1830.

In short, the history of material life for most of the last 1,000 or 2,000 years has been one of long ups and downs but with little overall progress. As late as 1800, ordinary workers in England and Holland received roughly the same average earnings as workers in those countries 300 years earlier. Ordinary people in 1800 may have had access to a greater variety of products from expanding local and international trade, but they could not afford any more food or better shelter than their great-great-great-great-great-great-grandparents could.

As the centuries passed, there were periods of good times for merchants and landlords (who bought and sold foodstuffs and did best when prices were rising) interspersed with periods of good times for ordinary workers (who depended on wages or on subsistence farming combined with craft work and did best when food prices were stable or even declining). World economic history before 1800 shows many ups and downs, differing a bit across different areas and for different groups of people, but with relatively little overall change.

Living standards thus moved within a fairly fixed range for many centuries. Still we might ask: Weren't there big differences among different regions? Even if both Europeans and Chinese had their ups and downs, didn't the overall course of change leave Europeans richer and better off by 1800?

So far, the evidence does not support that view. If we look at basic measures of the physical well-being of the population—such as life expectancy or the calorie intake of an average family—we find that the Chinese and the English were about equal in 1800, and that both of those societies were well ahead of other regions in Europe such as Italy or Germany. (We look at all these things in more detail in Chapter 5.)

How long people lived depended a great deal on how well they ate, and here too we find evidence of very similar conditions across Eurasia. Robert Allen, Jack Goldstone, and Ken Pomeranz have all estimated the available income for Chinese and English families in terms of calories or the amount of food they could purchase. Their data show that in the years around 1750, the majority of Chinese families probably consumed as much as or more food than the majority of English families. These families did not necessarily carry out the same routines: By 1750 most Chinese families were still peasants engaged in farming and home crafts, while most English families were headed by wage workers in farming or manufacturing. Still, their average calorie consumption appears to have been very nearly the same, or slightly higher for the Chinese.[9]

One might immediately think that such a balance of income is astonishing—didn't Europeans have the lead in technology? Wasn't there an agricultural revolution in seventeenth century England that greatly increased productivity? Didn't the Dutch (that is, the people of the Netherlands, who spoke the Dutch language) have fantastic cargo ships, fishing vessels and windmills that did everything from sawing wood and pounding pulp to pumping water to clear swamps and irrigate canals? Didn't the Portuguese and Spanish (and later the English) lead the way in mastering the oceans and sailing the seas?

Long-Term and Global Patterns of Technological Change Before 1800

Just as ignoring the generally cyclical nature of change in long stretches of history can lead one to seize upon isolated or short-term upswings as breakthroughs, looking at only a few episodes of technological change can also be misleading. Let us look more closely at the global history of technology, and here too we will find more parallels than divergences between East and West in the period prior to 1800.

The first thing to realize about technological change before 1800 is that it certainly did occur. Roman aqueducts, Gothic cathedrals, and Islamic domed mosques were breakthroughs in architecture (skip ahead and look at Figure 7.1 to see what Roman builders could do almost 2,000 years ago). At different times, mounted knights, longbows, mounted archers, stone and earthen fortifications, gunpowder, the magnetic compass, sternpost rudders, and firearms all transformed exploration and warfare. The technology of organizing human activity changed as well. Trade shifted from caravans to corporations of merchants. In military organization, companies of knights and foot soldiers who could do little more than advance or retreat in response to orders gave way to well-drilled regiments that could execute hundreds of discrete movements and maneuvers at the shout of a command. States changed from little more than family-run endeavors to large and complex bureaucracies.

However, the second important thing to recognize about such technological and organizational changes is that they were widely scattered over space and time and tended to be isolated, rather than generating continuous and cumulative further change. A new technological complex—such as the military formations of the Roman legion or the earthwork fortifications of the Renaissance—might be invented and transform warfare but then would remain unchanged for hundreds of years. A millennium separates the invention of the Roman arch, used in the coliseums and aqueducts of the empire, from the invention of the flying buttress that supported soaring Gothic cathedrals. It took hundreds of years for even relatively simple technologies, such as wheelbarrows or clocks, to diffuse across Eurasia. Once people had discovered what seemed to be a superior way of doing things, they generally stuck to it rather than immediately seeking to change or further improve it.

Moreover, it is difficult to speak of overall technological leadership in this era, since so many different technologies were developed in different places and at different times. China took the lead in inventing or developing the wheelbarrow, canals and canal locks, the magnetic compass, exact mapping of large regions, the sternpost rudder ship, the oceangoing sailing vessel, gunpowder, cast iron, porcelain, silk, printing, and paper.

To illustrate China's early lead in shipbuilding, a complex technology requiring expertise in creating watertight joinery, strong rigging and sails, and overall design, Figure 2.3 compares the ships Columbus used to sail to America with the Chinese sailing ships commanded by Admiral Zheng He. Admiral He's fleet sailed from northern China to the coast of Africa and back—a far longer voyage than Columbus's trip from Spain to North America—some 80 years before Columbus.[10]

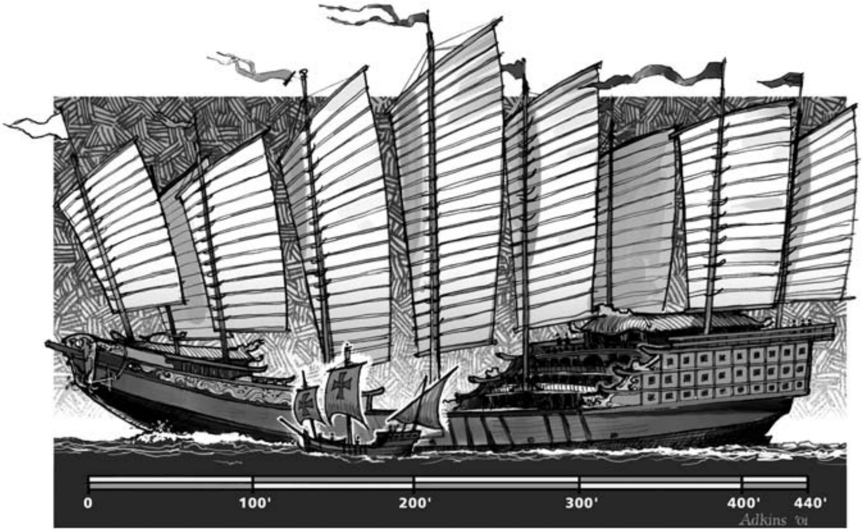


FIGURE 2.3 ADMIRAL ZHENG HE'S FLAGSHIP, COMPARED WITH COLUMBUS'S *SANTA MARIA*

In this drawing, Columbus's main ship, the *Santa Maria,* is pictured in front of the flagship of Zheng He's oceangoing fleet. Zheng He's flagship measured 135 meters, dwarfing the *Santa Maria,* which was only about 20 meters (or about 66 feet) in length.

India held the global lead in producing cotton textiles of outstanding variety and quality. The Muslim world excelled in producing spices and working in brass and wood inlay and was preeminent (as it remains to this day) in producing fine rugs and carpets. In Europe, Venice produced the world's finest and purest glass; England produced an outstanding variety and quality of woolen cloth; and the Netherlands excelled in fishing, printing, and brewing. Spain was famous for the silver it imported from the Americas, which it minted into coins—called pieces of eight—of such uniform weight and fineness that for much of the sixteenth and seventeenth centuries they became the first worldwide currency.

Japan and southeast Asia, Russia and Africa, all had their unique products and artisanal industries in which they achieved eminence—Russian furs and Japanese swords, for example, were the highest quality of their kind in the world, while Africa was the leading source of gold and ivory and exotic animal products. It was precisely this dispersion of technological talents that fueled the global trade linking Europe, Asia, and Africa that had been carried out by merchants since Roman times.

The best way to describe technological innovation and change before 1800 is to say that it was sporadic—different technologies were developed at different times and in different places and then not developed much further if at all. It is true that each such technological innovation conferred substantial benefits, in trade, in agricultural output, in transport, or in war. But because those innovations remained sporadic and isolated, they could not carry whole societies forward in leaps and bounds as the linked and accelerating technological changes of the past 200 years have done.

Let us look a bit more closely at two major technological changes in Britain to see how this worked—the agricultural revolution and the early stages of the Industrial Revolution." Both these events had certainly occurred by 1800—how is it possible that they left no mark on Britain's level of material well-being, compared with other leading societies and civilizations?[11]

Change or Revolution? Agricultural and Industrial Change Before 1800

For many years, school children in Europe and the Americas were taught that the rise of the West began in England in the seventeenth and eighteenth centuries. In this period, England was said to have created an agricultural revolution that boosted agricultural productivity to unprecedented levels. This increase in agricultural production was then said to have provided the basis for feeding large numbers of workers in manufacturing, who toiled in new water-powered factories to spin bale upon bale of cheap cotton thread that undercut competitors worldwide and thus launched the Industrial Revolution.

We now know that this story is something of a myth. There were changes in English agriculture, to be sure, and they did produce higher output. But they were hardly a revolution, if by that is meant pushing productivity to historically new levels. As early as the Middle Ages, farmers in Norfolk county near the thriving commercial city of Norwich had produced as much as 25 bushels of wheat per acre by planting clover and other fodder crops to feed sheep and using the sheep manure as intensive fertilizer to increase their yield of barley and wheat. This level of productivity, achieved in Norfolk in 1300, was not exceeded for another 500 years. The "Norfolk rotation" was thus an old success story. Flemish farmers in Flanders, in northern France, had been doing something similar for generations as well.

In the sixteenth and seventeenth centuries, first the Dutch and then the English began to experiment with more varieties of seeds and fodder crops and more breeds of animals to extend these intensive farming methods to more and more regions. By using more animal manure, different combinations of grain and fodder crops, and learning to make the best use of specialized soil and climate zones for particular kinds of farming, English farmers were not only able to feed a population in 1750 that was about the same size as the population in 1650 (and even export surplus grain abroad), but also achieved this with about one-third fewer farm workers than had been required earlier.[12]

Where did those workers go? Some simply went into terrible rural poverty. Others were herded into workhouses by the authorities or moved to city slums. Some, after 1770, went to work in the new factories producing cotton thread and woolen yarn. But those factories, using new machines invented in the 1760s, only employed a few percent of England's population by 1800—nowhere near the roughly one-third of its population that was no longer needed in farming to feed the population. Those millions went mainly into traditional urban and rural crafts or unskilled labor. Many worked at producing textiles and clothing, whether becoming handicraft weavers who set up small looms in their cottages to weave thread into cloth, or doing embroidery, lacework, or tailoring. Others worked for wealthy households as domestic servants or toiled on construction sites or in breweries. Still others took up traditional crafts in wood, leather, and metalwork or labored in shops, taverns, and market stalls.

Those workers now also exhibited another characteristic—they no longer needed to wait to inherit a farm to start a family; they merely needed to find a job or set up a loom to make an income from weaving. So these workers began to marry at younger ages, propelling a population boom in England. But this created another problem: The improvements in agriculture had not boosted total production enough to keep pace with yet a further population surge.

From roughly 1660 to 1760, England's population was nearly constant, so the improvements in agriculture had allowed England to feed itself and even export extra grain with far fewer farm workers. But after 1760, when population growth resumed, this situation changed. Population grew, while agricultural productivity hardly increased any further. By 1800, food production had clearly fallen behind population growth, real wages had fallen, and England had to import grain from Ireland, the Netherlands, and Germany to feed its people.

In short, we find another cycle, not a revolution. A substantial increase in agricultural output did occur from 1600 to 1760 as a result of the improvement and spread of better farming methods. But there was no breakthrough to completely new methods of farming or unprecedented levels of output per acre. The vast majority of those who left farming did not go into new industries, but into traditional crafts and occupations. And from 1760 to 1800, England's agriculture again was failing to produce enough food to feed its population.

At the same time, China too was experiencing major improvements in its agriculture. In China, people grew and ate mostly rice, not wheat and rye as did Europeans. One advantage of rice is that it can be planted in low and wet fields and in mud. This meant the soil required less plowing to break up and aerate the clods, and so far less animal power was needed for farming. This in turn meant more land could be planted for human food. As a further bonus, rice plants produced far more edible grain per plant than wheat or rye. The problem for rice farmers was that low-lying rice fields were often too severely flooded or were hard to farm if the weather was too dry. Seasonal monsoons—which delivered the rains, but sometimes brought too much or too little—made rice farming possible, but also precarious.

In the fifteenth and sixteenth centuries, Chinese farmers began to experiment with more varieties of seeds and animals. They found that one particular strain of rice, the champa variety from the Vietnam area, grew very fast and matured early. These characteristics allowed the rice crop to be grown and harvested in a short enough time that farmers could then grow another crop of wheat or beans on the same land later in the year. This double-cropping of the same land greatly increased output. In addition, new strains of rice were developed that were more tolerant of dryness, or flooding, or salty water, allowing rice to be grown on more lands. The cultivation of cotton, corn, and soybeans also spread in areas not well suited for growing rice.

Over the sixteenth and seventeenth centuries, the Chinese developed a wide array of double and multiple crop rotations adapted to different areas and crops. In the north, where it was too dry for rice, the Chinese grew sorghum and soybeans and cotton in rotation; in the south they grew rice and wheat or rice and beans; in certain upland areas they grew corn and beans; in other areas they grew tea. By the eighteenth century, the Chinese grew such a variety of crops in such vast amounts that it fueled an enormous trade—larger than that of Europe and North America—in cotton, beancake, rice, wheat, and other products. The growth in food output was such that unlike England, China did not have to import food grains. China's population was able to more than double from 1700 to 1800, with very little change in the standard of living. In fact, as of 1800 the average Chinese farmer probably ate better than the average English farm worker or urban laborer.

Chinese and Indian production of cotton textiles in the eighteenth century also exceeded that of Britain, in quality and quantity. The Chinese had started growing cotton, spinning it into thread, and weaving it into cloth on a large scale from the late fourteenth century. The Chinese had developed water-powered spinning machinery to draw out threads from ramie, a rough plant fiber, a century earlier.[13] But for spinning cotton, they preferred to use small spinning wheels in family homes. Unlike most European spinners, however, the more skilled among the Chinese used multispindle machines powered by foot treadles, which allowed spinning two, three, or even more spindles at once. The best Chinese home spinners were thus two or three times as productive as their European counterparts and thus had less to gain from the simple water-powered machinery introduced in Britain in the 1760s. The Chinese excelled in producing very fine yarns and weaving them into light cloth so that even in the early 1800s, European merchants were still buying bolts of high quality Chinese cotton to sell in Europe.

In India, cotton had been produced for thousands of years and was exported as a luxury good to the Romans and Persians. Even though cotton cultivation spread throughout Asia and the Middle East, India remained the world's highest quality producer of lightweight, brightly colored cotton cloth. In the seventeenth and eighteenth centuries, the Indian region of Bengal was a global export center, sending high-quality cottons to England, central Asia, and the Middle East.

In fact, in the late 1700s, although the British were producing good strong cotton thread from water-powered factories, this thread was too coarse for the taste of many Asians, who preferred their own finer yarns. Among woven and dyed fabrics, the calicoes of India and prints of China remained finer than anything European craftspeople could produce. China and India thus continued to dominate global trade in cotton textiles until 1800.

Britain's early Industrial Revolution—until 1800—consisted mainly of a substantial expansion of the production of cotton thread by water-powered spinning factories, increased output and use of coal, the development of a domestic pottery industry capable of creating quality porcelain, and the production of a wide range of iron and steel goods from medium-size forges. These were all striking advances for Britain, but in many ways were actually a catching up with the advanced civilizations of Asia, which already produced high-quality cotton cloth, porcelain, and cast iron in vast quantities.

In most parts of Asia during the seventeenth and eighteenth centuries, the silk, cotton, and porcelain industries underwent a huge expansion of manufacturing that dwarfed anything seen in Europe. In these centuries the English, Dutch, Portuguese, and Spanish sent hundreds of ships bearing silver to Asia, ships whose goal was to return laden with Indian and Chinese cotton cloth and with Chinese silks and porcelains. Even in the early nineteenth century, the British were desperate to find goods that they could trade with China, for the Chinese placed little value on what they saw as inferior European manufactured goods. It was for this reason that the British encouraged the growing of the addictive drug opium in India and forced the Chinese to accept a trade in opium as the means to finance British trade. Far from experiencing a revolution in manufacturing, Britain in the eighteenth century was merely achieving a certain amount of parity with more advanced manufacturing processes in Asia. The days in which British and European exports of manufactured goods would dominate the world still lay in the future.

In short, by 1800, both Britain and China had experienced substantial changes in their economies and seen major increases in their output of both foodstuffs and cotton textiles. Yet neither had experienced any true breakthrough to a higher standard of living. Both societies were still operating within the range of the long-term cycles of prior centuries as to how well people lived. Long-terms ups and downs in climate, population, and earnings produced ups and downs in living standards as well. The true breakthroughs that created a different world still lay ahead. The pattern of accelerating economic growth does not appear until after 1800, when it begins in Britain and then spreads to western Europe, eastern Asia, and the rest of the world.

The advanced agrarian civilizations of Europe and Asia thus lived at much the same level in 1800. What then accounts for their rapid divergence? If it was not how they lived, perhaps it was how they thought or what they believed that made the crucial difference. Let us now take a comparative look at world religions.

Additional Reading

Fischer, David Hackett. *The Great Wave: Price Revolutions and the Rhythm of History.* Oxford: Oxford University Press, 1996.

Hatcher, John. *Plague, Population, and the English Economy 1348–1530.* London: Macmillan, 1977.

CHAPTER THREE

The Great Religions and Social Change

CHAPTER PREVIEW: The world's great religions have much in common in their origins and basic beliefs. If religion has an effect on economic growth, it is not because the beliefs of any one religion are better suited to economic growth. Rather, times and places wherein different religions freely mixed were characterized by more innovation and growth. Such growth tended to be stifled where religious authorities imposed a single rigid orthodoxy.

From the time that people first began to express themselves in sculptures and paintings on the sides of caves, men and women have pictured supernatural beings associated with the forces of nature such as rain, wind, and fire; with the mysteries of life and death; and with the wanderers in the night skies—the sun, the moon, and the planets. Such religions with many gods (called "polytheistic," from the Greek words for "many," *poly,* and "god," *theos*) have been common in all parts of the world throughout history and persist in some cultures today.

Although we sometimes call such religions primitive, that is an error. Polytheistic religions were practiced by many advanced civilizations, such as those of the classical Greeks and Romans, that were distinguished for their complex philosophy and literature. Most polytheistic religions have rich oral or literary traditions of considerable subtlety and moral depth and show a long-accumulated wisdom in human affairs. Most polytheistic religions also developed elaborate priesthoods and ceremonies to record, influence, and interpret the wishes of the gods.

However, a shift away from polytheism began to spread throughout the Old World in what social scientists call the *axial age,* roughly from 600 BC to AD 630.[1] Although we find new religions being born and old religions splitting into sects and giving rise to new patterns of beliefs throughout history, this period was exceptional for giving rise to what are today called the great or world religions of rabbinical Judaism, Confucianism, Buddhism, Hinduism, Christianity, and Islam.

The Axial Age and Religions of Salvation

Although all of the great religions absorbed and borrowed elements from polytheistic religions, they shifted their emphasis away from interpreting the wishes of a vast pantheon of different gods. Instead, the world religions all shared three major characteristics that distinguished them from prior polytheistic beliefs. First, they sought to look behind the various gods to a single fundamental source of order in the universe. That single supreme deity might appear in different forms (such as the Father, Son, and Holy Ghost of the Christian trinity or the Hindu trinity of Brahma, Vishnu, and Shiva), and the faithful might recognize other beings who share aspects or elements of divinity (angels, saints, paragons), but only one supreme being or source of universal order is at the center of these religions. Second, they insisted that a single, overarching moral code of righteous behavior was necessary to live in accord with that fundamental source of order. Third, they argued that their faith was accessible to all human beings.

Polytheistic religions had found it relatively easy to simply accept that different peoples had different gods, since the basic principle of polytheism was that many different gods could coexist on something like equal and competing terms. However, the new monotheistic (from the Greek words for "one god") religions argued that there was only one true source of fundamental order for everyone on the planet (or in the universe, if there are other beings elsewhere).

Several of the great religions had their origins much earlier. Judaism traces its origins to the assertion of monotheism and an attack on idolatry by Abraham of Ur, around 1800 BC. The *I Ching* of Confucian tradition had its origins long before Confucius, around 1000 BC. And the earliest versions of some Hindu texts (e.g., the *Rig Veda*) were composed around 1500 BC. However, it is only in the axial age that all of the major sacred texts of the great religions become fixed in something like their current form.

The axial age spanned the years in which the Old Testament was enriched with the teachings of the Hebrew prophets and the Talmudic school of interpretation arose, and in which the life of Jesus and his teachings were presented in the New Testament by his apostles. Also in this period, the Upanishads were composed in India as the authoritative commentary on the Hindu Vedic scriptures. The key figures of the axial age—Jesus in

Palestine, Siddhartha Guatama (the Buddha) in India, Confucius and Laozi (founder of Taoism) in China, and Muhammad in Arabia—all lived, taught, and gained their chief disciples during these centuries. This period also saw the origins of Western philosophy in the works of Socrates, Parmenides, Plato, and Aristotle.

The axial age lasted roughly 1,200 years—a long period—yet nothing quite like this remarkable emergence of world religions occurs in any other period. Why did it happen?

No one can say for sure. But the most likely cause was that from roughly 700 BC, contacts among different parts of the Old World led to a sharing of ideas and of questions about life and the universe across different cultures. Greeks increased their contacts with Persia and Egypt; the Chinese increased their contacts with India and Southeast Asia, and the Middle East became a crossroads of civilizations. Philosophers and prophets were forced to think about systems of morality and ethics that would transcend the specific circumstances of their own local group; in response they searched for universal principles of moral behavior and values.

The breakthrough of the axial age was replacing animal sacrifices and rituals with a code of moral and ethical behavior. These rules for righteous behavior, usually presented through stories showing the consequences of right and wrong behavior, were compiled in sacred texts such as the Old and New Testaments, the Analects, the Vedas, and the Koran. These religions offered their followers a promise of salvation or relief from earthly suffering if they would follow the moral codes.

In the process of reasoning and developing moral codes, the great religious and philosophical traditions drew on and were influenced by each other. Both Christianity and Islam were powerfully influenced by the Hebrew Old Testament and by Greek philosophy. Buddhism developed out of Hinduism and greatly influenced later developments in Confucianism. To this day, the process of newer religions developing on the foundations of older ones—Mormonism as an offshoot of Christianity and Baha'i as a development from Islam—continues. However, and perhaps remarkably, the great majority of the world's population today still follows one of the major faiths that developed during the axial age, just as they did many centuries ago.

Secular and Sacred Rules: The Clash of Religion and Empire

The rise of the great religions spread a concern for ethical and moral behavior across the Old World but also raised a new problem: How should the need to follow the word of God be reconciled with the need to follow the commands of earthly rulers—the kings and emperors who ruled over various territories?

The problems involved in reconciling the requirements of new religions, which made major demands on people's energy and behavior, with the demands of earthly rulers, who also sought loyalty and obedience, became one of the great drivers of social change over the last 2,000 years. Different societies tried different solutions to this problem, and different solutions held sway at various points in time.

One approach was simply to have the same people serve as leaders of both religion and society. Although this seems like a simple solution, it almost never worked in practice. Becoming a specialist or leader in matters of religion required a certain style of life—devotion to the study of sacred texts and exemplary behavior in regard to the moral rules—that was seen as far too demanding by the majority of the kings, nobles, and wealthy merchants, whose pleasures consisted mainly of hunting, fighting, and lusting. These latter elites might be happy to have a priest lead them in ritual devotions or even, in extreme old age, retire to a monastery and adopt the religious life, but for the most part those who wielded earthly wealth and authority were unwilling to give up their power or their pleasures. Rulers therefore sought to find a form of social organization that would allow a sharing of power and status between the kings or emperors who commanded a society's armies and the priests or prophets who commanded its souls.

Only in China did the simplest solution—having the same elites lead both religion and the state—eventually work out fairly well. From the time of Confucius (551–479 BC)[2] in the sixth century until the Song dynasty in the twelfth century AD, a variety of religious faiths spread through China, including Taoism, Buddhism, and others. At times, there were major conflicts between China's imperial court and religious specialists, particularly the Buddhist monks—whose monasteries spread throughout China and acquired considerable wealth and influence. To this day, certain Buddhist religious leaders and China's secular government remain in contention over leadership of the territory of Tibet. However, by the time of the Song Dynasty, the scholar Zhu Xi (1130–1200) developed a synthesis based mainly on the works of Confucius and his great follower Mencius that became the dominant moral and philosophical foundation for China. In Zhu Xi's interpretation of the Confucian texts the core moral principles are righteousness, filial devotion to parents, loyalty to one's ruler, and respect for proper rituals.

Zhu Xi turned away from Buddhism, which argued that all our perceptions of reality are illusions to overcome and escape; he also turned away from a legalist framework that would put all decisions regarding right and wrong under the absolute power of the emperor. Instead, he argued that there is a code of moral values that stands apart from political decisions and regulates all relations among rulers and peoples; he also argued that behavior is real and meaningful and should be righteous.

The Zhu Xi or neo-Confucian program became the basis of all official education in China from the early fourteenth century until the collapse of the Qing dynasty early in the twentieth century. Throughout this period, China's elites—the officials who ran the empire for the emperor, from the level of imperial grand secretaries to county magistrates—were selected based on their performance on examinations testing their knowledge of the Confucian classics and their moral principles. Oversight of examinations, publication of official texts of the classics, and directing the Ministry of Rights to oversee the proper performance of rituals (for harvests, the seasons, births, marriages, and funerals) all became key parts of China's imperial regime.

In every reign, there were officials who, following the dictates of their conscience, risked beatings, exile, or even death for reprimanding the emperor or higher officials for acting contrary to Confucian values. Yet for the most part, Confucianism provided a remarkably stable foundation for the unity, status, and power of China's elites, from the emperor and his court down to local schoolteachers and village elders who were entrusted with teaching the classic texts and administering Confucian rituals. Mastery of Confucian texts and conduct in accord with Confucian principles became the mark of all educated or influential individuals throughout the empire. Thus the Chinese officials functioned as both the religious and political elite.

A second, rather different, approach was for the religious leaders or specialists to simply withdraw from the normal routines of political and economic life and confine themselves to special sites (such as monasteries) in which they could practice and teach their religion free of the need to compromise or clash with secular authorities. Monasticism has been a practice in many major religions, including Christianity, Hinduism, Islam (in Sufi orders), and particularly in Buddhism.

In most Buddhist countries, such as Thailand, the political rulers are wholly in charge of daily life, while religious practice is centered on monastic institutions. Many people enter a monastery for religious training at some point in their lives. Although exceptions exist (such as in Tibetan Buddhism, where the Dalai Lama was both the spiritual and political leader of the Tibetan people prior to their incorporation into China), for the most part Buddhist religious specialists cope with secular authority by withdrawing from the field.

A third approach is for religious leaders to focus on tending to the spiritual and ritual needs of their local communities, acting as teachers and moral guides and leaving political leadership to secular rulers. This is the approach generally followed in Hinduism, where religious specialists in each local community (the Brahmins) focus on spiritual direction and instruction, while specialists in politics or economics (the military or merchant castes) focus on war, politics, and the creation of wealth. It has also been typical of Judaism since the destruction of the Jewish state under the Roman Empire, with rabbis operating as specialists in Jewish law, ritual, and spiritual authority, but not claiming any political or economic roles.

Finally, a fourth approach is for religious leaders to constitute themselves as a power in their own right, separate from secular rulers, with holdings of land and political authority over a subject population in addition to their spiritual authority. This approach gives great power to religious elites, but it is also most likely to lead to clashes between religious and secular leaders, each seeking to increase or protect their political power.

Both Christianity and Islam have used several of these approaches, in different places and at different times. In most Muslim lands that follow the Sunni variety of Islam, religious specialists have adopted the third approach. That is, they have adopted roles as teachers and judges and work in local communities but do not seek to exercise political authority. They do not constitute themselves as a coherent priesthood or ecclesiastical hierarchy but rather work as small groups of scholars or sages.

However, in Persia and other regions where the Shi'a variety of Islam prevailed, the religious specialists constituted themselves as an integrated hierarchy and adopted a more active role in politics. Shi'ites believe that political as well as spiritual authority should follow the line of succession from the family of the Prophet Muhammad. Yet because the direct line of descendants has been lost or broken, many Shi'a clerics argue that the next best course is for religious leaders to play a major, even dominant, role in political and religious affairs. Today, the Islamic Republic of Iran (the former Persia) is led by a Supreme Leader and a Council of Guardians, all of whom are senior religious leaders, who must approve all laws and all candidates for the elected presidency and parliament. It is the largest country in the world ruled by religious elites.

Christianity has had perhaps the most varied and tangled set of approaches to the issue of religious versus secular authority. Early Christians often withdrew from society into monasteries, and monasticism remains a recurrently popular, even powerful, element in Christianity. But Christian leaders also organized their church for involvement in social life. Under the Roman Empire, the Christian Church constituted itself as a hierarchy of priests and bishops and archbishops, led by the pope in Rome.

At first, this hierarchy was mainly concerned with defending Christian doctrine, recruiting adherents, and working for the salvation of believers.

However, over the centuries, as wealthy Romans left their property in increasing measure to the church (to pay for prayers for their souls in the afterlife), the church came to accumulate more and more land and wealth. When the Roman Empire collapsed in western Europe in AD 476, the church hierarchy found itself the only power left in many regions. Although the Catholic Church learned to work with the powerful Germanic kings and nobles who conquered Western Europe, such as Charlemagne—who was crowned emperor by the pope—many church leaders held enough land and commanded enough servants to rival nobles and even kings in their wealth and political power.

Eventually, after centuries of conflict throughout the Middle Ages, the major kings of Europe established political control in their territories, leaving the pope in control only of certain papal territories in central Italy, and a variety of independent bishops in control of small sovereign estates in northern and central Europe. (Many of these were located within the boundaries of the Holy Roman Empire, shown in Figure 1.1, page 5.) However, in every kingdom in Europe the bishops and abbots (the leaders of wealthy monasteries) were counted among the important lords and nobles, often playing a crucial role in the king's government as ministers, judges, or leading participants in councils and parliaments. A kind of partnership developed in which the Catholic Church agreed to defend the divine right of kings to unchallenged rule as God's chosen rulers, while the kings defended the wealth and political power of church leaders. As one Christian king (James I of England) was fond of saying, "No bishops, no king"—as each supported the authority of the other.

A similar, but slightly different form of harmony between rulers and religious elites developed in the lands of Eastern Orthodox Christianity, from Greece to Russia. When the western Roman Empire fell after the collapse of its government in Rome, the eastern Roman or Byzantine Empire—ruled from Constantinople—survived. Indeed, it not only survived but thrived as a center of East-West trade and Christian learning. Fashioning itself as the "New Rome," the imperial government in Constantinople developed into an intensely Christian empire (unlike Rome, which had been pagan for most of its years leading the republic and empire), adopting the rites and organization that have come to be known as those of the Eastern Orthodox Church.

In the Byzantine Empire, the emperor acquired semidivine status as Christ's emissary and the chief guardian of Christian society on Earth. The Byzantine Empire lasted almost 1,000 years beyond the fall of the western Roman Empire and bequeathed its traditions of Christian art and worship to Christian communities throughout southeastern Europe and parts of the Middle East.

Russia converted to Orthodoxy in AD 988 and, after the fall of the Byzantine Empire to the Ottomans in 1453, the Russian church became an independent branch of eastern Orthodoxy with its own patriarch in Moscow. Although the Orthodox Church in Russia liked to claim that Moscow had become, after the fall of Constantinople, "The Third Rome," the various Orthodox patriarchs throughout southern and eastern Europe and the Middle East continued to operate independently as the religious leaders of their domains. Moreover, the tradition of a dominant, semidivine ruler meant that the rulers of Russia, the Ottoman Empire, and other political lords of Orthodox lands were seldom challenged by leaders of the Orthodox Church.

In general, by about AD 1500, or almost 1,000 years after the close of the axial age, this kind of mutual support arrangement—with political rulers generally using their power to uphold the authority of religious leaders, and in return religious leaders using their moral authority to defend the authority of kings and other lords as an inevitable part of God's divine plan—came to prevail in almost all major world religions.

In India, Brahmin religious elites teamed up with warriors and kings to maintain the social order, while in China Confucian elites supported the Chinese emperors. In the Muslim lands, Koranic scholars and judges supported the authority of ruling shahs and sultans, who in turn granted privileged status to the Muslim religion and Muslim institutions. And in Christendom, priests and bishops served, and were preserved by, kings, dukes, tsars, and princes.

Also in almost all regions, the temples and churches of the major religions amassed considerable wealth, and their leaders acquired great influence in affairs of state. Those who paid for this arrangement were ordinary peasants and workers, and non-noble businessmen and craftsmen, who were instructed that it was their holy duty to pay taxes, tithes, fees, and dues to support the priests, bishops, nobles, and kings.

Religion and Economic Growth: Traditional Theories

If the world religions of 1500 were similar in offering moral codes, a singular guiding power, promises of salvation, and cooperation with noble and royal leaders, what role could religion have played in leading to a distinctive rise of the West?

Two basic proposals attempt to explain how religious factors could have produced a unique Western path to riches: One proposal is that

Western religion is generally different from Eastern religion. Western religion, it is suggested, is more active and more interested in controlling nature and thus drives its believers toward exploration, acquisition, and material progress. Eastern religions, by contrast, are more passive, more interested in harmonious cooperation with nature, and less interested in spreading their beliefs. They thus fostered a more contemplative, mystical, inward-turning attitude that led to great literature and moral debate, but not to outward striving and material gains.

We will examine whether this is true below. But we should also consider a second claim, first expressed by the German sociologist Max Weber. Weber argued that one particular Western religion—the Calvinist Protestantism that arose in the Reformation of the sixteenth century—is what made the West different.[3] Protestantism is credited with three major shifts in Western history that increased Europe's material wealth.

First, the Protestant Reformation prevented the rise of a pan-European empire that could have imposed a stifling orthodoxy throughout Europe. The Reformation led to a division of Western Europe into competing Protestant states—of which the most powerful were the Netherlands, England, Sweden, and Brandenburg-Prussia—and Catholic states, of which the strongest were Spain, the Austrian Empire (which came to include Bohemia, Hungary, and northern Italy), and France. The balance of competition among all of these entities, it is argued, led to the development of modern nation-states as rulers sought to mobilize and discipline their populations to compete with and defend themselves against rival states. The variety of states with different beliefs also allowed a large number of different approaches to government, social structure, and economic organization to emerge. By contrast, the large empires of Asia, uniting tens of millions of people under uniform imperial systems, remained stagnant, maintaining traditional orthodoxies in their institutions and beliefs.

Second, the Reformation led adopters of Protestantism away from the dedication of wealth to the church. Instead of seeking salvation through withdrawal from the world or giving up their worldly wealth, converts to Calvinist sects were told to focus their religious energy on leading simple but industrious lives, avoiding both idleness and ostentatious riches. They were instructed to show their worthiness for salvation by their thrift and modesty and also by constant involvement in useful activity and success in their business. The extraordinary dedication to work, savings, and investment of these followers of the Protestant ethic led to their steady accumulation of profits and the creation of large and powerful firms. The rapidly mounting prosperity of Protestant communities—which set the pace for all other European communities—thus spurred the unique material progress of the West.

Third, the Protestant faith emphasized Bible-reading and personal relationships with God, rather than following the authority of the pope and relying on the intercession of priests and saints to earn the favor of the Lord. Protestantism thus led to a boom in printing and literacy (so believers could have direct access to sermons and biblical texts), and to questioning received authority, including that of the ancient philosophers as well as churchmen. Protestantism thus led to a reinvigoration of independent thought that paved the way for the modern scientific revolution and thereby the future power of Western science and technology.

Altogether, these arguments make a powerful case that Western society was somehow more dynamic and that its rise and eventual superiority was inevitable. Enormous differences have thus been read into the world's great religions, despite their fundamental agreements and similarities. This interpretation of history has become known as orientalism—that is, a belief that Eastern and Western societies are deeply different in ways that disadvantage societies outside the West.

As we shall see, such beliefs were used to justify Western imperialism. To this day, many Westerners look at Islamic societies and claim to see a radically different, sometimes threatening, sometimes backward, way of living. Yet orientalism and the specific arguments about religious differences in the rise of the West are based on a series of misunderstandings and distortions of history and religion. From the economic dynamism of modern-day Confucian, Hindu, and Buddhist societies (China, Korea, India, Sri Lanka, Thailand), to the outstanding technical achievements of pre-modern Eastern societies—many of which were critical for the West's later progress—the notion that Asian societies were inherently stagnant or backward is easily disproved.

Religion and Economic Growth: A Closer Look

First, the very notion of Eastern versus Western religion is something of a misnomer. Is Islam an Eastern or Western religion? Like Christianity and Judaism, Islam is based on the teachings of Abraham, Moses, and Jesus and centers on a sacred text of histories and moral laws. Like Christianity, Islam is fiercely evangelical, having been spread throughout the world by fervent believers. Like Christianity, Islam was a religion of enterprising explorers and traders who established ports along the coast of Africa, penetrated its interior and traded from the China Sea to the Mediterranean. In short, Islam seems in every respect an active, dynamic, "Western" religion. Nonetheless, the lands of Islam were largely excluded from the rise of the West after 1800 and instead suffered relative economic and political decline in the nineteenth century.

Moving farther east, Buddhism too was actively spread by believers throughout southern and eastern Asia and was a religion of traders and explorers. Buddhists were also industrious and thrifty and enthusiastic in remolding nature through agriculture and engineering, as the remarkable monastery complexes of Tibet and southeast Asia reveal. Indeed, some scholars have argued that the Buddhist monasteries of the East were a model of acquisitive enterprise and early capitalism.[4]

Indeed, for almost 1,000 years, from AD 500 to nearly AD 1500, it was Chinese, Indian, and Arabic merchants, seafarers, and explorers who created a global network of East-West trade. The Chinese admiral Zheng He (whose flagship was shown in Chapter 2) traveled from China across the Indian Ocean to the coast of Africa. Indian merchants settled from Zanzibar to Indonesia. Muslim merchants traveled the silk roads through Persia, central Asia, and China and traveled west to Spain and Morocco and as far north as England. Meanwhile, European merchants and seafarers, though imbued with Western religion, remained within the coastal waters of Europe, from the North Sea to the Mediterranean. We shall look in more detail at global trade in Chapter 4; but it is no longer possible to claim that Westerners have always been more vigorous in expanding their religious, trade, or geographic frontiers than Easterners.

Indeed, quite the reverse. A generation of research in economic history makes it clear that for most of the first 2,000 years of Christianity, India, China, Japan, and the Middle East were richer and more powerful than Western Europe. The greatness of Rome (Christianized from the third century AD) was overwhelmed first by Germanic tribes, then by Arabs spreading Islam, and finally by Muslim Turks. Throughout the Christian era, while the Chinese and Indians were inventing technologies that transformed agriculture, commerce, seafaring, and warfare (detailed in earlier chapters), the Europeans of the Middle Ages simply sought to borrow and catch up. European technology eventually surpassed that of the rest of the world—but not until relatively recently, in the nineteenth and twentieth centuries. For dozens of centuries, the lands of Eastern religions were economically, technically, and militarily equal to or ahead of those of Christianity. There is no evidence here for any long-term European superiority.

The claims regarding Protestantism and its impact on European states, individuals, and knowledge are more complex; but again the arguments regarding the impact of Protestantism seem overdrawn. It is certainly true that the Reformation split Christendom and helped lead to a system of religiously and economically competing states. Yet such a system of competing states was neither unique to Europe nor generally led to greater prosperity.

The Indian subcontinent was never unified and spent most of its history divided by military and religious competition among Muslim, Sikh, and Hindu empires, states, and princedoms. Southeast Asia was similarly divided into multiple, competing states, many of which were quite wealthy. Although China did spend most of its history from 1279 onward as a unified empire, it was nonetheless in constant military competition with central Asian states, some of which had great success against China. It was not until the high point of the Qing dynasty in the mid-1700s that most of central Asia was brought under Chinese control. In the lands of Islam, from the twelfth century onward, the Muslim world was persistently divided among warring states, most notably the Persians, the Turks, and the Arabs.

Even in Europe, simply being part of a system of competing states generally did not promote economic progress. Russia and the Ottoman Empire were integral parts of the European competing-states system, as were Austria-Hungary, Poland, Lithuania, Naples, the states of northern Italy, Spain, and Portugal. Yet none of these areas showed any great economic response to being part of such a system. Rather, all these states lagged badly behind the economies of England and Holland well into the nineteenth and twentieth centuries.

Of course, these last two states were both Protestant nations. Did Protestant beliefs perhaps provide the unique key to modern growth? Again, the evidence cannot support such a claim. Some Protestant states were economic leaders at certain times, but others were economic laggards. Catholic states were similarly varied in their success.

Protestantism emerged in the early sixteenth century, and its Calvinist branch took root most strongly in Geneva (Switzerland), Scotland, and the Netherlands. Yet throughout the sixteenth century, the creative and economic dynamos of Europe were the Catholic cities of Renaissance Italy, and the leaders of global exploration and commerce were Catholic Portugal and Spain. Most Protestant nations—including Switzerland, Scotland, Brandenburg-Prussia, Sweden, Denmark, and England—made no great economic advances in the sixteenth century, whereas Catholic nations led the conquest of the New World and the opening of maritime trade with India, China, and Africa.

Protestant Holland did become the dynamic hub of Western Europe and the technological leader in windmills, brewing, shipping, and finance for a time, during the Dutch Golden Age of the seventeenth century. But its Golden Age was short-lived—by the mid-eighteenth century, Holland's shipping and manufacturing went into a sharp decline. In the century after 1750, when Protestant Britain became the world's leading industrial nation, it was followed most closely by the Catholic countries Belgium and France, whose industrialization forged ahead rapidly while other Protestant nations (Prussia, Sweden, Denmark, and even Holland) fell behind. Thus during the centuries from 1500 to 1850, one cannot explain economic advance or industrialization in different countries simply by pointing to their religion.

Finally, what of the claim that Protestantism, by undermining established religious and philosophical authority, provided the key impetus to the modern scientific revolution? This claim, too, depends on rather selective readings of the history of science. Certain key figures in the development of modern science and technology were Protestants, to be sure—Johannes Kepler, Robert Boyle, Isaac Newton, and James Watt are among the most famous. But the most dramatic challenges to the authority of the church came from the scientific claims of three Catholics in central and southern Europe: Copernicus, Galileo, and Descartes. Copernicus, the father of the heliocentric theory (placing the sun at the center of the solar system) was a Catholic priest and dedicated his book to the pope. Copernicus's friends were most concerned that he would be attacked by the Lutherans, whose emphasis on Bible reading was not accompanied by much flexibility in biblical interpretation. Galileo was the foremost advocate of Copernicus's system in Europe, and his insistence that the Earth moved around the sun brought him into conflict with the pope. Yet the Catholic Church merely put him under house arrest, despite his radical views. Descartes—who argued that the use of reason and good actions, and not merely God's grace, could lead people to salvation—was harassed into fleeing his home for his heretical beliefs. That threat came from the Dutch Calvinist Church in Holland, which had grown increasingly concerned with defending strict Calvinist doctrine against free thought.

In fact, from 1500 to 1700, the Catholic Church was often open and supportive to scientific progress, and it was two Catholics—the Italian Torricelli and the Frenchman Pascal—who made the breakthrough discovery of the existence of atmospheric pressure. The emergence of the scientific revolution in the sixteenth and seventeenth centuries was a pan-European, not primarily Protestant, creation, in which Catholics played a crucial role.

In sum, although it remains true that Britain emerged as the world's dominant technological, industrial, and military power in the early nineteenth century, with the rest of Europe following its steps in the next 100 years, this development cannot simply be tied to the characteristics of Western religion in general, or even Protestantism or Calvinism in particular. Britain's rise as an industrial power was relatively late and in many ways unique, quite distinct from the broader trends in many other countries of Christian and Protestant religion. For most of the last thousand years, it was scholars, craftsmen, and seafarers from China, India, Persia, and the Islamic states in Asia and Africa who were the drivers of invention, economic growth, and global trade.

Given these facts, how did the idea of Western religion as the basis for economic growth arise? Such ideas were developed by European scholars in the nineteenth century who had just seen their societies go through the radical changes of the industrial revolution and the overthrow of the British and French kings in the American and French Revolutions. They studied their own societies up close and were overwhelmed by the evidence for change. Blithely dismissing 1,000 years of European history as a "Dark Age," they drew a picture of Europe that emphasized the genius of Greece and glory of Rome as leading directly to the flowering of the Renaissance and then to the political and industrial revolutions of the eighteenth and nineteenth centuries. In the hands of nineteenth-century European scholars, the rise of the dynamic West was made to seem a continuous, inevitable surge forward of European destiny.

By contrast, European scholars viewed Eastern societies from afar, through the fragments of Eastern texts in Western European libraries and travelers' accounts. Much as early astronomers, before they had telescopes, looked at the moon and saw a shining heavenly sphere rather than an Earth-like body with vast mountain ranges and craters, so nineteenth-century scholars trying to understand thousands of years of Asian history with inadequate means failed to see its detailed character and instead assumed an unchanging and featureless stagnation.

In addition, we have to realize that the late nineteenth- and early twentieth-century histories were written by Europeans at a time when Europe was, however briefly, the dominant power in the world. In order to justify that position, Europeans looked for things in their history and society that would explain their newly powerful position. By pointing to their distinctive religions, Europeans (and in particular, Protestants in England) persuaded themselves that their rise to world power was not only inevitable, but morally deserved.

Toleration or Orthodoxy: Trading Stability for Growth

In retrospect, it is clear that many different societies, at different times, have played a leading role in technological innovation and economic growth. The Middle East under the caliphate of Baghdad, Song China, Medieval Spain, Renaissance Italy, Golden Age Holland, and England in the Industrial Revolution each experienced an efflorescence of exceptional creativity and prosperity. Is there anything that accounts for the advent and passing of such unique periods?

In fact, we can identify an important element of religion that does appear to accompany such periods. This is not the characteristic of any particular religion, but rather the existence of *many* religions, under conditions of pluralism and toleration. By contrast, the passing of such efflorescences are almost always marked by the return or imposition of a crushing official religious orthodoxy.

The rise of Islam in the Middle East in the seventh century was marked by a mixing of the new religion of Muhammad with the older Jewish, Christian, and Zoroastrian traditions of Palestine, Egypt, and Persia. The Arabs also discovered the Greek philosophers' works in Byzantine libraries and in the succeeding centuries became avid translators and innovators in mathematics, philosophy, and natural science, building on the Greek example. For over 700 years, during which Islamic leaders ruled tolerantly over people of other faiths, Islam led the world in scientific advances.

The decline of science and technology in the Islamic world appears to have begun in the twelfth century when, after the conquest of Baghdad by the Seljuk Turks, certain Muslim scholars decried the study of secular Greek philosophy and Hindu science and sought to refocus education on traditional Islamic teachings. Then from 1200 to 1500, a series of disasters befell the major scientific centers of Mesopotamia and Spain: The Mongol invasion in the thirteenth century destroyed libraries, universities, and hospitals and depopulated major cities; the Black Death in the mid-fourteenth century further depopulated the region; and then in 1400–1402 the invasion of Tamerlane again devastated Iraq and Syria. In the eleventh century, the Islamic caliphate in Spain was destroyed by civil wars and the Christian Reconquista. Many areas were thrown into political disorder from which they never fully recovered. Scientific and technical progress in the Islamic world did continue, but mainly in Persia, Syria, and North Africa. The former center of the Islamic world in Mesopotamia no longer had the wealth to support vast communities of scholars and scientists, and conservative religious ideas spread in the wake of these disasters.

In the fifteenth and sixteenth centuries, the most dynamic society in the Near East was the Ottoman Empire, whose military technology and organizational skills allowed them to expand into southeast Europe and across North Africa and gain control of much of the Middle East. Yet in the seventeenth century any further scientific progress in these regions was virtually halted when the religious elites of the Ottoman Empire responded to a series of internal rebellions by criticizing the Ottoman rulers for falling away from the pure practice of Islam. Their solution was to impose a traditional Islamic orthodoxy and halt all philosophical innovation.

Song China had become perhaps the most prosperous and technically advanced society in the world in the twelfth century, following the spread of Buddhism from India and Islam from central Asia. Even Christian and Jewish communities (founded by traders and missionaries who had reached China) flourished alongside Confucianism, Taoism, and other beliefs. China's burgeoning trade brought influences from throughout Asia. The Ming dynasty in the sixteenth and seventeenth centuries also saw a variety of new ideas and technical advances. However, in the late seventeenth century the Manchus conquered China and promoted a more rigid Confucian ideology to help justify their rule. Their reinstatement of Zhu Xi's twelfth-century Confucian philosophy as the official orthodoxy of their new Qing dynasty stifled further innovation in many areas, and convinced visiting Europeans that China had remained unchanged for many centuries.

In India, the prosperity of the Mughal Empire in the sixteenth and seventeenth centuries arose from a mixture of the Islamic culture brought by the invading Mughal rulers and the rich Hindu legacy of ideas and beliefs maintained by the native Indian populace. The ruler Akbar (r. 1560–1605), the greatest of the Mughals, was renowned for his toleration and often invited Jesuits, Sikhs, Hindus, and Muslims to debate matters of faith and practice before him in his court. Yet he was followed by harshly intolerant rulers, who presided over the decline and decay of the Mughal empire. The last of the great Mughal rulers, Aurangzeb, made strict adherence to orthodox Islam a key element of his reign, destroying many Hindu temples and antagonizing the non-Muslim majority in his realm.

Thus throughout the world, the practice of religious toleration sharply declined from the seventeenth century onward. In China, the Middle East, and India, rulers treated religious dissent as a danger to their authority and enforced increasingly rigid orthodox religions.

In most of Europe, the same trend prevailed. Although there were episodes of religious toleration before 1800, orthodoxy under a state-supported established church usually won out in the end. In medieval Spain, a fusion of Islamic and Jewish scholarship had led to the flourishing centers of learning in Granada and Cordoba. However, these groups were increasingly suppressed under the Christian Reconquista, and in 1492 the Catholic monarchy expelled the Jews and remaining Muslims and empowered the Inquisition to enforce Catholic orthodoxy.

In Italy, in the wake of the Crusades an active trade with the Middle East and North Africa had led to a mixing of Latin, Byzantine, and Arab cultures and a rebirth of learning in the thirteenth and fourteenth centuries. This renaissance spread throughout Europe, spurring new scholarship from England to Poland. Poland embarked on a policy of religious tolerance for both Protestants and Catholics in the late sixteenth century. That is, until the Catholic Church, unable to cope with the pressures of the Protestant Reformation, began to lead a counter-reformation to reimpose Catholic orthodoxy in Europe.

During the sixteenth century, as Protestantism spread, a number of rulers accepted the coexistence of Protestants and Catholics in their territories. However, as conflicts between Protestants and Catholics, and between different Protestant sects, grew ever more violent, tolerance declined. The Thirty Years' War (1618–1648), which began with the crushing of Protestant elites in the Austrian province of Bohemia, hardened the lines of religious intolerance throughout Europe. Led by the Jesuits, the Catholic Church aimed to restore its dominant role as the sole Christian faith. The Jesuits were perhaps most successful in Poland, where by the mid-seventeenth century they had reversed Poland's policy of religious tolerance to the point where no nation in Europe was more strongly identified as a Catholic state. Meanwhile, Lutheran, Calvinist, and Anglican states also sought to make their dominant churches the state-supported orthodoxy, with harsh restrictions on other religious communities. In 1685 Louis XIV of France, the most powerful ruler in Western Europe, abolished toleration of Protestant worship in his country, leading to the exodus of thousands of Protestants to England and Brandenburg-Prussia, where Protestantism prevailed.

Only in England, Denmark, and Prussia did religious toleration grow from the late seventeenth century onward. England had seen decades of bloody purges and struggles for power between Catholics and Protestants from Henry VIII through Mary I and Elizabeth I, and later civil war between Anglican Protestants and more radical Puritan sects. The Anglican Church tried to gain recognition as the only established religion and to ban all Catholics and other sects, but it failed in the attempt. Kings Charles I and James II were driven from office in religious controversies, having been unable to secure religious settlements among their divided subjects. Finally, in 1688, England's Parliament passed the Act of Toleration, making it the first major nation in which religious tolerance became a lasting official policy as a matter of law, not just as a royal policy.

In Denmark, King Christian V, desperate to attract fresh immigrants after losing vast territories in a disastrous war with Sweden, issued a series of edicts in the 1680s providing tolerance for Catholics, Jews, and Calvinists in his mainly Lutheran kingdom. In Brandenburg-Prussia, Frederick William tolerated Catholics, Jews, and Lutherans in his mainly Calvinist territories and in 1685 issued the Edict of Potsdam, which guaranteed religious freedom to French Huguenots if they came to settle in his country. Yet these states remained the exception for almost a century.

In the rest of Europe, and indeed throughout the world, state-enforced religious orthodoxy became the norm.

In sum, if we ask what has been the role of religion in global economic growth, we have to say it is neutral or unclear at best. Every major world religion has provided leading thinkers, world travelers, and episodes of dramatic economic growth. What does seem clear is that economic progress thrives best when different religious views coexist in a pluralist and tolerant society. By contrast, economic growth is limited and gradually fades away when states impose a harsh uniformity of religious thought. The choice of tolerance or strict orthodoxy—a choice that appears in *every* religious tradition—appears more important than the characteristics of any particular religion in tracing patterns of economic growth in world history.

If religious differences between the societies of Europe and those of Asia and the Middle East do not explain the "rise of the West," we need to look elsewhere. Perhaps the crucial factors were simply material differences. Did Europe surpass Asian societies through greater abilities in trade and conquest?

Additional Reading

Eisenstadt, S. N., ed. *The Origins and Diversity of Axial Age Civilizations.* Albany, NY: State University of New York Press, 1986.

Weber, Max. *The Protestant Ethic and the Spirit of Capitalism.* New York: Routledge, 2001.

Zagorin, Perez. *How the Idea of Religious Toleration Came to the West.* Princeton, NJ: Princeton University Press, 2005.

CHAPTER FOUR

TRADE AND CONQUEST

CHAPTER PREVIEW: From 1500 to 1800, Chinese and Indian merchants continued to control most of Asia's trade. Europeans managed to insert themselves into global trade patterns by their conquest of the Americas and by trading American silver for Asian manufactures and products. During these centuries, Europeans also built up a large trading system around the Atlantic Ocean, trading among themselves, with Africa, and with their American colonies.

Still, the Atlantic trade in slaves, sugar, and cotton did not replace Europe's need for Asian goods, which if anything increased. Europeans thus became more aggressive in seeking to conquer parts of Asia to gain access to Asian products. In India, where the Mughal Empire was falling apart due to internal conflict, and Southeast Asia, which had always been divided into many small states, the Europeans had success. Yet China and Japan, the major Asian states in 1700, continued to dominate East Asian trade and, in their own lands, they confined Europeans to remote ports of call.

Trade and conquest run together like partners in world history. Trade often followed successful conquests, opening up new routes and pacifying borderlands. Conquest was often necessary to trade, to persuade reluctant rulers to open their ports to foreign merchants or to obtain access to precious materials. Europe's desire to increase its trade with Asia prompted Europeans to make conquests in the New World and along the shores of Asian states; Europe's conquests in the New World then provided the silver that allowed Europe to expand its Asian trade. Later, the growth of Europe's colonies in the Americas created the conditions for a new Atlantic trade, tying together west Africa, Europe, and the Americas from Canada to Brazil. Thus trade led to conquests, and conquests led to trade.

One theory for the rise of Europe is that Europeans were better traders than other societies: They were willing to venture farther from home, were more aggressive at overcoming political and economic barriers to trade, and were more efficient in running their trading companies and accumulating profits than were the merchants of Asia and the Middle East. Another theory is that Europeans—by 1500—were better at conquest, using superior military technology to conquer other civilizations. Perhaps the strongest version of this argument, given the close links between trade and conquest, is that Europeans excelled at both, using their military advantages to expand their trade and the wealth accumulated from trade to finance further economic and military triumphs.

Prior to 1500, however, it is quite clear that Europeans were *not* conquerors of other societies—quite the reverse, as we have seen in Chapter 2. How did things suddenly change in 1500? The answer lies in trade.

Until 1400, the Italians had been able to trade with a variety of different states in the eastern Mediterranean—the Mamluks in Egypt, the Arabs in Syria, and the Byzantines in Constantinople—from which they gained various trading privileges. Yet by 1453, the Ottomans had conquered the entire Byzantine Empire and had begun to close off trade routes to the Europeans.

The stranglehold that the Ottoman Turks held on Europe's access to Asian goods drove Europeans to seek other ways to reach the East. Such access was vital, because without the Asian trade, Europe lacked many of the necessities of daily life, from spices to preserve food (pepper, cinnamon, cloves, and others), salves and unguents for holy and medical needs (frankincense and myrrh), cotton cloth for clothing (in Europe only linen and wool were available as native textiles), and paper for drawing and for books.

Hence in the late fifteenth and early sixteenth centuries, European seafarers set out in all directions to seek a new trade route to the East. Columbus sailed west, hoping to find a direct route to India by sailing around the world; thus he was certain that when he reached land in the Caribbean that he had arrived in the fabulous "Indies." A few years later, Vasco da Gama opened a more successful trade route to Asia by sailing south around the tip of Africa and up into the Indian Ocean. Europe's wave of seafaring expansion in the fifteenth century was thus not the result of some new upwelling of European political or military power, but rather a concerted effort to respond to the vigorous expansion of Ottoman power. Europe's age of exploration was driven by the search for another way to reach Asia—a path outside of Ottoman control—to conduct trade.

But in the four centuries from 1492 to 1892, Europeans also conquered all of North and South America and began regular voyages around the world. They sailed around the tip of South America, then north to Peru and Mexico and across the vast Pacific Ocean to the Philippines, where the Spanish founded the port of Manila. Europeans colonized Australia and New Zealand, and in Africa they settled in the Cape of Good Hope and the Rhodesian and Kenyan Highlands. India became a prized possession of the British monarchy, while other parts of Asia and Africa came to be ruled by Portuguese, French, German, Dutch, and Italian traders. China was forced to cede control of its coastal trade to European trading firms, and Japan had to enter trade relations on terms dictated by Western powers.

How did what started out mainly as a search for a trade route to the East end with Europeans in control of most of the surface of the globe? The easy way to explain this—and one usually found in earlier textbooks—is to treat the entire era of exploration as one smooth period of steadily growing conquests: First, in the sixteenth century, the Portuguese gain the Indian Ocean, then the Spanish and Portuguese conquer Central and South America. Next, in the seventeenth and eighteenth centuries, the British, Dutch, and French take over North America, Indonesia, and India. Finally, in the nineteenth century, the Europeans impose their will on China and Japan and take control of Indochina, Australia, and most of Africa. All of this was seen as evidence of irresistible European superiority in navigation, trading prowess, military technology and tactics, and economic and political organization.

Yet this would be quite wrong. The 400 years of European exploration, trade, and conquest after 1492 in fact comprised many different stories and many different experiences in different parts of the world. In some areas trade preceded conquest by many centuries; in other areas conquest came first and was the foundation for later trade. Some European nations experienced limited periods of success but in other respects experienced failures. The correct way to view this period is as a long, drawn-out effort in which a number of European nations tried to crack open a centuries-old, enormously vast, and well-established system of Eurasian trade and only gradually went from being relatively weak outsiders to finally becoming dominant players at a relatively late date.

The Portuguese Entry into Eurasian Trade, Circa 1500

The Arab seafarer Shihab al-Din Ahmad Ibn Majid, who had been born in Oman on the Arabian Peninsula in 1430, wrote 40 books on trade and navigation, covering the winds and ports of the Indian Ocean from East

Africa to Indonesia. He was familiar with European ships and sailors from his travels up the Red Sea to the ports of the Mediterranean. Here is his comment on the state of European navigation in the late 1400s, compared with that of Arab sailors:

> We have . . . the measurement of stellar altitudes, but they have not. They cannot understand the way we navigate, but we can understand the way they do; . . . They admit we have a better knowledge of the sea and navigation and the wisdom of the stars.[1]

Along with this superior knowledge of navigation, Asian societies also had superior methods of constructing ships, pioneering the sternpost mounted rudder, hulls divided into multiple compartments, and the lateen sail—all key elements of oceangoing vessels. Arab dhows and Chinese junks remained the most widely used ships in the Indian Ocean and the Chinese seas through the nineteenth century. Even many European trading companies eventually had their ships built in Asia, where they got greater quality for the price.

Vasco da Gama's expedition to India relied on the advice of Indian or Arab navigators whom he encountered in the already-established East African ports of Malindi and Mombasa, who instructed him on how to use the monsoon winds to cross from Africa to India. When the Portuguese, led by da Gama, landed in India in 1498, they came from the far edges of the Eurasian trading system into its center—and they were astounded by what they saw. Immense quantities of cinnamon, pepper, precious stones, exquisite fabrics, tropical woods, and other exotic goods filled the warehouses of Asian merchants.

The Portuguese also noted that they were at a considerable disadvantage in trading. Compared with the Muslim merchants, who brought silver and goods from the Middle East (coffee, carpets, incense, and dyestuffs) to trade in India, the Portuguese arrived with only woolen cloth, glass vessels, and iron tools—items worth little in exchange for Asian goods. Therefore the Hindu ruler of Calicut, with whom they sought to open trading relations, ordered them to leave but gave da Gama a letter promising to trade Calicut's gems and spices if the Europeans would bring him coral, scarlet cloth, silver, and gold.

Buoyed by the discovery of an alternate route to India and determined to exploit it, the Portuguese returned in force a few years later. In 1502, da Gama again appeared at Calicut, now commanding 20 well-armed ships. This time, the Portuguese were successful in forcing trade, but they did so mainly by a show of astonishing brutality rather than superior trading or seamanship skills. Shortly after arriving, da Gama captured a ship returning to Calicut from Mecca with nearly 400 passengers, many of them women and children. After seizing all the merchandise on board, the Portuguese locked all the passengers below decks and set the ship on fire, killing all on board. After this and other such demonstrations of his power, da Gama negotiated an alliance with the ruler of Cannanore, an enemy of the ruler of Calicut, and pressured Calicut's ruler into a favorable treaty guaranteeing Portugal's right to trade. This was the opening foray in Europe's trading relations in Asia.

Da Gama returned to Europe with his ships filled with spices and gems from Calicut, and in the next 30 years, the Portuguese sent out more armed fleets, establishing local fortifications on the Indian mainland at Goa, in the Persian Gulf at Hormuz, and in the southeast Asian islands at Malacca. These fortifications were the hub of a Portuguese empire that sought to bring the wealth of Asia directly to Europe.

Although this tale of conquest is often told as one of overwhelming Portuguese (hence European) success in Asia, the Portuguese were successful mainly against isolated kingdoms where they could find local allies, or in areas remote from the centers of Asian states.

The Portuguese entered the Indian Ocean with a clear advantage in naval armaments over the Muslim vessels operating around the coasts of Arabia, Africa, and India. The latter had small guns mounted fore and aft, whereas the Portuguese ships were built to hold larger cannon all along their sides. European naval artillery was thus far more powerful than any ship-mounted weapons in Muslim navies. This gave the Portuguese a critical edge in encounters at sea. In addition, the Portuguese brought advanced skills in constructing fortifications, developed in Europe through years of siege warfare. The star-shaped battlements and heavy sloping walls of Italian Renaissance-designed fortresses soon became characteristic of Portuguese fortresses and fortified settlements throughout southern and southeast Asia.

However, the advantage of superior naval artillery was of little use when the Portuguese faced land forces. When the Portuguese attempted to take the port of Aden, the major trading center in southern Arabia, they were repulsed by the Ottoman armies.

The Portuguese's main advantage was that the true powers in Asia—the Mughal rulers of India and the Ming rulers of China—cared little who managed trade along their coasts, as long as taxes and trade continued to flow inland. Most of all, the scale of Portuguese activities was never a threat to anyone other than the local rulers of small coastal kingdoms or of island states. Compared with the scale of trade and settlement in Asia, wherein hundreds of millions of people were served by millions of merchants from Arabia to Japan, the Portuguese were like fleas on a camel.

The biggest threat to Portugal came precisely from those who were most threatened by their role in Asian trade—not any Asian nation, but their European rivals in maritime trade, the British and the Dutch.

THE EUROPEAN POWERS IN ASIA AND AFRICA, 1500–1700

For almost a century, the Portuguese were the major European power in Asia. From 1500 to 1600, most of the other nations of Europe were consumed in fighting wars of religion at home—Protestants and Catholics battled for power in Britain, France, and Holland—while Spain focused on its conquest of the New World (see the section on the Spanish conquests below). However, by the seventeenth century, merchants in various parts of Europe had seen enough of Portuguese success that they too sought to obtain valued goods directly from Asia by the sea route around Africa.

Yet unlike Spain or Portugal, whose rulers sent military expeditions to America and Asia, the rulers of England, France, and Holland simply encouraged companies of merchants to develop their Asian trade by granting them a monopoly on the import of Asian goods to their respective countries. Thus the English East India Company (founded in 1600), the Dutch East India Company (founded in 1602), and the French East India Company (founded in 1664) became these countries' representatives in Asia. Operating partly like private companies (buying and selling goods and selling shares in their profits on some of the earliest stock markets in Europe) and partly like small states (with their own armies, navies, and territorial administrations), the East India Companies became the creators of empires.

By combining superior naval firepower with alliances with friendly local rulers (that is, following the pattern established by the Portuguese), the English, Dutch, and French East India Companies carved out their own territories in Asia and largely drove the Portuguese out of business. Over time, England, Holland, and France would create huge empires in Asia—the English mainly in India, the Dutch in Indonesia, and the French in Indochina (present-day Vietnam, Laos, and Cambodia). But the development of these empires was not a sudden event; it took centuries to accomplish.

During their first century in Asia (roughly from 1600 to 1700), the East India Companies acted like the Portuguese, seeking fortified outposts for trade along the coasts; the Dutch even captured the established post of Malacca from the Portuguese. The English established forts at Madras, Calcutta, and Bombay in India, as the French did at Pondicherry; while the Dutch established settlements in Java, Ceylon (modern Sri Lanka), and Nagasaki, Japan.

But these Europeans, like the Portuguese before them, found themselves at a disadvantage in trade. If they wanted to bring the riches of Asia back to Europe, they had to offer something in return, and what the Asians wanted above all was silver. Silver was rare in Asia (except in Japan), but much in demand as a basic form of exchange. Both India and China used silver as the basis of their commercial and imperial economies (the Indian silver rupee and the Chinese silver tael being the main units of taxation and merchant wealth in those countries). As their economies grew in the sixteenth and seventeenth centuries, they developed a seemingly boundless demand for silver.

Fortunately for the Europeans, they had access to enormous stores of silver that Spain was mining in the New World. By the eighteenth century, thanks to the trading of silver, Europe was deluged with Asian goods. Indian cotton cloth—with rich dyes and delicate weaving for the rich; simple, coarser cloth for ordinary use—became the fabric of choice for basic garments throughout Europe, because cotton was lighter and more comfortable than the native European textiles of wool and linen. Coffee and tea—neither of which could be produced in Europe—became the daily beverages of European peoples.

However, it should be recalled that the reverse was not true—there was as yet no deluge of European goods into Asia, and in fact only a tiny part of the produce of Asia was drained away to Europe in return. The Europeans never obtained more than 10 percent of the pepper trade or more than modest fractions of the total trade in silk, porcelain, rice, cotton, horses, and other bulk goods. Overland trade, carried on with virtually no European intervention, continued to link China and India to central Asia, Persia, and the Ottoman Empire. The Europeans did not even wholly dominate the silver trade. During most of the sixteenth and seventeenth centuries, Chinese merchants brought home several times more silver from Japan than all European merchants *combined* carried to China. Similarly, the cloth merchants of Bengal obtained far more silver from other parts of India and from central Asia in exchange for their products than they obtained from trade with Europeans.[2]

Thus for their first two centuries in Asian waters, European merchants remained minor players, competing with much larger numbers of Asian merchants in vast Eurasian markets that linked Europe to Africa, the Middle East, India, China, Indonesia, and Japan. Until around 1700 the main accomplishment of European merchants was to vastly increase European consumption of Asian products by bringing ever-greater volumes of goods at lower prices directly from Asia to Europe.

European Relations with Asia and Africa, 1700–1800: Trying to Reverse the Flow

By 1700, Europeans had established themselves in numerous trading centers and settlements in Asia and become direct participants in the vast Eurasia trade. Yet this was almost too much of a good thing. When Asian goods became items of everyday use in Europe, rather than exotic rarities, their value fell. Similarly, as India and China took in more and more European silver, the relative value of silver and the goods that it would buy declined. Particularly in the late seventeenth century, when the population cycle across Eurasia had peaked and population growth ceased, the prices of most commodities stabilized or declined. European trading companies thus saw their profits squeezed, and they sought other ways to profit from their heavy investments in ships and fortifications along Asian shores than simply exchanging silver for Asian goods.

One way for Europeans to stop sending ever more silver to India and China was to make their own versions of Asian products. Britain's wool, linen, and silk weavers were so threatened by the volume of colored Indian cottons and Chinese silk brought by the East India Company that in the early 1700s they persuaded Parliament to outlaw the selling of all Asian silk fabrics and all colored Indian cotton cloth in Britain. If the British wanted to wear silks and cottons, they would have to make them at home—buying raw silk and plain white cotton cloth from India and China, and then turning them into dyed, printed, and finished fabrics in Britain. To reduce their imports of fine china, German, French, and British chemists tried to duplicate the formula for creating porcelain. Nonetheless, for most of the eighteenth century, European manufacturers could never match the price and quality of Chinese ceramics or of Asian cotton and silk.

Another way to gain from the Asian trade without shipping silver was for European merchants to make money just like Asian merchants did, by carrying on exchanges within the great Asian market. Europeans thus got involved in shipping Indian cloth to Africa and Southeast Asia, taking African gold and ivory to Asia, and carrying Chinese silks and tea to India. Europeans also eventually started moving Asian goods around to make their own trading easier—the Dutch planted coffee from Arabia in their Indonesian territories, and the British planted tea from China in northern India (in Assam). The Europeans even found that they could bring opium from India to China and fetch a high price—until the Chinese emperor, worried about the growing drug trade, sought to put a stop to opium imports.

Still, trading by itself was no longer providing fast-growing returns; in competition with most Asian merchants, the Europeans had no special advantages. So the Europeans changed their tactics. In the sixteenth and seventeenth centuries, Europeans had made their profits by trading for goods in Asian ports, depending on native producers and merchants to bring Asian products to trading centers along the coast. But in the eighteenth century, Europeans increasingly sought to cut out the middleman and exert direct control over Asian producers. For this they had to move inland.

The English East India Company expanded from its base in Calcutta to exert control over Bengal, the most important cloth-producing region of India. The Dutch East India Company, which had previously dealt with the rulers of Indonesian courts while controlling trade along the coasts from its headquarters in Batavia (Java), began to displace local rulers and exert administrative control over all of Indonesia, fixing quotas for producers. The Europeans thus sought to become more like rulers than traders—collecting taxes and demanding desired goods, rather than having to trade for them.

Over the course of the eighteenth century, this strategy worked fairly well in regions where Asian local authorities were weak or divided, so that Europeans could concentrate on isolated opponents and pick them off one at a time. This strategy worked particularly well in Indonesia, which was divided into hundreds of islands and princedoms, each with its own competing ruler, which the Dutch were able to gradually subordinate to their control. It also worked well in India, where the Mughal Empire had begun to disintegrate by the early eighteenth century, allowing many dozens of local rulers to exert their independence from Mughal rule.

The British Empire in India began when the Nawab of Bengal, exulting in his independence and overexerting his power, antagonized his own nobles. Robert Clive of the East India Company, seeing an opportunity, led the company's army against the Nawab in the battle of Plassey in 1757. The discontented nobles deserted the Nawab, allowing Clive to achieve a great victory, which laid the foundations of British conquest.

Still, neither company enjoyed untrammeled success. Although Clive's victory led the Mughal emperor to recognize the company's right to collect taxes in Bengal, the company's officers proved so rapacious that they ruined, rather than merely ran, Bengal's economy. The British government had to step in and appoint a governor-general to lead Britain's efforts in India. It took another 100 years for the British to chip away at various local Indian rulers—making deals to keep some as allies but fighting with and overthrowing others—before Britain could claim to rule the subcontinent.

By that time, the British government had taken authority away from the company and ruled India as a royal possession.

In Indonesia, the Dutch East India Company also found it difficult to keep its possessions profitable. The company was unable to keep its monopoly on the spices of the islands, because Arab merchants took cloves, their most valuable crop, to Zanzibar off the coast of Africa and grew it there for export. By the late 1700s the profits from tax collection were no longer providing growing revenues, as they were offset by the rising costs of administration and control of Indonesia's peoples. In 1798 the company was dissolved, and its territories became colonies administered by the government of the Netherlands.

Outside of Indonesia and India, the European powers had far less success in acquiring empires in Asia and Africa during the eighteenth century. In northern Africa, although Europeans established coastal forts, the Muslim rulers simply moved their capitals inland and retained control of their territories. In western and eastern Africa, the British, French, and Portuguese established coastal enclaves, but a combination of resistance from well-organized African kingdoms (armed with the latest weapons that they obtained in trade for slaves, ivory, and gold) and debilitating diseases prevented Europeans from occupying the interior. Only in southern Africa, where the Dutch first established extensive settlements, did Europeans acquire substantial territories before 1800.

Meanwhile, the two leading powers of East Asia, China and Japan, were quite capable of holding the Europeans at bay. China confined most European traders to a single point of access, at the southern port of Canton over 1,000 miles away from the Chinese capital. Japan similarly limited European merchants to arm's-length trading from the far western port of Nagasaki. Both countries tightly controlled the actions of European traders in their territories throughout the eighteenth century. It was only in the nineteenth century, with the deployment of newly invented steam-powered warships, that Europeans were able to bend China and Japan to their will and move up the great river systems of Africa into its interior.

Only in the nineteenth century, therefore, did the full conquest of the world by European powers occur. We shall examine that process below. But first, let us look at European conquests in the New World—for that is where the Europeans first established truly gigantic overseas empires.

The European Powers in the New World, 1500–1600: The Spanish Conquest

The New World conquests of the Spanish conquistadors—who were soon followed by the French, the English, the Portuguese, and the Dutch—seem quite miraculous. Mere handfuls of Europeans, a few dozen or a few hundred strong, managed to subdue and pillage longstanding civilizations embracing millions of Native Americans, from the Aztecs in central Mexico to the Incas in Peru.

In 1490, the New World was unknown to Europeans and was densely settled by Native American communities who had built vast and sophisticated civilizations. These included the Mound Builders of the Mississippi valley (whose great earthen structures can still be seen looming over the river valley around St. Louis and elsewhere) and the Puebloan peoples of the Southwest, whose huge multilevel complexes built of stucco or carved into caves still elicit admiration from Colorado to New Mexico. They also included the civilizations of Mexico—the Olmecs, Toltecs, Mayans, and Aztecs—whose monumental architecture and sculptures stood for 3,000 years and of Peru, whose Inca kings ruled territories stretching across several modern South American states.

Nor were the Native Americans uncivilized. Far from it. When Hernán Cortés and his men arrived at the Aztec capital of Tenochtitlán, they entered a city whose bustling commerce, grand buildings, and graceful gardens compared favorably with the capitals of Europe. At this time, perhaps 200,000 people lived in Tenochtitlán and its suburbs. By comparison, the largest city in Spain was Seville, with roughly 45,000 people. London had less than 100,000 people at this time, and only Paris could even approach Tenochtitlán in size. No wonder that Cortés's soldiers described their first vision of the Aztec capital as something out of a dream!

That Cortés and his few hundred soldiers managed to take the Aztec capital, or that Pizarro and a small party of Spanish soldiers vanquished the 5-million strong Inca Empire, seemed like miracles to Europeans at the time and still seem that way to many today. Both the Native Americans and the Spanish took their victory as evidence of the will of God, for nothing less than divine will could have explained such victories.

In fact, the Spanish initially succeeded in America in much the same way as did the Portuguese in the Indian Ocean or the British in India. They took advantage of their superiority in a few tactical weapons and exploited divisions among their foes to win allies and isolate their enemies. In the case of the conquistadors, their main tactical advantage lay in having long steel swords, crossbows, chain mail armor, and iron helmets to fight against Aztec warriors, who used shorter and more brittle weapons of obsidian and wore only cloth and leather armor. That gave Spanish fighters a sufficient edge over Aztec warriors in hand-to-hand fighting that the Spanish could kill or wound dozens of Aztecs without themselves being mortally wounded.

In addition, even in the earliest stages of their contact with the main Native American civilizations, the Spanish benefited from the internal conflicts within the Aztec and Inca empires. From their capital at Tenochtitlán, the Aztecs ruled a loose empire of many formerly independent Mexican peoples. Although the Aztecs treated their own people and guests with the utmost civility, the defeated warriors of their enemies were subjected to the most brutal mutilations and used as human sacrifices, and their peoples were made to pay annual tributes. When Cortés arrived in Mexico, he quickly learned of the local situation and planned his strategy accordingly. He chose his path to Tenochtitlán to gain as many local allies as possible and before reaching the Aztec capital had already formed alliances with the Cempoalans and the Tlaxcalans.

It was therefore not merely a few hundred Spaniards, but hundreds of Spaniards supported by tens of thousands of Tlaxcalan and other allied warriors who fought against the Aztecs. When Cortés and his men were expelled from Tenochtitlán following the death of Montezuma, the Tlaxcalans came to his assistance. Only with the help of his Native American allies was Cortés finally able to subdue the Aztec capital.

The Spanish, like the Portuguese in India, also used the tactics of displays of great violence to intimidate opponents and persuade them to come to terms. Common tactics included severing of the right hands or arms of native prisoners and killing women and sending their corpses home. Another technique was the massacre of unarmed women and children, especially during religious festivals and particularly if they were confined and set on fire in front of native witnesses.

All of these factors contributed to the Spaniards' initial advances. However, the ultimate advantage that sealed the Spanish victory in the New World was something that the Spanish had brought with them unknowingly, but which proved absolutely devastating to the Native Americans: the germs of Old-World diseases against which the Native Americans had no resistance.

The devastation wrought by European germs in the New World was even greater than that caused by the Black Death in Europe. The Black Death, after all, was only one disease; the Europeans brought not only smallpox, typhus, flu, and measles, but also a host of other viruses, bacteria, and parasites that were unknown in the New World. All combined to produce a huge variety of paths to illness and death. The toll was perhaps similar to what Europeans encountered when they tried to enter Africa, where malaria, sleeping sickness, and a variety of tropical fevers made Africa a graveyard for Europeans who sought to enter it.

It is difficult to know whether the death toll among Native Americans reached 90, 95, or even 98 percent (much depends on estimates of the initial population, which are uncertain), but it is clear that the devastation was unlike anything else known to world history. By 1600, a century after

European contact with the mainland, it appears that the population of Latin America had been reduced to a few million. By 1700, when the devastation had spread to North America, only a few hundred thousand Native Americans remained in all of present-day Canada and the United States.

Although seemingly miraculous, the Spanish conquests in the New World were hardly unprecedented in world history. It was, after all, small bands of Germanic tribes—the Franks, Goths, Vandals, Lombards, and others—who had looted Rome and eventually subdued and ruled the entire western Roman Empire. Similarly, a hundred thousand Mongol warriors, using their novel tactical weapon of horse-mounted archers for mobility and striking power and great displays of violence (massacring unarmed women and children and piling up skulls of their slaughtered opponents), were able to conquer the wealthy and highly advanced Chinese Empire of tens of millions. Many times in world history, more advanced and richer civilizations, when torn by internal conflicts and administrative decay, have fallen prey to ruthless and militarily powerful but numerically much smaller forces. The Spanish conquests—greatly aided by the onslaught of European diseases that laid waste to their Native American foes—followed this well-established pattern.

Two Women Who Changed World History: Isabella of Spain and Malinche of Mexico

Before continuing our story, we should pause to highlight the lives of two outstanding women who played critical roles in the events just described. They are Isabella I, the intellectually daring Queen of Spain, and Malinche, an Aztec noblewoman whose remarkable linguistic and diplomatic skills played a crucial role in Cortés's conquest of Mexico.

Without Isabella's willingness to take a risk on Columbus's vision, the great explorer would have never set sail. Many monarchs had turned Columbus away, doubting the wisdom of his plans to reach East Asia by sailing into the Atlantic. Isabella, who herself had learned Latin and had a great interest in scholarship and exploration, agreed to finance the mission in exchange for a claim to any lands that Columbus discovered. Her gamble produced a huge New World empire and riches in silver and gold for Spain.

However, the Spanish could never have conquered Mexico without help from their Native American allies. Like Queen Isabella, Malinche was a woman of extraordinary intelligence and ability who played a pivotal role in world history.

Malinche, the daughter of an Aztec nobleman, was sold to a Mayan slave-trader when she was a young girl. As part of a peace deal between a Mayan king and the Spanish, she was given to Cortés as a slave. Cortés discovered that Malinche could speak both the Aztec and Mayan languages; he then immediately made her his personal interpreter. Malinche learned Spanish as well and became so crucial to the campaign that Cortés was never depicted without her at his side. Malinche's skills allowed Cortés to forge agreements with the Tlaxcalans and other peoples of the Aztec Empire. After an initial battle, Cortés would rely on Malinche, who acted as diplomat and interpreter, to help persuade the natives to work with Cortés in exchange for support against their enemies. She thus helped build the alliances that made Cortés's victories possible. Scholars today debate Malinche's role. Was she wrong to help Cortés, or was she a brilliant diplomat who helped unify diverse communities to overthrow the cruel Aztec Empire? What is beyond doubt is that her abilities were essential to Cortés's progress.

The European Powers in the New World, 1600–1800: Settlement and Slavery

Following the Spanish conquests and the death of much of the native population, other European explorers and settlers rushed in to what were now largely empty lands. The Portuguese in Brazil, the British and Dutch along the Atlantic coast of North America, the French in the St. Lawrence and Mississippi valleys and the Great Lakes, and all of these powers in the Caribbean staked their claims to portions of the New World. Meanwhile, the Spanish pushed northward and south from their initial conquests, settling California, New Mexico, Texas, and the remainder of Latin America.

Of these settlers, the Spanish were initially the most fortunate in their pursuit of profits, as the lands of the Aztecs and Incas proved to be extraordinarily rich in silver and gold. The "silver mountain" of Potosí, in southern Peru, was for over a century the largest and richest silver mine in the world. Further deposits of silver were found in Mexico, and by the eighteenth century, large gold deposits were found by the Portuguese in Brazil. As discussed above, these huge finds of silver, shipped to Europe or across the Pacific, allowed the Europeans to participate in the Asian trade and to acquire Asian products for their own use.

Whereas the Spanish simply had to mine and ship silver, British, French, and Dutch settlers, by comparison, had to find other ways to profit from the lands that they claimed. The easiest way to gain profits was to take advantage of the climate and native crops to grow commodities that could not be found in Europe. Plantations were quickly established to grow sugar in the Caribbean, tobacco in the British colonies of Virginia and Carolina, and cotton (which Native Americans had been growing and weaving into fine fabrics for centuries) along the coast.

Yet all of the European powers in the New World soon discovered they had a problem if they were to gain any wealth from their new lands—the very collapse of the native population that had made conquest possible also meant there was insufficient labor to work the mines and the land. Thus they began seeking new sources of labor to supplement the enslaved Native Americans who had worked in mines and fields. Some came willingly as indentured servants or poor migrants from Europe, but most came involuntarily—as slaves from Africa.

Slaves were particularly useful where the land could produce high-value crops and where landowners had vast estates. Under such conditions, the sale of crops could offset the high cost of buying and maintaining slaves. The sugar plantations of the Caribbean and Brazil and the cotton and tobacco plantations of the American South thus became the prime consumers of African slaves. The mines of Mexico, Peru, and Brazil also came to depend on imported labor. It was only where the land was relatively rocky or the climate unsuitable for commercial crops that small-scale subsistence agriculture continued. In those areas, colonists working family-sized plots—as in New England, New France (Quebec), Pennsylvania, New York, and the southern portion of South America—dominated the local economy.

Some scholars have argued that the profits from slavery fueled the rise of the West. Slavery was a terrible injustice and inflicted suffering and death on millions. Yet it is hard to see what was won by such suffering. One cannot point to a single slave economy that emerged from the experience wealthy or productive—rather the reverse. The richest slave colony of the Caribbean was French-owned Haiti; now it is the poorest country in the Western Hemisphere. In the United States, the slave states of the South were economic laggards behind the industrializing North. Slavery may, in the short run, have generated profits for a relative handful of plantation lords. But in the longer run, keeping four-fifths of a population (a common ratio of slave to free in plantation lands) enslaved and uneducated was not a path to building national wealth.

Still, one can ask—did the profits from slave plantations or slave dealing fuel economic growth or industrialization in the West? Even more, how could industrialization have developed at all without cotton, which was produced by slaves in the New World?

If the owners of slave plantations had invested in industry or become industrialists, there might be some basis for this argument. In fact they did not. Moreover, against the profits of slavery must be set the enormous costs of slave rebellions, revolution, and civil war. Revolutions in South America created generations of chaos, and civil war in the United States left much of the plantation-owning South destitute. None of these regions gained anywhere near as much in profits as was laid waste by the political consequences of being slave-holding societies.

It is true, of course, that by 1800 cotton grown in the New World was a major input into the British cotton industry, one of the vanguards of British industrialization. However, it was not raw cotton that made the industry, but innovations in British machinery and the harnessing of water power and steam power that made it worthwhile for Britain to import cotton, spin it, and weave it into fabrics. If not for that machinery, it would have made no sense to import raw cotton to England, as the cost of the finished product would have been far greater than that of cotton textiles produced by raw cotton–producing countries such as India and China. The new British machinery made it profitable to import raw cotton, whether from India, Egypt, Turkey, or the Americas.

There is one more thought-experiment we can perform to examine the impact of empire and slavery on the eventual wealth and prosperity of European nations. We can readily rank the various countries of Europe by the size of their overseas empires and the degree to which those empires depended on slavery. First would come Spain and Portugal; next Britain, Holland, and France; much lower would be Belgium, Germany (formerly Brandenburg-Prussia), and Italy (all of which acquired colonies only in the nineteenth century); and finally Switzerland, Austria-Hungary, and Russia (which had no colonies at all, except for a few Russian settlements in Alaska and on the Pacific coast).

How did these nations fare? As of 1830, Spain and Portugal had ceased to be either wealthy or powerful among European nations. Holland had been in decline since the mid-eighteenth century and took its cues from France, which had been defeated in the Napoleonic Wars by Germany (Prussia) and Russia in concert with Britain. By 1871, France would again fall to Germany in the Franco-Prussian War. In the 1850s, Britain, Belgium, and Switzerland were in the vanguard of industrialization. In short, with the exception of Britain, there is very little correlation between pre-1800 overseas empire and slavery by European nations and their nineteenth-century power and economic dynamism.

If slavery and empire were a means to industrialization and modern economic growth, then the Romans of Italy, the Mongols of China, the Ottomans of Turkey, or the Spanish colonists of Latin American should have led the way to the modern world. They did not. It was small and slave-free regions and countries—Britain, New England, Switzerland, Belgium—that did so.

Claims that the rise of the West was built on slavery and empire before 1800 thus cannot be supported. History provides no justification for slavery; misery breeds misery, and by the 1860s the regions of the Americas that had practiced slavery saw ruin—in the form of civil war, revolution, and decades of economic backwardness—come to the slave owners and their lands. Meanwhile, most of the major colonial powers—Spain and Portugal, Holland and France—were losing ground to Britain, Germany, and Russia in the race for power in Europe.

The European Imperium After 1800

After 1800, however, is when the grand age of European imperialism really takes off, as the leading European powers—Britain and France, the Netherlands and Germany and Italy, even Russia—exert their control over all corners of the globe. Why did this happen, and why at this time?

From 1800 onward, advances in the technologies of production and of war rapidly occurred in several Western European countries and in the United States. (We shall discuss this in more detail in Chapter 7.) For now, it is enough to list the changes to get a sense of what was happening. In Britain, the United States, Holland, Belgium, France, Germany, Austria, Italy, and even Russia, engineers began to use steam power to run mining operations, making vast quantities of coal, nickel, copper, and iron available. New techniques for using that coal to refine iron and other metals gave rise to huge increases in the availability of low-cost wrought iron and steel. Steam power was put to use to drive steamships and railroads, steam shovels and steam threshers. Steam power was also used in factories to drive bellows for refining steel and to drive spinning and weaving machinery to produce cotton and woolen textiles of unrivaled low price and uniform quality.

By the 1860s, steam-powered warships under American and European flags were spanning the globe, and networks of rail lines moved goods and people at unprecedented speeds across continents. Mass production was applied to guns and rifles, and new designs increased their accuracy and rate of fire. The result of all these changes was that over the course of the nineteenth century, European countries and the United States became able to control huge new stores of energy and manipulate huge amounts of materials at incredibly low costs.

At the same time, however, most Asian and African countries were running into difficulties. China's economy and administration failed to keep pace with its population growth, leading to revolts and eventually a vast civil war (the Taiping Rebellion) that lasted 13 years (1851–1864), killed tens of millions, and destroyed central authority in the empire. In Japan, the shogun too faced rebellion from the provinces, as did the Ottoman sultan. In Africa, the strains of centuries of slaving and increasingly rapacious demands by traders and colonists undermined many once-powerful African kingdoms.

The result of these opposing tendencies was that in the course of the nineteenth century, European nations (and the United States) brought vastly increased capabilities to project force and to produce cheaper goods into their relationships with weakening Asian and African societies. Not surprisingly, the Europeans and Americans used their advantages to expand their authority and control, employing new steam-powered gunships and battle cruisers to impose conditions on China and Japan, respectively, and using rail lines and modern weapons to wrest control of Africa.

It was not colonialism and conquest that made possible the rise of the West, but the reverse—it was the rise of the West (in terms of technology) and the decline of the rest that made possible the full extension of European power across the globe.

The Costs of Imperialism and the Riddle of Economic Growth

Some scholars and nationalists have blamed the poverty of all areas outside of Europe on European imperialism. Certainly, countries that were dominated by European, American, and Japanese imperialism have suffered. The influx of European-made products undermined domestic manufacturing, and Europeans made sure that their colonies played the desired role of being suppliers of raw materials and consumers of European goods, rather than independent producers and competitors. Educational systems and administrations were often built on foreign models, sometimes with very poor results, and transportation systems were built to suit European needs for exporting raw materials or for military control, rather than for economic integration.

Moreover, one European import that was readily adapted to conditions in many developing countries—revolutionary Marxism—struck another blow against sound economic administration and political stability. In short, although European imperialism cannot be seen as the cause of the rise of the West, it certainly did impose a certain degree of relative stagnation or decline on many of the rest—in some cases for several centuries.

Yet even if we judge the overall impact of imperialism to have been negative on the world outside of Europe, not all of developing nations' woes can be blamed on imperialism. Some countries that were never colonies (Liberia, Ethiopia) are as poor today as any victim of imperialism. Many Latin American countries, which ceased being colonies shortly after 1800, have done no better economically than countries that were colonies until the 1960s. Some countries that were victims of imperialism have recently started rapidly developing, such as India, China, and Korea; other post-colonial societies (such as Sierra Leone) have regressed in the last 50 years from their levels of economic development at independence. Even if imperialism is a negative factor in economic growth for countries that were colonies, it is clearly not the *only* or even the most important factor in economic success.

If imperialism by itself does not explain why some parts of Europe grew rich while others lagged, or why some countries—such as China, Korea, and India—today are overcoming their colonial past to achieve rapid growth, we need to look again at the riddle of economic growth. It may be useful to look first at how and where economic growth occurred in history. How rich were Europeans *before* 1800, both compared with later periods and with other leading civilizations of the world? That is the question we try to answer in the next chapter.

Additional Reading

Parker, Geoffrey. *The Military Revolution: Military Innovation and the Rise of the West 1500–1800.* Cambridge: Cambridge University Press, 1996.

Pomeranz, Kenneth, and Steven Topik. *The World that Trade Created: Society, Culture, and the World Economy 1400 to the Present.* Armonk, NY: M. E. Sharpe, 2006.

Restall, Matthew. *Seven Myths of the Spanish Conquest.* Oxford: Oxford University Press, 2003.

CHAPTER FIVE

FAMILY LIFE AND STANDARDS OF LIVING

CHAPTER PREVIEW: Western scholars have long believed that even before the development of modern industry, Europeans had become more prosperous than people in other parts of the world, whereas China and India were becoming overcrowded with masses of people who were desperately poor. Some scholars based their arguments on beliefs about Europe's population dynamics being different than that of China and India. Others argued by pointing to the early commercial successes of Venice and Florence in Italy or of Antwerp and Amsterdam in the Netherlands. Still others argued that gains in agricultural productivity or rising real wages were propelling Europeans ahead of any competitors.

However, the most recent data show that these beliefs were mistaken. Western scholars did not appreciate how the European and Asian family systems, though different, produced similar levels of population growth. Nor did they recognize the continuing commercial and urban successes of Asian societies. Finally, more recent data on life expectancy, incomes, and productivity show greater differences in prosperity *within* Europe across countries than between Europe and China. In fact, average incomes and productivity were probably higher in most of Asia than in most of Europe until 1800, with even the most advanced parts of Europe (England and Holland) only just catching up to China by that date.

"In the 1500s, under the great tsar, Ivan the Terrible," goes a bit of old Russian Communist propaganda, "life in Russia was truly terrible. The peasants were so oppressed they were left with nothing; they were starving. But things got no better when the Romanovs took power in the 1600s—instead it was even worse. And then under Alexander II, in the 1800s, although the serfs were freed, they had to pay so much in taxes and rents that it was even worse. And under Nicholas II in 1914 Russia went to war, and it was even worse—until the Great Communist Revolution came and overthrew the tsars in 1917."

In fact, the Communist Revolution proved to be the greatest disaster, with tens of millions actually starving to death in the 1930s under Stalin's campaign to create collective farms and Communist agriculture. Still, one has to wonder—how could anyone believe a story that says the peasants were starving in the 1500s and had nothing, but were worse off in the 1600s, still worse in the 1800s, and worse off yet in the early 1900s? How can things get worse and worse for centuries if people were already starving?

Yet many of the stories about the rise of the West seem to parallel this one: In the past, peasants were so poor and so heavily exploited that they had nothing and were starving, *always,* until the advent of the modern world. Even if not universal, these tales were certainly used to describe the zones outside of European settlement, as in China and India and the Ottoman Empire: Everyone was always terribly, horribly, poor—starving or on the verge of starvation.

In fact, as we have already noted, premodern economies were cyclical. The numbers of poor people went up and down over time, as did wages, unemployment, land rents, and other measures of economic life. Poverty was always widespread in the preindustrial world, whether in Europe or Africa or Asia. Poverty meant not having shelter from rain and cold, or shoes for your feet, or clothes to cover your back—and not being sure whether you would have enough to eat.

Poverty of this degree was always present in preindustrial societies—but as a state of unusual deprivation or result of bad circumstances (injuries that meant one could no longer work; the death of a husband; the loss of one's animals, farm, or land) rather than the normal state of affairs. Poverty of this degree may have affected 1 person in 10 in good times, and 1 person in 3 in truly bad times. But in no major civilization of Africa, Asia, Europe, or the Americas did a majority of the people live for centuries on end at death's door.

We know this from the simple fact that world population grew substantially from 1500 to 1750, so it is not possible that people were *always* starving during these centuries—women who are starving have trouble conceiving children, feeding them, and raising them. In both Asia and Europe, population roughly doubled in these two-and-a-half centuries.[1]

Growth occurred to a similar degree in countries that seem to have been relatively rich or relatively poor: From 1500 to 1750, the population of England (a relatively rich pre-industrial country) increased from between 2 and 2.5 million to 5.75 million. Russia (widely thought of as one of the poorest countries in Europe), however, grew just as fast during this period; its population increased roughly from 17 to 35 million. China—much larger of course, and reputedly even poorer—still grew just as fast, from under 100 million in 1500 to over 200 million by 1750.[2] In short, growth trends were similar in many societies across Eurasia.

During some periods, however, considerable numbers of people did starve. Roughly two or three times each century, a series of terrible winters or dry summers would produce several bad harvests in a row, and food became so scarce that many could not produce enough or buy enough food to feed their families. At those times, we see the numbers of funerals recorded in church registers rise dramatically—to the point where perhaps 20 percent of the local population would die in the course of two or three years. Yet such mortality crises did not destroy population growth. Those who died were usually the weakest—the old, the very young, or the sick—who likely would have died soon anyway. And although such mortality crises especially affected young babies, their deaths were soon made up by a rise in births in the following years. Even in the harshest times, it was uncommon for healthy men and women of working age to die of hunger. Such was the fate only of the most unfortunate minority, and only in the worst crises, which hit perhaps once or twice a generation.

To really discover whether any part of the preindustrial world was markedly better off than others, we need to look at several different kinds of data, addressing such issues as people's health, their earnings, and how much typical workers produced.

Before we look at that data, however, it is important to note that people did not live alone. Just as they do now, people have always spent most of their lives as part of families, and it was the family unit as a whole that produced and consumed. Indeed, in preindustrial societies, one's income was so much a function of one's family income that people's main concern was to protect their family property and their family line. Thus before examining differences in incomes across societies, we need to say something about differences in families.

Marriage and Family Life

Families were not structured the same way everywhere. In northern Europe, for example—in Britain, the Netherlands, northern France, and Scandinavia—families were built around new households. That is, when a couple got married, they started their own household, and supporting the family and home was the main responsibility of the new husband. Men would either inherit the family home from a parent who passed away or became too old to work, or—if they had saved enough money to buy or lease their own land and build a home—they would move out of their parents' family home and establish their own domicile. Men would then take their wives to their new home, while women would leave their parents' households to join their husbands. Sometimes, an elderly parent would follow the new householders. But still the newly married couple was the foundation of the new family, and they and their children would remain that foundation until their children married and moved out, or until they retired and left their home to one of their children.

In this system, because people who married had to have sufficient savings to start a family of their own, both men and women typically worked to earn wages for several years before they looked for a husband or wife. They often started working in their mid-teens and continued working into their early 20s. Therefore, they usually did not marry until they had reached their early to mid-20s. In addition, many men and some women never married at all—either because they lacked the resources to establish a new household or because they never found a mate willing to start a new family with them.

In eastern and southern Europe, however, families tended to be more extended and more complex. When people married they might move into the same home as other relatives and form a larger, multifamily household. Indeed, whole villages might be made of various related families in households of various sizes. This system allowed men and women to marry younger, because they could obtain some of the support they needed from other relatives who lived with them or very near them.

In China, yet another pattern prevailed. Families were built around the combination of husband and wife and their eldest son and *his* wife. That is, as soon as the eldest son was able to marry, he would take a wife. But the new couple would not seek their own home. Instead, the son would remain at home, and the new wife would move in with him and his parents. Because the son and, even more, the wife tended to be young and inexperienced in household affairs, the new wife would be under the authority of her mother-in-law, who would supervise her work around the garden and the house.

Under this system, men could marry fairly early, because they did not have to start a new household. Women could marry as soon as they were able to leave their parents—sometimes as young as 12 or 13—even before they were ready to have children of their own. Indeed, women could marry while virtually children themselves, because they would be looked after by their husband's parents in their new home.

Some scholars of family structure had supposed that these differences went far toward explaining why some countries were richer than others.

They argued that family systems that allowed for earlier marriage also encouraged more children (because women entered marriage with more childbearing years ahead of them). But more children, they argued, consumed more resources and produced more workers competing for work and land, driving down wages and productivity. In this view, countries of early marriage like China or Russia would be overrun with people, whereas people in countries like England, with later marriage, would have fewer children and thus be able to save more and build up their wealth.

This looks like a fairly persuasive story and suggests an easy explanation of why northern Europe pulled ahead of other regions in income. But like many other easy explanations, it is based on assumptions that do not hold up to closer scrutiny. The key assumption of the view that women in late-marriage countries would have fewer children is that a woman's chances of bearing a child are the same in every year of marriage, until the time a woman is too old to bear children. If that were true, then the more years of marriage experienced by the female population (whether because women married at younger ages, or because more women got married, or both), the more children they would bear. Yet, as you might expect, with family systems so different in different societies, women's chances of bearing children in any given year of marriage were quite different across different societies as well. Thus, population growth did not simply depend on how many years women spent in marriage. Rather, what mattered was how many children an average woman had over her entire lifetime.

No society would benefit if it grew so rapidly that it quickly outran its food supplies, and in premodern societies, that was always a concern. So almost all premodern societies developed social practices that limited population growth by reducing the total number of children that women were likely to bear. This could be done in one of two ways: either by customs that restricted people's access to marriage or customs that reduced the number of children people had within marriages. Such social practices were not perfectly rigid, of course; they were usually flexible enough to allow societies to grow more rapidly after periodic famines or other disasters or if new lands were being settled. But they generally did limit total fertility and kept population growth rates much lower than they otherwise would have been.

The northern European family system described above made it hard for women to marry. Since couples had to have the resources to support a new household before marriage, men and women either had to inherit a farm (which meant waiting for the retirement or death of a parent) or save up the means to buy one (which meant many years of working and saving before marriage). Many people wed late or never at all.

However, once the pair was married, society imposed no further obstacles to childbearing. Rather, European societies asked families to follow the Biblical injunction to "be fruitful and multiply," so couples were encouraged to have as many children as possible. Moreover, if a husband died while his wife was still young, she was encouraged to remarry and bear children for her new spouse (and having an inheritance generally made a young widow a very attractive target for marriage). Not all children survived, as childhood diseases were often fatal. Still, the main limits on total fertility were the obstacles to couples initially getting married.

By contrast, societies with early ages of marriage had a variety of customs and practices that worked to limit childbearing among married women. This could be done in many ways. First, husbands were often expected to work a certain number of years away from their home village *after* they were married. This forced separation of husbands and wives naturally reduced childbearing! Thus Russian villagers often sent young males to the city (or less voluntarily, to the army) to work; Chinese villagers sent young men on sojourns to cities or to other provinces to trade. The populations of cities in these societies showed a disproportionately large number of young men, most of whom were supporting (but not immediately having children with) wives at home.

Second, widows were often severely restricted from remarrying. Mandatory periods of mourning of many years or permanent widowhood would be the norm for those whose husbands died. Thus societies with early marriage would usually have a large number of widows who, although they married young, lost husbands to illness or accident and thus faced an early end to their childbearing.

Finally, societies with early marriage often allowed infanticide or severe neglect (and hence increased incidence of illness and death) for undesired children. Thus, should other means fail, families in such societies could still ensure that the number of their surviving children remained within manageable bounds.

All these practices meant that even though women in China married much earlier than women in northern Europe and almost all young Chinese women were married, Chinese mothers typically had their first child only after several years of marriage, typically had greater spacing between children, and typically stopped having children much sooner (especially because of widowhood) than women in northwest Europe.

In short, most Asian societies successfully limited fertility *within* marriage, whereas northern European societies limited fertility by delaying *access to* marriage. Both systems worked to keep fertility and population growth at moderate levels. Indeed, the number of children surviving into adulthood was very nearly the same for families in England and in China from 1500 to 1750.

Thus, even though societies in Europe and Asia had very different ways of regulating marriage and family life, these differences did not produce any marked differences in overall rates of population growth. To be more precise, from 1500 to 1750, the increase in population in England was approximately 130 percent, while that in China was 125 percent—hardly much of a difference! Since growth rates were so similar regardless of family structures, we cannot say that differences in marriage patterns or rates of population growth were responsible for differences in living standards across Eurasia in the sixteenth, seventeenth, or eighteenth centuries.

To see how much living standards varied in these centuries, we should look at data on key indicators that tell us how people lived:

- We can explore overall health and nutrition by looking at life expectancy and stature—that is, how long people lived and how tall most adults would grow.
- We can look at the wages that workers earned in cities and on farms and see how much food those workers could buy.
- We can look at estimates of people's consumption to see what people ate and wore and used in their lives.
- We can look at the populations of cities to try to estimate the surplus production of society—how much more than the bare minimum to keep farmers alive was available to support urban centers?
- Finally, we can look at estimates of labor productivity—that is, how much workers produced per day of labor.

Life Expectancy and Stature

One of the most direct and useful measures of how well people lived was how long they lived. Demographers (scientists who study population change) use the term "life expectancy" to describe the average lifespan for men and women in a society.

Life expectancies, like so much else in history, show long-term cycles. Life expectancies in all societies were lower during periods of epidemic disease outbreaks and higher when disease levels declined. Still, in looking at different societies at the same periods of world history, we would expect that where people had more food, better shelter, and better clothing they would live longer.

In fact, we find that life expectancy in virtually all preindustrial societies was remarkably low—lower than even in the poorest countries of the world today. This is because infant mortality—the percent of children who died in

TABLE 5.1 LIFE EXPECTANCY AT BIRTH IN SELECTED COUNTRIES AND TIME PERIODS, IN YEARS

Country or City (population)	Time Period	Life Expectancy (e_0)
England	1750–1800	37
Rural China (Liaoning, males)	1792–1867	36
France	1800	34
Rural Japan	1776–1815	33
The Netherlands	1800	32
Rural China (Anhui, males)	1300–1880	31
France	1750	28
Roman Egypt (villagers)	AD 11–257	28
England (tenants)	1300–1348	less than 28
London	1750–1799	23
Beijing (males)	1644–1739	27

Sources: Massimo Livi-Bacci, *History of World Population* (Oxford, UK: Blackwell, 1992); James Lee and Wang Feng, *One Quarter of Humanity: Malthusian Mythology and Chinese Realities* (Cambridge, MA: Harvard University Press, 1999), p. 54; Gregory Clark: *A Farewell to Alms: A Brief Economic History of the World* (Princeton, NJ: Princeton University Press, 2007), p. 114.

their first year of life—was so incredibly high. In preindustrial societies, infants died in large numbers from diseases that are easily treated today, such as diarrhea or malnutrition. Because so many died in early childhood, average lifespans were short—life expectancy was not much more than 30 years, compared with 50 years in the poorest societies today. This does not mean that most people lived to be only 30 years old; rather, this means that for every person who survived to age 60, another one died within their first year of life, leading to an average lifespan of about 30 years.

Table 5.1 shows historical data for life expectancy in various preindustrial societies. This data was compiled painstakingly by historical demographers working with individual family histories, China's imperial genealogies, and European church records of baptisms and burials.

The highest life expectancies in this table are those of England and rural China in the late eighteenth/early nineteenth centuries. The lowest national life expectancies were in ancient Roman Egypt, medieval England, and eighteenth-century France. Thus some areas of Europe in the eighteenth century had life expectancies no different than those achieved during the most prosperous years of the Roman Empire!

There is further evidence of very long-term stability from studies of people's stature—that is, their height. Modern studies of growth and nutrition have found that people's heights are strongly related to the quality and quantity of their diet. Moreover, we can gather data on heights throughout history by examining the length of people's bones from their skeletal remains. According to one of the latest studies of stature from burial remains throughout Europe, the data from roughly AD 100 to AD 1800 show virtually no changes in the average of people's heights. This is surprising if one expects that Europeans were richer in the Renaissance or in the seventeenth and eighteenth centuries than in the Middle Ages or classical Roman times. Yet this finding is quite consistent with the evidence from life expectancies, which also show little change from Roman times to the eighteenth century.[3]

In addition, we should note that the life expectancies of those who lived in cities, such as London or Beijing, were much shorter than for those who lived in the countryside—the opposite of what we usually find in modern societies. Cities had more people who were completely dependent on wage labor and who literally starved when work could not be found or when grain shortages pushed the price of food beyond their reach. Cities also were hotbeds of disease, not only because of crowding and unsanitary conditions (both animal and human wastes were routinely dumped in streets, which also served as open sewers), but because trade brought diseases from all over the world directly to the cities.

As shown in Table 5.1, there were greater differences in life expectancy within Europe than between most European and Asian societies. For example, in 1800, life expectancies in England, France, and the Netherlands were, respectively, 37, 34, and 32 years. At roughly the same time, life expectancies in rural China and rural Japan were 36 and 33 years. Rural China was thus comparable to England, whereas Japan was closer to the Netherlands. But nowhere do we see a big split between the societies of Europe and those of Asia.

This is a pattern we will see again and again as we go through the data on standards of living. The notion that the rise of the West represented a gradual increase in the wealth of Western societies—so that by the sixteenth or seventeenth century Europeans had already become substantially richer than they had been in the Middle Ages, and richer too than rival societies in Asia—is not supported by the evidence. In fact, there were rich and poor areas in both Europe and Asia, and the richest areas in both continents were quite comparable in most aspects of material well-being until the 1800s.

Wages, Incomes, and Consumption

Wages moved up and down over time in both Europe and Asia. Yet one of the surprising things about the preindustrial past is that the average level of real wages—that is, what a worker's earnings would buy in terms of food, clothing, and other necessities—changed fairly little across many centuries.

Figure 5.1 shows the long-term changes in real wages for a number of European cities from 1500 to 1913. The data in this graph show the

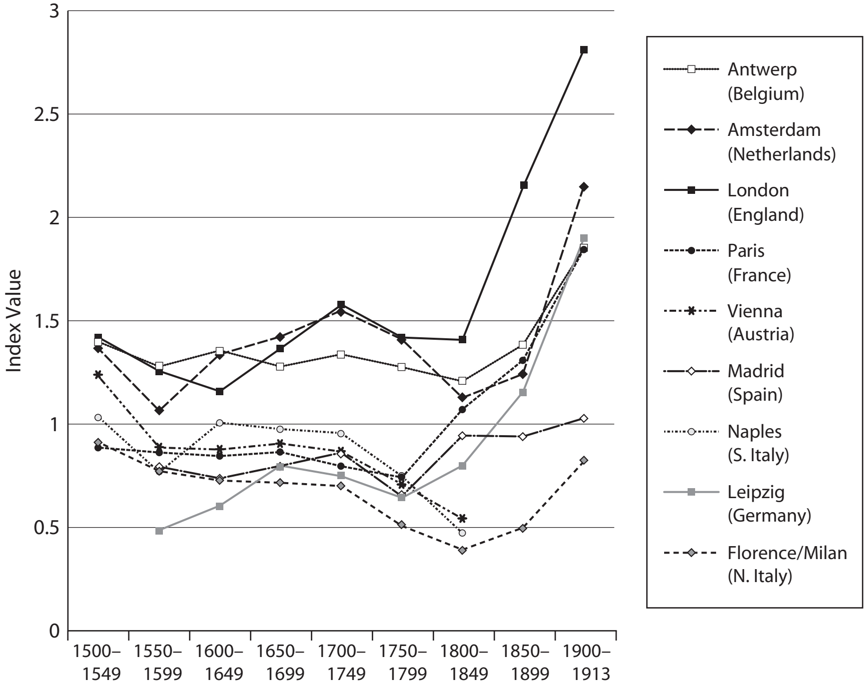


FIGURE 5.1 REAL WAGES OF LABORERS IN EUROPEAN CITIES, 1500–1913
Source: Robert C. Allen, "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War," Exploration in Economic History 38 (2001): 428.

average level of real wages during each period, compared to that in Naples, Italy in 1600–1649. In fact, wages moved up and down quite a bit from year to year, depending on the quality of the harvest and price of food (always the biggest item in families' budgets before industrialization), so if we showed the wages for every year, the graph would zigzag up and down and look like a radio wave! This table presents the average level of real wages during each half-century and in 1900–1913, so that the long-term trends stand out clearly.

There is a lot going on in this graph, so let's work through it step by step. The first thing to notice is that on the left side, in the earliest period (1500–1549), the various major cities of Europe all had fairly similar levels of real wages (these were all court cities—that is, they were capitals of various kingdoms, duchies, or confederations). However, on the far right side, in the latest period, the level of wages has spread out greatly. Real wages in London left all other areas behind, although wages in Amsterdam, Antwerp, Paris, and Leipzig had also risen to fairly high levels. Other cities, however, had lagged badly—Florence, Milan, Naples, Madrid, and Vienna had much lower wages, in some cases not much different (or even less!) than what they had been in 1500 or 1550!

What this means is that the rise of the West was, as late as 1900, not a general European rise. Rather, the richest countries of Europe (Belgium, the Netherlands, England, France, Germany) had grown wealthier than ever before, but the poorer countries of Europe (Spain, Italy, Austria) had not. In fact, in the poorest European cities, workers in 1850 or 1900 earned less than their great-great-great-great-great-great-great-great-great-grandparents had earned.

Perhaps the most striking feature of Figure 5.1 is how nearly flat *all* the lines are before 1850. Real wages in London in 1800–1849 were no higher than they had been in 1500–1549, three centuries earlier! For most cities, real wages moved in shallow waves, up and down by 20 or 30 percent and back again, across the centuries, without any real long-term change. This is an astounding lack of progress in living standards for the richest cities in Europe.

The graph then shows a sharp break after 1800–1849. London was the first city to break out of Europe's premodern wage levels: In 1850–1899, real wages reached a height never seen before in European history. This is not true anywhere else in Europe, however; by 1850–1899, although wages in most countries improved, they had not yet broken out of the centuries-old European range of real wages to reach new highs. But by 1900–1913, urban wages in all the countries of northern Europe jumped to levels sharply higher than had been reached at any time before. In the century from 1800 to 1900, real incomes doubled and rose to unprecedented levels in London, Amsterdam, Leipzig, Antwerp, and Paris.

Several major puzzles thus present themselves. Why did the rise of the West come only to some countries in Europe by 1900, while others remained at much lower income levels? Why was the rise in income so much greater and sooner in London than in any other city in Europe? Perhaps most curious, why did the rise in incomes appear so suddenly and so late?

If we ended this graph at 1800–1849, there would be no indication at all that tremendous growth was coming. The richest cities—London, Antwerp, and Amsterdam—were all on the downswing, showing declining real wages from their peaks in 1700–1749 and no significant increase from wage levels in 1500–1549. Paris and Madrid had improved to converge with Antwerp and Amsterdam in income by 1800–1849, but this was in part because wages in Antwerp and Amsterdam had fallen, dropping below the level they had been in 1500–1549. The cities of Italy and Austria were in sad shape, real wages having fallen to their lowest level in centuries.

This was Europe until 1850—a land of relatively unchanging real wages over many centuries, with the poorest areas getting steadily poorer, their

TABLE 5.2 REAL WAGES OF FARM LABORERS IN EUROPE AND ASIA (Deflated for cash wages and indexed to real wages in England in 1600 = 100)

Year	England	N. Italy	Japan	China	India
c. 1500	170	120	—	—	—
c. 1600	100	140	—	—	110
c.1750	110	100	90	90	—

Source: Robert C. Allen, "Real Wages in Europe and Asia: A First Look at the Long-Term Patterns," in *Living Standards in the Past: New Perspectives on Well-Being in Asia and Europe,* ed. Robert C. Allen, Tommy Bengtsson, and Martin Dribe (Oxford, UK: Oxford University Press, 2005), p. 122.

incomes falling to only one-half to one-third of the income in the richer areas by 1800–1849. What was happening in the major regions of Asia?

Table 5.2 gives a summary of farm wages in Japan, China, and India at various times compared with farm wages in Europe. At this time we have much less data for rural wages in Asian societies than in Europe, so this table has only a few data points. Still, the data that we have shows that Japanese, Chinese, and Indian wages are roughly in the same range as those of Europe. Indeed, Indian wages reported ca. 1600 were as high as English wages ca. 1750!

Of course, much happened after 1750. According to calculations by Robert Allen of Oxford University (who also provided the data on wages used throughout this chapter), Indian real farm wages made no progress or even declined after 1600, so that as recently as 1961 rural wages in India were slightly lower than in 1595. By contrast, in Britain real wages in 1900 had already tripled compared to 1750, and increased much faster yet again in the twentieth century. A great divergence thus took place in the late nineteenth and early twentieth centuries.

It seems that across both Europe and Asia, workers' real wages, despite some ups and downs, were in roughly the same range from 1500 to 1800. Differences between European and Asian wages seem to have been smaller than the differences between wages in different parts of Europe. For example, from 1600 to 1750, Chinese and Japanese farm wages were generally closer to English farm wages than urban wage levels in Spain and Italy were to those in England and the Netherlands.

Yet Asian wages, based on other fragments of data, do not appear to have increased after 1800; indeed they may have declined considerably. Thus when the wages of workers in northern European countries sharply increased after 1850, they left the major regions of Asia, as well as the poorer parts of Europe, falling badly behind.

Of course, we should point out that these real wage data are based on many estimates and are only approximate. Researchers had to combine data from different tax rolls, merchant records, and market accounts to estimate workers' wages and then factor in estimates of changing prices for many different goods, to develop the figures shown in Table 5.2. Still, the overall message that the wage data send—that material conditions in Europe and Asia were fairly similar in levels and fairly stable over the long run until about 1800—seems consistent with our other evidence. Only after 1850 did incomes in several European countries sharply diverge from the rest of Europe and from Asia.

City Life and Agricultural Productivity

We usually think of city life and country life as opposites: Cities are dense and their inhabitants depend on jobs in manufacturing, construction, trade, and services, whereas people in the country live on farms, produce food, and raise animals. In premodern times, the contrast was not quite that great—even great cities like Paris had herds of animals driven to the butchers, and just outside the city walls were fields, orchards, and vegetable gardens. Meanwhile, even the countryside had tavern-keepers, blacksmiths, itinerant traders, story-tellers, cobblers, and many who engaged either part-time or full-time in spinning and weaving textiles.

Moreover, however different their lifestyles, cities and the countryside were connected by mutual need. Cities could not exist unless the countryside provided surpluses of food to feed urban residents; rural villagers could not obtain such small luxuries as good clothing, gloves or shoes; coffee, wine, tea, sugar, and spices; or decorative items and other manufactured goods without trading with towns. Urban craftspeople depended on the countryside for raw materials—leather, wood, and woven fabrics to be dyed and finished by skilled city workers. And farmers could not invest in more labor- or capital-intensive farming methods or in specialized production unless they had a ready market for their output in urban centers.

One of the striking characteristics of the major civilizations of Asia is how many large cities existed there at a relatively early date. Of course, in preindustrial times all major civilizations were made up mostly of peasants, who produced the essential food and raw materials for themselves and everyone else. Still, whether a society could support cities of any size—from only a few tens of thousands to millions—offers substantial insight into how much additional output, above and beyond their own consumption, rural workers were producing that could go to feed city dwellers. The presence of large cities also suggests extensive networks of trade to provide for the needs of urban populations and vast transportation systems to bring goods to urban markets.

Table 5.3 gives rough population estimates for the 10 largest cities in the world in 1500, 1800, and 1950. In 1500, Asia completely dominates the list. In 1800, Asian cities still dominate the list, but not quite as completely—three European cities have joined the top 10. Yet Beijing remains the world's

TABLE 5.3 THE LARGEST CITIES IN THE WORLD: 1500, 1800, AND 1950

1500

Rank and City	Population
1 Beijing, China	672,000
2 Vijayanagar, India	500,000
3 Cairo, Egypt	400,000
4 Hangzhou, China	250,000
5 Tabriz, Iran	250,000
6 Istanbul, Turkey	200,000
7 Gaur, India	200,000
8 Paris, France	185,000
9 Guangzhou, China	150,000
10 Nanjing, China	147,000

1800

Rank and City	Population
1 Beijing, China	1,100,000
2 London, United Kingdom	861,000
3 Guangzhou, China	800,000
4 Edo (Tokyo), Japan	685,000
5 Istanbul, Turkey	570,000
6 Paris, France	547,000
7 Naples, Italy	430,000
8 Hangzhou, China	387,000
9 Osaka, Japan	383,000
10 Kyoto, Japan	377,000

1950

Rank and City	Population
1 New York, United States	12,463,000
2 London, United Kingdom	8,860,000
3 Tokyo, Japan	7,000,000
4 Paris, France	5,900,000
5 Shanghai, China	5,406,000
6 Moscow, Russia	5,100,000
7 Buenos Aires, Argentina	5,000,000
8 Chicago, United States	4,906,000
9 Ruhr, Germany	4,900,000
10 Calcutta, India	4,800,000

Source: Tertius Chandler, *Four Thousand Years of Urban Growth: An Historical Census* (Lewiston, NY: Edwin Mellon Press, 1987).

largest city, and China and Japan each have three of the world's largest metropolises. Only the Middle East has lost ground, although Istanbul remains on the list. In short, as in so many ways we have found before, not much changed in the world from 1500 to 1800!

By 1950, however, the urban pecking order had been reversed. The largest city in the world is no longer in Asia, nor indeed are most of the top 10 cities of the world. By 1950, only three Asian cities (Tokyo, Shanghai, and Calcutta) are on the list, and most of the major Asian cities of the prior charts have gone. The rise of the West appears clearly in these tables, but again as a post-1850 phenomenon. During the centuries from 1500 to 1800 Asia supported more grand metropolises than did Europe, another sign that Europe's rise came relatively late.

To show that the underpinnings of urbanization did indeed reflect the real resources of societies and not just a crowding of the poor as it often does today, we can look at the factor that makes urbanization possible: agricultural productivity. The higher the output of food per person, the greater the surplus that is available to feed those who do not themselves farm and raise food, such as urban populations. So if we can estimate the amount of crops and livestock that farmers in various societies produced each year, we can estimate the productivity of their agricultural economy.

The productivity of labor in agriculture is a measure of how much total farm output is produced by the average worker in a given unit of time, say an average year. The more that laborers produce, the more there is to consume and invest. And since in any society in the world before 1800, farmers and farm workers provided most of the labor and output in society, the agricultural productivity of labor should be a fairly good guide to the overall level of income and wealth in that society.

Figure 5.2 presents data on agricultural productivity for several European nations and for China, all the way from 1300 to 1800. It is striking how much the data in this graph resemble that in Figure 5.1 (page 80). We find that the countries with the highest levels of agricultural productivity in 1700—Belgium, the Netherlands, and England—were also the countries where urban wages were highest. Italy and Spain, by contrast, had productivity that was low and declining after 1700.

Belgium's productivity is shown as starting at a very high level. Belgium was indeed famous for its superior agricultural productivity in the Middle Ages, which supported the largest urban concentration of its day in Europe. Yet it slowly declined and lost its lead to other European countries by 1800. Finally, England's exceptionally fast productivity growth—essentially leaping from the level of Spain and Italy, where it was from 1300 to 1600, to the level of Belgium and the Netherlands by 1700—also seems to preview its rapid growth in wage levels in the following centuries.

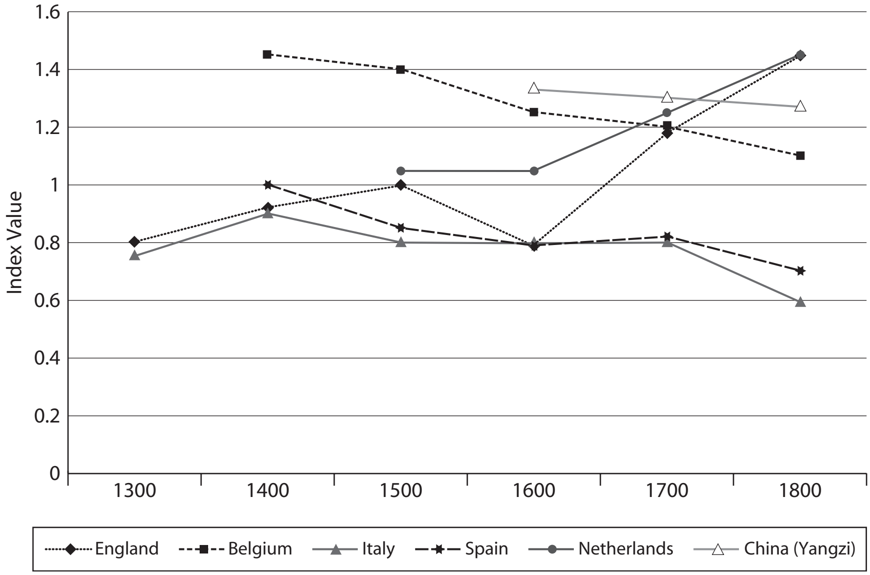


FIGURE 5.2 AGRICULTURAL PRODUCTIVITY OF LABOR, 1300–1800
Source: Robert C. Allen, "Agricultural Productivity and Rural Incomes in England and the Yangtze Delta, c. 1620–c. 1820," *Economic History Review*, forthcoming.

Figure 5.2 also provides estimates of agricultural productivity in China from 1600 to 1800. These are not taken from all of China, but from the Yangzi River delta, a region whose size and population resembled that of a major European country. It was one of the richest regions in China. Although China has only two centuries covered on the graph, these findings still give us much information on comparisons with Europe. First, we find that the Yangzi delta had very high levels of labor productivity—in 1600 and 1700, productivity levels were higher than those of any country in Europe.

This is consistent with the fact that China had the most large cities of any major society in the world in the centuries before 1800. It also suggests that Chinese society was not poor but was relatively rich compared with most European countries in the 1600s. That too is consistent with travelers' tales that stress the wealth and prosperity of Asia (remember, this is what motivated Columbus to set out across the Atlantic and the Portuguese to sail around the Cape of Good Hope in search of pathways to Asia).

The story told in Figure 5.2 is again one of greater differences *within* Europe than between Europe and Asia. In 1400, agricultural productivity in Belgium was 50 percent higher than anywhere else in Europe, while Italy, Spain, and England were within 10 percent of one another. By 1600, productivity in all these places had fallen, as population had grown and there were more people on the land. China was slightly more productive than Belgium at this point. Then in the next 200 years, things changed dramatically in Europe. The Netherlands and England experienced a surge of agricultural productivity, surpassing Belgium and becoming about twice as productive as Italy and Spain, in both of which productivity declined. This surge also brought them up to Chinese levels of productivity: Whereas in 1600, agricultural productivity in China was about 26 percent greater than in the Netherlands and 66 percent greater than in England, by 1800 both England and the Netherlands had levels of agricultural productivity about 10 percent higher than China's.

Figure 5.2 thus raises some puzzling questions. Why was agricultural productivity so high in China but also so stable? Why was productivity so high at an early date in Belgium, and why did it increase so rapidly after 1600 in England and the Netherlands? We answer these questions in the final section of this chapter.

How Did Agricultural Productivity Grow?

Why did some countries have higher agricultural productivity than others? Part of the answer lies in favorable conditions of soil, weather, and water. Areas of rich soil and plentiful water—whether obtained from regular rainfall or by irrigation from rivers—had higher productivity. Thus the lands of northern China along the Yellow River, the Middle Eastern region of Mesopotamia along the Tigris and Euphrates, the Indus River valley in India, and the Nile River valley in Egypt were the earliest centers of large civilizations because of their relative abundance of well-watered, easily worked lands.

But as populations grew, the simple availability of good land was no longer sufficient to establish and maintain high productivity. To continue to boost output, what began to matter more was how intensively the land was worked. Intensity, in turn, was a matter of identifying and using various combinations of crops and animals and fertilizers—as well as improved farming techniques, which made absolute maximum use of the available land while sustaining soil nutrients—all of which allowed farmers to produce more and more output per acre.

Europe and Asia pursued different paths to higher productivity, reflecting their different soils, crops, and climates. From the Middle Ages onward, most areas in northern Europe used a three-field system to grow crops and support their animals. In this system (described in Chapter 1), one field was used for the main grain crops, which could be wheat, barley, rye, or oats. A second field was used for a non-grain crop, such as peas, beans, or clover, which increased soil fertility by taking nitrogen from the atmosphere and releasing it into the soil. A third field was left unplanted (or fallow) and used as rough grazing for sheep, whose manure enriched the soil. Each piece of farmland thus spent one year under manuring and one year under nitrogen-fixing crops before being planted for a season of grain; this resulted in much higher yields of grain. Each village also kept communal meadows to grow grass and hay for feeding horses and cattle.

China and India, however, relied much more on river irrigation. In these countries the heavy monsoon rains created flood surges that allowed irrigation channels to flood the soil. The same was true in the Nile valley, where seasonal rains in Ethiopia caused by tropical moisture from the Indian Ocean crashed down from the Ethiopian highlands to create annual floods in the Nile.

The annual flooding, which deposited richly fertile silt on the fields, allowed the soil to bear good crops of grain every year, without leaving half the land fallow and without relying so heavily on animal manure for fertilizer. As a result, the northern plains of India and China, and the Indus and Nile river valleys achieved high agricultural productivity from an early date, so much so that Egypt was the breadbasket of the ancient Mediterranean, and India and China were able to build large civilizations while Europe was still developing its first city-states.

Europe's three-field system was not very intensive. Not only was two-thirds of the land at any one time not used for growing grain, but the rough grazing on weeds on the unplanted land could not support very many or very large sheep. This limited the amount of manure, which was crucial to restore the land for the grain crops. If only another way could be found to increase the output of animal feed and manure, then more land could be fertilized and planted in grain.

This answer was found in the Middle Ages. If the animals were kept in a shed or pen, instead of being allowed to graze on unplanted land, and if that land was planted in a crop that produced a rich animal feed, such as turnips or alfalfa, then the animals could be fed in their stalls or pens. Their manure could then be collected from the pens and spread on the fields before planting. This meant that land did not have to lie fallow in rough grazing for a whole season in order to receive the needed manure.

After a bit of experimenting, farmers found that the best output came from a four-field rotation: One-quarter of the land was used for animal feeds such as turnips or alfalfa; one-quarter for nitrogen-fixing crops such as clover or beans or peas. Then the rest of the fields could be planted in grain, usually half in wheat and half in barley. This system not only produced more grain and higher yields, it also produced more and larger animals because of the better quality of animal feed.

However, converting from the three-field to the four-field system was quite expensive for farmers. They had to invest in new crops (turnips and alfalfa) and in building pens or stalls for their animals. The whole process was only worthwhile where farmers had markets close at hand for the extra animal meat or could be assured of a good price for their extra grain. This usually meant that the new system could be adopted only near major cities that provided such markets.

The first place this began was in Flanders, now the southern part of modern Belgium. In the early Middle Ages, the powerful counts of Flanders sought to fortify their lands against invasion from Viking raiders by building a string of fortress-towns, including Bruges, Ghent, and Ypres. People flocked to these towns for protection and shelter and made a living by weaving raw wool imported from England into expensive and luxurious cloth. As Bruges, Ghent, and Ypres became wealthy and populous centers of woolen cloth production, with large numbers of prosperous workers who needed to be fed, Belgian farmers began converting to the four-field rotation and achieved the highest agricultural productivity in Europe. The process spread with the growth of the Belgian port city of Antwerp, which in the 1500s became the leading trading center of northern Europe.

In the 1600s and 1700s, first the Netherlands and then England too began to adopt the more intensive modes of farming. The great trading cities of the Netherlands—mainly Amsterdam, but also Rotterdam, the Hague, and many others—became the supermarket for surrounding regions and could therefore reward greater farming investment and increased productivity and output. In England the city of London, which could be supplied by river or coastal shipping from much of the country, provided a similar stimulus to English farming.

Other countries in Europe also had small areas of intensive farming around cities, such as the Seine basin around Paris. But for most of continental Europe, especially the Alpine regions (Austria) or the Mediterranean regions (Spain and Italy), the climate was too dry, or the main urban markets too distant, for farmers to benefit from investing in fodder crops and stalls for raising animals. Farmers in these areas tended to diversify into wine production, which produced added cash but not more grain. As a result, in these countries, agricultural productivity and incomes tended to lag behind.

One should not think that while Europe was increasing its agricultural productivity, China and the rest of Asia simply stood still. From 1600 to 1800, the population of China increased by more than the entire population of Europe, from roughly 100 million to 350 million inhabitants. Adding 250 million inhabitants to existing lands without any substantial decline in the productivity of labor would have been impossible without improvements in agricultural technology (the very modest expansions that occurred in China's farmland in this period were mainly in Manchuria in the far north—with its limited growing season). China fed its increased numbers by also intensifying agriculture using new fertilizers and crop rotations.

Of course, the fertilizers and crops were quite different! In addition to manure (mainly from pigs, poultry, and fish ponds), China pioneered the large-scale recycling of waste products from food processing for fertilizer. Chinese food uses a great deal of soy sauce, bean curd, and cooking oil, which were obtained from pressing and processing soy beans, rapeseed, and other vegetable seeds. The leftovers from these processes—mashed seeds and beans and husks—were collected into cakes (often called beancake) and sold as fertilizer for spreading on rice fields and other planted lands. The availability of this additional, easy-to-use fertilizer and the spread of early-ripening varieties of rice allowed the planting of two crops in a single season. The use of beancake and early-ripening rice crops spread through China from the early 1600s.

In some areas of China, rice was alternated with wheat or beans; in other areas peasants grew two rice crops on their lands in a single year. The cultivation of cotton and maize also spread to sandy and hilly soils, which were less suited for rice, and mulberry trees (for silk cultivation) were grown along the edges of rice paddies. In the north, sorghum and soybeans (which, like other bean crops, added nitrogen to the soil) were alternated in the same season. After 1500, the Chinese even appear to have been more advanced than Europeans in incorporating new crops discovered in the Americas—corn (maize), potatoes, sweet potatoes, peanuts, and cashews—into their diets and farming.

In addition, Chinese farmers developed more refined techniques for planting and irrigating. Seed drills were used to conserve seeds and plant more efficiently. Water buffalo were used not only to plow the soil (using the superior, lightweight cast-iron plow), but also to pump irrigation water, saving human labor. Throughout China, the ability to harvest multiple crops from the same land each year, complex new mixes of new seeds and new crop rotations, plus new tools and techniques all allowed families to grow far more food on a given piece of land.

Families therefore often sold or leased some of their land to other families. In addition, smaller family holdings meant that female labor could be released from farming. Women instead could devote their full time to spinning silk or cotton and weaving cloth. By the late eighteenth century, the Chinese summed up their new system of farming with two sayings: "one family, 10 *mou*"—meaning that a small amount of land (10 mou are about an acre) could support a family—and "man plows, woman weaves"—meaning that farming was now almost entirely man's work, while women worked within the home on textile production.

Since smaller holdings could now feed a family and additional cash income could be obtained from women's spinning and weaving, far more families could prosper in the same area than was possible a century before. Population thus grew rapidly, as we have seen. Yet the new techniques meant that this population growth, for at least a century and a half, could occur without any decline in living standards. Indeed, farm incomes probably rose by 1750 to historically high levels—as we can surmise from complaints by elites in the local county gazettes that farmers were wearing fancy clothes and putting on airs!

Only toward 1800 did population growth start to exhaust these gains, so that China's continuing population increases after 1800 started to produce shortages of land and excess labor, with greater competition among families everywhere in China to sell the cloth that they produced at home. These trends probably led to fairly steep declines in family incomes by 1850.

The new multiple-cropping and fertilization techniques nonetheless allowed China to sustain productivity levels on par with those of the leading countries in Europe from 1600 to 1800, even while its population tripled. Multiple cropping also spread in other rice-growing regions, such as India and Southeast Asia.

In short, we find that around the world from 1500 to 1800 the basic story was much the same—living standards were shaped by agricultural productivity, and agricultural productivity depended on techniques for intensifying agriculture. Where agricultural intensification was achieved by new crop rotations, new seed varieties, and increased use of fertilizers, productivity and living standards could be raised to, or maintained at, relatively high levels. But without such intensification, population increases over time meant that productivity and incomes would fall.

Still, we are left with one last puzzle. Agricultural productivity was high in England, the Netherlands, and China through 1800. But that does not explain the break in wages shown in Figure 5.1 (page 80). Why did real wages in London suddenly shoot up after 1850, while wages in the Netherlands fell? Why, by 1900, had real wages in northern Europe risen to previously unseen levels, while real wages in Asia declined substantially after 1800?

The Industrial Revolution and Real Wages

If we focus on the period from 1500 to 1750, material life is really all about agriculture and trade. Making things is generally the work of small numbers of craftspeople or individual households. There are some large-scale industrial processes, to be sure: brewing in Europe, pottery-works and silk weaving factories in Asia, sugar refining in the New World, and of course the mining of coal and precious metals. Nonetheless, for most of the world, upward of 70 percent of the population worked in farming, and the ways to get rich were either to own a great deal of land or to engage in trade on a very large scale. The stereotypical wealthy manufacturer who grew rich by high-volume production and mass sales of manufactured goods did not yet exist. It is thus not surprising that the richest countries in the world in those centuries were also the ones with the highest productivity in agriculture.

Yet farming alone did not transform societies from traditional to modern. No matter how many bushels of corn or pounds of meat a society produced, even if enough to feed its population many times over, that achievement would not lead it to produce railroads, iron and steel foundries, textile factories, or electricity and automobiles. Such objects require a different kind of production that uses modern engineering to invent new technologies.

The limits of agriculture, even in Europe, are readily apparent. We have already observed that real wages showed substantial swings up and down but tended to stay within a stable range over many centuries. This is because as agricultural productivity grew, population tended to increase as well, to the point where productivity gains were canceled out or even began to fall. Even in England, it appears that there was little real growth in agricultural productivity after 1750. If we look at farm wages by region within England, we find that from 1700 to the 1820s real wages actually fell by about 5 percent in the southern (mainly agricultural) part of the country. The reason real farm wages eventually rose in England was entirely because farm wages rose in the northern and midland regions, by a whopping 50 percent, over this same period.[4]

Why did wages rise in the north, but not in the south? The answer is that in the late eighteenth and nineteenth centuries, the northern and midlands regions of England were the sites of booming new textile and metalworking factories. Cotton spinning, weaving, and the making of iron and steel and their products—from nails and cutlery to tools and decorations—grew dramatically in these areas from 1750 onward. The growth of new factory towns, such as Birmingham and Manchester, led to a booming local market for farm products and thus for farm labor. It was industry that drove the rise in wages after 1750, while regions and whole countries that relied mainly on agriculture fell behind.

We see this if we revisit Figure 5.1 (page 80) and focus on the fate of Amsterdam. In 1750–1799, the Netherlands had agricultural productivity as high as that in England. Yet in the century to come, real wages in

London rose by 50 percent from their level in 1750–1799, while in Amsterdam real wages *fell* by 10 percent over the same period. The reason was simple—portions of England's economy were being transformed over the nineteenth century by steam power, railways, steamships, and coal-fueled metal production and metalworking trades. The Netherlands remained mainly an agricultural and trading economy—a relatively productive and prosperous agricultural and trading economy, to be sure, but not yet making a transition to industrialization, and thus with little room for further growth.

In England, we find that the increases in productivity in the nineteenth century came mainly in manufacturing and transportation, not in agriculture. (We shall explore these in more detail in Chapter 7.) For now, the main point to note is that although agriculture may have carried the burden of a country's economic welfare before 1850, after that date, when the wages shown in Figure 5.1 start to break out of traditional patterns, it is because the labor force too is breaking out of agriculture and into industry.

The vulnerability of the agricultural economies, even in Europe, was driven home in 1848. One reason that agricultural productivity had risen in many places in Europe, including Ireland and western Germany, was the spread of potato farming. Many new crops were introduced from the Americas into the global economy, reaching Africa and China as well as Europe. These included maize (corn), potatoes, tomatoes, tobacco, rubber, and cacao. Potatoes were particularly valuable, because they provided the calories and protein to feed people on a much smaller plot of land and because they stored well. In some areas, especially Ireland and western Germany, farmers grew grain to pay their landlords, but supported their families mainly by growing potatoes. Then in the 1840s, a terrible blight hit Europe's potato crop, and those who had become dependent on potato cultivation were devastated. Famine hit Europe one last time, and millions starved or were forced to leave their homes in search of work and land. As late as the 1840s, much of Europe still depended upon, and was vulnerable to, the vagaries of agriculture for the core of its well-being.

The rise of industry as a source of mass employment, which allowed workers to earn wages from producing manufactures and then buy their food (much of it imported from great distances) changed the basic conditions of economic life. As we can see from the wage data, it did so rather suddenly. To be sure, people did not suddenly become rich. Indeed, the conditions of industrial employment in mines and metalworking factories were often harsh and dirty and hard. Even where industrial work was not physically demanding, as in textile mills, the work was often stupefyingly boring. And in the early days of industrial manufacturing, wage gains remained modest. But wage growth began to accelerate in the years after 1800, and by the 1850s people in Western Europe realized they were living in a different world from that of their fathers—a new world in which factories rather than fields held the promise of steady work, and owning factories rather than landed estates could be a pathway to great wealth.

Still, the spread of industry was relatively slow. Only in England, of all the countries of Europe, did industrial and manufacturing work employ as much as half of the population by 1850. And only in England had workers' wages risen to historic heights before 1900. The Industrial Revolution was thus something of a slow-motion revolution, rather than a sudden change.

Recent and careful work by economic historians has shown that economic growth in Europe accelerated only slowly, as large sections of the economy—not only agriculture, but the making of all kinds of other goods, from leather items to carriages, from hats to finished clothing—continued to rely on handiwork and not machine manufacturing for many decades. Nonetheless, year by year and decade by decade, the spread of machinery and steam power and the use of coal, iron, and steel lifted first England, and then other parts of Europe, out of the agricultural past. As Figure 5.1 clearly shows, despite all the terrible stories about horrible factory conditions and the poverty of industrial workers, it was in the countries where industry remained almost absent through the nineteenth century—Italy, Spain, and Austria—where the real wages of workers fell the most, and workers earned the least.

Conclusion: The West was Very Diverse, and Not Always Richer than the East

We note four valuable lessons in this chapter. First, no preindustrial societies were always poor, nor always well-off. Rather, living conditions varied considerably across both space and time. Across Europe, there were considerable differences in the productivity and living standards of peoples in different regions. And even within relatively well-off countries, such as England or the Netherlands, there were periods in which wages and living standards fell quite low and other times in which they rose strongly. Moreover, the richest countries at certain times, such as around 1500, were not the same as the richest countries at other times, such as 1700.

Second, although living standards varied considerably from time to time and from place to place, these changes were mainly cyclical fluctuations; the long-term average standard of living changed very little for many centuries. Life expectancy and stature in Europe remained roughly the same from Roman times through the eighteenth century, and real wages remained within the same range from the Middle Ages until 1850.

Third, when we compare living standards across Europe and Asia, we find that until about 1800, living standards were fairly similar across the major nations of both continents. Indeed, around AD 1600, Asian societies may have been slightly in the lead. But from 1800 to 1950, we see a great divergence. The leading areas of Europe raised their incomes very dramatically, while the lagging areas declined, so that by 1900 the richest areas of Europe (England, Belgium, and the Netherlands) are perhaps three or four times richer than the poorer areas of southern Europe. The major civilizations of Asia—Japan, India, and China—also appear to have stagnated or declined in income after 1800, so that by 1900 the richest areas of Europe greatly surpassed the major Asian societies as well. The existence of a rich Europe and a poor Asia is thus, historically speaking, a relatively recent phenomenon. From 1800 to 1950, explosive growth in incomes and urbanization in northwest Europe combined with substantial decline or stagnation in Asia to reverse their respective positions in the world economy and create the disparity that became known as the rise of the West.

Fourth, the secret to this divergence appears strongly rooted in domestic productivity. That is, the richest parts of Europe in 1800 were those in which agricultural productivity had caught up to Asian productivity levels. Then after 1800, the richest parts of Europe were the regions that industrialized, complementing high levels of agricultural productivity with vastly increased productivity in manufacturing and industry. In other words, the richest European nations did not become rich because they took more treasure from other parts of the world or because they had empires or slavery—as we have seen, the European countries with the largest empires, the most treasure, and slavery (namely Spain and Portugal) generally fared poorly after 1800. Rather, it was because workers in the richer countries—especially England, but also the Netherlands and Belgium—became more productive than workers elsewhere in Europe and more productive than workers anywhere in the world.

We have in this chapter discussed agricultural productivity and shown why China, India, and later Belgium, the Netherlands, and England were relatively prosperous preindustrial countries. Yet we still need to ask how England, and later the rest of Europe, made the transition from preindustrial to industrial societies, for it was the onset of industrial production that accounts for the breakout of real wages after 1800–1849.

To understand what truly lay behind the rise of the West, we therefore need to look more closely at two major factors that led to the rise of modern industry: the power of the state, and the development of industrial technology, which we examine in the next two chapters.

Additional Reading

Laslett, Peter. *The World We Have Lost.* New York: Scribners, 1965.

Livi-Bacci, Massimo. *A Concise History of World Population.* Oxford, UK: Blackwell, 2006.

Marks, Robert. *Tigers, Rice, Silk and Silt.* Cambridge, UK: Cambridge University Press, 1998.

Pomeranz, Kenneth. *The Great Divergence.* Princeton, NJ: Princeton University Press, 2001.

CHAPTER SIX

States, Laws, Taxes, and Revolutions

CHAPTER PREVIEW: Europeans might not have started out with material advantages, but did they benefit from superior government? Some scholars have claimed that competition among European states led rulers to lower taxes and tariffs and to grant more secure property rights in order to gain elite and popular support. This, it is claimed, gave Europeans a foundation for growth rapid enough to eventually overtake Asia, where vast empires and arbitrary rulers blocked growth. Where European rulers were too severe in taxation or too arbitrary in royal authority (as in seventeenth-century Britain or eighteenth-century France), this argument suggests that revolutions overthrew them and brought liberty.

In fact, Europe's great revolutions of the seventeenth and eighteenth centuries were not the result of unique political processes but part of long waves of state formation and social conflict that were found in Asia as well as in Europe. Moreover, Europe's economic leader in the 1800s—Britain—spent the eighteenth century with the highest taxes and tariffs in Europe, far higher than any empire in Asia!

Across both Europe and Asia, the typical pattern of government in the seventeenth and eighteenth centuries was for state rulers to grow stronger at the expense of local elites and to respond to political crises by enforcing more orthodox religious beliefs. The major exception was Britain, where in the course of the late seventeenth and early eighteenth centuries, a stronger Parliament, the unique common law, and religious pluralism and toleration created a most unusual state.

We have learned in the preceding chapters that the economic history of the world prior to 1800 was one of cycles and waves of moderate change. Real wages moved up and down, and agricultural productivity and incomes moved up in some parts of Europe and down in others. By 1800, there had been significant gains in agricultural productivity in some parts of Europe, but population growth was overtaking those gains, so that workers' incomes started to fall even in London in 1750–1799 and in Amsterdam in 1800–1849. As late as 1848, the onset of a potato blight meant widespread hunger across Europe.

Agricultural productivity in Asia, meanwhile, although it had been very high, did not increase further but appears to have declined after 1800. As population in Asia surged forward in the nineteenth century, incomes fell sharply. If Figure 5.1 (page 80) showed only the data through 1800–1849, we most likely would have expected the world economy to enter the late nineteenth and early twentieth centuries in much the same historical range as had been experienced in the preceding five centuries. Many regions—Italy and Austria in Europe, and China and India in Asia—were about to set new lows in historical living standards, rather than reach new highs.

Yet this gloomy picture does not tell us all that happened in the 1800s. As we saw, there was a sharp break from the past in the late nineteenth century, in which real incomes suddenly headed upward in Europe, and which occurred earliest and with the greatest magnitude in Britain. How could this have occurred?

A number of scholars have urged that we look for an answer in the rules under which people lived—in other words, their governments. "Institutionalists," as these scholars are called, have suggested that the rules under which people held property or the freedoms people had to acquire money and invest it were the crucial ingredients that enabled economic growth to take place. Censorship, high taxation, arbitrary and tyrannical government, religious authority, and excess bureaucracy were all said to be obstacles to change and to better ways of doing things. So too were privileges granted to guilds or existing producers that stifled competition or high tariffs that formed obstacles to trade. By contrast, the institutionalists argued, free and open markets, light taxation and a small bureaucracy, security of property, encouragement of trade, and restrictions on the authority of government were the keys to rapid economic growth.

These scholars claim that understanding the rise of the West therefore depends on identifying the special characteristics of European states. Was there something unique about this group of medium-sized states—often at war and always in competition—and the nature of their governments that promoted economic progress? In particular, was there something about the British government (for Britain led Europe in industrialization) that was especially favorable to economic improvement?

Was it perhaps the political revolutions that overthrew kings in Britain in 1640 and in France in 1789 that paved the way for the later Industrial Revolution and all that followed? These are the questions that we explore in this chapter.

Did European States Have More Military and Religious Competition than Asian Empires?

One of the obvious differences between the history of European states and that of the major civilizations of Asia is the absence of large empires in Europe, particularly in the period from 1500 to 1800. Although various European monarchs aimed to establish their authority all across Europe, at no point were Britain, France, Germany, and Spain (the major states of Western Europe) all controlled by a single ruler. Napoleon, from 1800 to 1815, came close—he placed Italy, Spain, and France under his (or his relatives') control. Yet he was defeated first by Russia and then by a combination of British, Russian, and German forces. Without any one dominant power that could impose order, Europe was repeatedly convulsed by wars between states during most of 1500 to 1800 (indeed until 1945).

By contrast, from 1500 to 1800 most of North Africa and the Middle East was ruled by the Ottoman Empire, most of India was ruled by the Mughal Empire, and all of China was ruled by the Ming and then the Qing Empires. These empires dominated their immediate regions and created unified rule over territories and populations that matched or exceeded that of all of western Europe.

Several leading European scholars, such as Eric Jones and David Landes, have suggested that the presence of multiple, competing states made Europe more innovative. Such scholars have pointed out that groups of competing states—from the time of ancient Greek city-states to the medieval Renaissance states of Italy to the states of preindustrial Europe—seem to have been unusually dynamic in art, politics, and military technology. Competition among states would lead rulers to improve their military organization and technology and to give concessions to their subjects, granting lower taxes to win their support. In addition, in a competing states system, even if one ruler suppresses a new idea, it can grow elsewhere.

By contrast, these scholars argued, in a large unified empire the ruler is more likely to be concerned with keeping control over his existing empire than with fending off competitive threats. Methods to maintain tight control—such as insisting on strict religious conformity and obedience to the ruler or levying heavy taxes to maintain an oppressive state—would be more important than finding new ways to increase economic wealth or improve military power. Even if a valuable new idea arose or filtered in from abroad, it might be snuffed out in a large empire and have no other chance to develop.

Although this theory seems attractive, it is a misleading oversimplification to say that from 1500 onward Europe had a system of competing states whereas Asia had empires without competition. It is more accurate to simply say that Asia had several states that were larger than any in Europe. If we look at a map of Asia circa 1600, when the Ming and Mughal (or Moghul) and Ottoman Empires were all well established, we see that Asia was also divided among a large number of states. Figure 6.1 identifies 22 states, large and small (and the map does not show Oman and Yemen on the Arabian Peninsula nor Java and other states in Indonesia). Several of the largest states bump right up against major military competitors (the Ottomans against Persia, the Mughals against Persia and the south Indian states), and the map as a whole looks not all that different from Figure 1.1 (page 5), showing Europe in 1500.

The states of Asia were often at war. The Persians invaded the Mughal Empire and sacked its capital city of Delhi in the eighteenth century. The Mughals were also repeatedly at war with the Maratha confederation. The Ottomans were frequently at war with the Persians, losing as often as winning, as well warring against the Austrians, Russians, and Poles. In China, the Manchus conquered the Ming Empire in the mid-1600s and set up their own new dynasty, the Qing. The Qing emperors then spent the next century leading vast firearm-equipped armies—supported by an astonishing logistics system extending thousands of kilometers across mountains and deserts—in wars with rival kingdoms in central Asia.

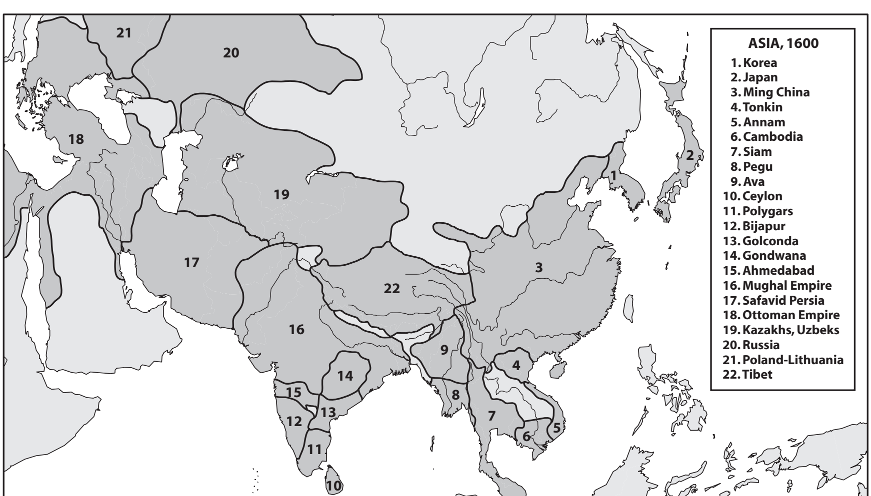


FIGURE 6.1 ASIAN STATES IN THE SEVENTEENTH CENTURY

The smaller states were also impressive fighters. The Vietnamese fought multiple wars with China and repeatedly invaded Cambodia. Indeed, the small states of Indochina—Annam, Tonkin, Champa, and Khmer (Cambodia)—fought each other for centuries, all the way from the twelfth up to the twentieth centuries. In one stretch from 1771 to 1845, Annam, Thailand (then Siam), China, and Cambodia were involved in wars among themselves in 44 out of those 75 years.

European historians sometimes point with pride to the castles and fortifications developed from medieval times to the Renaissance and to the spirit of military competition among European states. Historians of China and Japan, by contrast, often stress the highly civilized court and elite culture of these societies, which emphasized Confucian learning, painting, calligraphy, and poetry. Yet we can hardly ignore the military spirit of these Asian societies, which in the seventeenth century not only completed the Great Wall of China (a battlement and fortification on a scale unimaginable in Europe) but also produced the world's finest steel and swords, created (and to this day is still renowned for) the world's most elaborate martial arts, maintained huge armies equipped with firearms and artillery, built large and powerful navies, and operated formidable supply and communications networks. In the 1300s Chinese navies used massive, three-deck warships with iron-clad castles, each holding over 2,000 men. One conflict involved several thousand ships and 400,000 soldiers and sailors. Europe would not wage wars on this scale until many centuries later.[1] Both China and Japan were easily strong enough militarily to keep Europeans bottled up in small outposts distant from their capitals for over 300 years, until steam-powered naval vessels from Britain and America arrived on their shores in the nineteenth century.

It must also be acknowledged that the competition among European states was not generally beneficial to freedom and pluralism—in fact, such competition led most state rulers to turn sharply *against* pluralism within their borders, which squelched innovation and freedom of thought. By the late seventeenth century, monarchs in Catholic lands—notably Philip IV in Spain, Ferdinand II in the Austrian Habsburg Empire, and Louis XIV in France—had driven Protestants and other dissenters out of their territories. Many Protestant states, such as the Calvinist Netherlands and Lutheran Sweden, were also strengthening the official state-supported religion. In the middle of the eighteenth century, only Denmark, Prussia, and Britain tolerated the practice of different religions, in contrast to the increasingly intolerant and uniform religious practices in most of Europe.

In Asia, just as it is wrong to see the major empires as always dominating their neighbors and being free of military competition, it is wrong to see them as simply closed to new influences and uniform in their beliefs.

From the fifteenth through the eighteenth centuries, the number and variety of states in Asia promoted a flourishing international trade in commodities and ideas, which crossed borders to enrich the diverse cultures of northern and southern India, Persia, Tibet, central Asia, Indochina, southeast Asia, China, Korea, and Japan. As in Europe, there was also competition among religious faiths—chiefly Islam, Buddhism, Hinduism, and Confucianism—each with its own various sects and heterodoxies.

Confucianism may have become more rigid and orthodox in China under the Qing, and marginalized the Buddhism that prevailed in earlier centuries, but a great variety of Buddhist beliefs and practices found homes in the southeast Asian states, Tibet, and Japan. The Ottomans may have favored an increasingly orthodox form of Sunni Islam by the eighteenth century; but the Shi'ite heterodoxy thrived in independent Persia (today's Iran), and various Sufi and other sects found shelter in parts of the Middle East, central Asia, and south Asia. In India, the period of Mughal rule was marked by the coexistence of Islam and Hinduism and also by the flowering of diverse new religions, such as the Sikhs and various schools of Indian philosophy. Mughal courts also lavished patronage on the arts and literature that rivaled that of Renaissance Italy, leading to new styles of artistic expression.

In short, both Europe and Asia had dozens of competing states. In both areas the large number of states led to constant military competition and allowed diverse views and religions to flourish despite the efforts of individual rulers to foster religious uniformity within their own countries.

Cycles of Revolution and Rebellion in Europe and Asia

Another reason given for the rise of the West is that the West had more economic vitality than Asia because European countries had more dynamic politics. Western social thinkers from Adam Smith and Thomas Malthus to Karl Marx and Max Weber believed that Asian empires had experienced no significant political changes for centuries, from the earliest days of their great empires until their encounters with European imperialism. Individual rulers and even dynasties might change; there might be rebellions and civil wars, but nothing of importance was thought to have altered.

Yet the claim that Asia had unchanging political structures and unchanging economies is completely mistaken. In fact, *all* of the major societies of Europe and Asia underwent periodic transformations in the centuries from 1500 to 1800. State power rose and fell, class relations changed, the power of the central government versus local elites shifted, and the administration of government was reformed. Such changes in political, social, and economic organization usually occurred in response to social and political crises, which were widespread in Europe and Asia.

From the late 1500s to the mid-1600s civil wars and rebellions occurred in France, Britain, the Netherlands, Spain, Naples, Portugal, and Bohemia. There were also rebellions in the Ottoman Empire; widespread national revolts overthrew the Ming dynasty in China; and the Mughal Empire started to disintegrate in India. Then again from the late 1700s to the mid-1800s, there were revolutions in France, Italy, Germany, Austria, and Hungary in Europe. This period also saw rebellions against Ottoman rule in Egypt, Greece, and Serbia; the Great Mutiny in India; and the largest revolts and rebellions in history in China (the Taiping rebellion). In all of these cases, rebellions and revolutions led to the restructuring of the government, new class relations, changes in economic organization, and a shift in the dominant ideological framework of these societies, whether to defend and re-establish the old regime or to create and justify a new one.

Why were all these states affected by rebellions and revolutions, and why in roughly the same time frame? The reason is fairly simple. All of the major societies of the world from 1500 to 1800 depended mainly on agriculture. When population grew faster than agricultural output, food prices rose. When food prices rose, both elites and ordinary people needed more money, and states needed more money too. Figures 6.2 and 6.3 show that, in all the major regions of Europe and Asia, the movements of population and prices tended to track each other, moving in the same directions over time. These simple trends in population and prices had surprisingly powerful effects on the politics of agrarian states.

Agrarian societies depended on the balance between population and agriculture. Farming supplied food for living and raw materials for manufacturing; and taxes on farming provided the vast majority of revenues to the state. Rising prices and rising population coupled with bad harvests could lead to massive hardships. Likewise, population growth made labor plentiful and jobs scarce for workers, while many farmers—squeezed by large families or rising rents—lost their lands. As elites too grew more numerous and struggled for resources and positions, factional divisions and infighting increased. The combination of these conditions created a situation in which a small spark could ignite the flames of rebellion.

In some countries, religious divisions or regional conflicts added fuel to the fire, while in others rulers overreached in their efforts to raise taxes and increase revenues, threatening elites—who then turned to revolt. Such upheavals occurred throughout Europe and Asia from 1560 to 1660, and again from 1770 to 1860, with the number and intensity of upheavals peaking in the 1640s and the 1840s. Europe and Asia thus both experienced long

Figure 6.2 Population in Europe and China, 1500–1850 (Indexed to 1500 = 1)

Figure 6.3 Grain Prices in Europe, the Middle East, and China, 1500–1850 (Indexed to 1500 = 1)

swings of political crises alternating with periods of stability, driven everywhere by the same rhythm of long-term waves of population and prices.

Nonetheless, European historians have long argued that, even though the timing of such events was remarkably similar, the results of these upheavals were different in Europe than in Asia. In Europe it seemed that these revolts and revolutions were all about liberty and freedom and resulted in major changes in the powers of kings and the status of nobles. By contrast, in China and the Middle East it seemed that nothing much had changed—emperors and elites went on much as before. Yet the idea that these great revolts and rebellions changed everything in Europe, but nothing in Asia, is deeply mistaken. Not nearly so much changed in Europe as was once thought, and much more changed in Asia than has been previously realized.

REBELLION IN EUROPE

In Europe, the seventeenth-century rebels may have shouted their desire for liberties, but they generally did *not* mean the individual liberties and freedoms that we think of today. Rather, they meant privileges for specific groups, which often could be extremely oppressive of individual members of society. That is, they sought the freedom for their own group to do things that were denied to the rest of society—not freedoms for individuals or for society as a whole.

For example, the Puritans who led the British Revolution of 1640 hoped to restrain a king who they thought was pushing the Church of England much too drastically toward the religion and practices of the Catholic Church. Yet the Puritans were famously oppressive of what we consider individual liberties, and the revolution ended up bringing military rule by the Puritan army of Oliver Cromwell to England, Scotland, and Ireland.

The seventeenth-century crises in Europe in fact did not create any lasting change in the powers of kings or the privileges of nobility. Indeed, quite the reverse: By 1687 the Catholic King James II in Britain had banned the free assemblies in the North American colonies and replaced them with royal viceroys, built a Catholic army, suppressed the Protestants in Scotland, and was seeking to pack a loyal Parliament to support the loyal appointees with which he had already packed the judiciary. In France, Louis XIV had banned freedom of religion and driven the Protestants from his kingdom, just as the king of Spain had driven the Muslims and Jews out of his kingdom 200 years earlier. Even in Holland, once a haven for individual freethinkers and representatives of many faiths, the hard-nosed leaders of the Calvinist Dutch Reform Church were driving their opponents out of the country.

It is thus no surprise that from the late eighteenth to the mid-nineteenth century, rebels once again raised their voices to call for liberty and democracy. But again—with the exceptions of Britain and its former colonies in America—rebellions and revolutions generally failed to bring lasting freedom and political change. In France, the French Revolution of 1789 was followed by the imperial reign of Napoleon and later of Napoleon III, so that stable democracy was delayed until the citizens of Paris rose up in 1871 to finally end the series of kings and emperors that had ruled almost continuously since 1801. In Germany and Austria-Hungary, calls for democratic government were suppressed by strong noble ministers and kings who kept a firm grip on the reins of power until they were forced out in World War I. In Spain and Italy, kings and dukes held their power into the nineteenth century. Even in Britain, although kings were restrained by elected Parliaments after the Glorious Revolution of 1688, political participation fell far short of true democracy, as a narrow elite of landowners remained firmly in control of the government until the Reform Acts of 1832 and 1867 extended the franchise and allowed more people to vote.

True, the ideals of democracy and individual liberty had no counterpart in Asia, but neither did they enjoy much success in Europe—until the late nineteenth century, when the cities filled with industrial workers who then joined with industrial manufacturers to overturn the power of landed elites and traditional royalty. In other words, although the ideals of liberty had a long history in the West, it appears that the final triumph of democracy and individual liberty across Europe owed much to the rise of modern industrial economies, which increased the numbers and economic power of ordinary workers. Rather than liberal revolutions paving the way for modern industry, modern industry came to many nations (including Germany, Russia, Austria-Hungary, and even France and Britain) long before they achieved full democratic freedom.

REBELLION IN ASIA

The great rebellions of Asia did bring about massive political, social, and economic changes, yet they did not create any strong movement toward modern industrialization. In the Ottoman Empire, the seventeenth-century rebellions led to a substantial and permanent reduction in the control of the Turkish countryside by the central government in Istanbul. After the rebellions, the government relied on fairly autonomous local commanders and landed elites to keep local order, instead of the military forces that had served in return for land grants from the sultan. However, the state expanded its recruitment of a paid professional infantry (the janissaries) to lead its armies abroad. Local elites thus greatly increased their autonomy, while the central government gained a more efficient and powerful military, which it used to regain the offensive in southern Europe and the Middle East.

In the late eighteenth and early nineteenth centuries, the Ottomans underwent a further round of modernizing reforms, reorganizing their state and military and introducing Western bankers to manage state finance. These changes—creating a state bank, improving state finances, smashing corruption in the army, and rationalizing the bureaucracy—helped preserve the Ottoman Empire as a military and administrative unit until the 1920s. But these changes did not strengthen its economy enough to compete with the industrialized European powers of the late nineteenth century or to stand up to them on the battlefield.

China's transition to Manchu rule in 1644 created one of greatest outbursts of productivity in history, based on a massive change in class structure and power relations. In the last century of the Ming empire, local landlords in the richest parts of China had been able to avoid taxes by colluding with officials and had gained control of more and more land, creating vast estates. These landlords offered to protect peasants from taxes by absorbing peasants' lands into their own estates; but in practice once the peasants gave up their lands, they were dependent on the landlords and became little better than serfs.

However, when the weakened Ming state was overthrown by the Manchus, the new Manchu rulers sought to strengthen their government by radically changing the relationship between the state and elites, and between elites and their tenants. First, the Manchus kept their own military forces in place as a check on bureaucratic officials, who were held strictly accountable for delivering taxes and obeying the new rulers. Second, the Manchus placed huge taxes on any estates of substantial size, making it ruinous to try to hold them. As a result, the landlords of the late Ming were forced to free their tenants and sell their lands or lease them out piecemeal, giving rise to a rural economy dominated not by large estates but by family-sized holdings. Third, the Manchus placed strict limits on local taxation and made it clear that the government would prevent landlords from forcing peasants to give up their lands. Thus the peasants were assured of secure control over their family holdings. The unleashing of private enterprise on these family-owned or leased parcels contributed to the spread of multiple cropping, new fertilizing routines, and other intensive techniques that increased agricultural output enough to allow China to triple its population in the following two centuries.

In short, it is just as mistaken to see Asia's history as one of rigid and unchanging empires over the centuries as it is to see the history of Europe as fostering the swift and easy rise of democracy and individual freedom. Both images are distortions of a much more complex reality. In fact, by 1750, the more prosperous parts of Europe and China were about on par economically, and India and the Ottomans were close behind and still proudly independent. At this time, democracy had not advanced very far in Europe, whereas sweeping changes had shifted the relations among producers, landed and civil elites, and state rulers in much of Asia. Politically as well as economically, it was really only in the following century and a half that we would see the changes that led to a great divergence in the fates of different regions and the clear rise of the West.

Thus, if we are to understand what led to this divergence, we shall have to look at more subtle differences, not sweeping and overdrawn contrasts, between events and institutions in Europe and in other societies.

Laws, Taxes, and Business Institutions

One striking difference between European and non-European societies was in their systems of law. In most of Asia, laws were made by decrees of the ruler and were designed to regulate the activities of, and the relations among, the rulers' subjects. Such laws neither bestowed rights on those subjects, nor did they in any way limit the authority of the ruler. A ruler was seen as just if his laws led to prosperity, prevented the rich from exploiting the poor, and allowed trade and agriculture to flourish.

In Europe, the notion of law was rather different. In part, this was because European law was rooted in the laws of Rome, which originated as laws passed by a ruling group—the Senate of Rome—that was responsible to the Roman citizens. The founders of Rome had thrown out the Etruscan kings who ruled over them and created a republic. Since the laws were passed "by the Senate and People of Rome," they generally did not exempt the ruler; instead the laws applied to all and gave specific rights to certain groups and individuals vis-à-vis the state.

This system of republican laws deteriorated and, under the later Roman emperors (who had come to declare themselves gods and rule by decree), there was no longer much difference between a Roman emperor and a Turkish or Chinese ruler. After Rome fell in the fifth century, the barbarian kings that arose in western Europe from among the conquering tribes of Franks and Saxons sought to claim the absolute powers of Roman emperors for themselves. However, matters of law soon fell to the wayside in a world ruled more by superstition and crude coercion than by law and reason.

This began to change profoundly only in the eleventh century under the influence of Pope Gregory VII. Gregory envisioned a world in which the Catholic Church—including not only the pope and his lands in Italy, but all the church lands and bishops and priests throughout Europe—would be united and free of interference and control by the kings and emperors in Europe.

Gregory aimed to give the church strength and independence by shaping it according to rules based on Roman law, which was being studied and recovered at this time. Under Gregory's system, the Catholic Church claimed to be a corporate entity (literally, a "separate body") that was autonomous and separate from the authority of kings and emperors. Thus the decrees of the king did not apply; instead the church's own law—the canon law, as it was called—took precedence for the church, its priests, and its possessions.

Over the next few centuries, the church was so successful in building up its system of canon law and using this legal structure to manage its vast bureaucracy of officials (cardinals and bishops and priests, in a hierarchy of dioceses modeled on the Roman Empire) and to regulate its possessions, that even kings and emperors and princes came to admire its efficiency. By the thirteenth century, European kings commonly hired trained churchmen to shape their own legal systems and often to manage their own state bureaucracies. The cardinal-minister became a common figure in the courts of Europe, and state law began to take on the forms of Roman law again.

The principle that laws were equally binding on the state and its subjects and the idea of legal privileges for corporate bodies spread, so that by the seventeenth century a host of bodies—towns, universities, guilds, and professional societies—claimed the privileged status of corporations before the law. Groups such as the Parliament in England, the law courts in France, the city councils in Spain, and other professional groups jealously sought to defend their corporate privileges against the demands of the king, claiming exemption from certain taxes and obligations as their legal rights and liberties. Yet throughout Europe, kings fought back by asserting their status as supreme rulers under God, and in most countries kings succeeded in becoming more absolute, whittling away the privileges and exemptions of the corporate groups.

There was only one area in Europe in which the Roman legal system did not prevail, and that was England. In the thirteenth and fourteenth centuries, England had, like the rest of Europe, followed the pattern of appointing cardinal-ministers and other educated churchmen to high state offices and granting corporate status to varied groups in society. But in the sixteenth century, following a dispute with the pope over a king's right to divorce, King Henry VIII abolished the Catholic Church in England and Wales. He seized the monasteries, churches, and other assets and claimed that he, as king of England, was the sole and rightful leader of the new

Anglican Church. These acts weakened canon and Roman law as the basis for regulating social relations in Britain and strengthened the role of traditional or common law—which consisted of prior decisions handed down by learned judges in the past and collected as a guide for current judges.

The common law was not a systematic set of principles and responsibilities of the ruler and the ruled; rather it was a collection of received wisdom, collected and built up across the generations by skilled judges seeking to advance the principles of fairness and justice between claimants in legal proceedings. Yet it was to prove an unusually powerful force to forge and preserve individual liberties.

Roman law, after all, had a history of being subverted by rulers to allow them more and more absolute power over their subjects. Whatever was for the good of the kingdom could, under Roman law, be justified and imposed. Especially after the crises of the seventeenth century, most European rulers used the principles of Roman law to build stronger bureaucracies, increase their control over their subjects and their resources, and create a new bureaucratic absolutism that put more power directly in their hands.

By contrast, the common law was not so easily bent to the ruler's wishes. The common law insisted that all parties in legal proceedings—even when one party was the state or the ruler himself—be subject to the same law and the same standards of proof and principles of justice. The Stuart kings of England in the seventeenth century, unwilling to be held back by the common law, used a special royal court known as the Star Chamber to judge opponents of the government. Cases in Star Chamber were decided in secret and according to the king's will. But one of the principles fought for and won in the British civil wars of the seventeenth century was the abolition of the Star Chamber and the primacy of the common law. Thus various characteristics of the English courts (and the American courts, which followed the English pattern) survived and remained unique—especially the principle of trial by jury.

In a jury trial a judge presides, like a referee in a sports match, over the efforts of competing lawyers to persuade a jury of ordinary people of the facts of the case and the guilt or innocence of the accused. The members of the jury are laymen, meaning they are ordinary people, not experts or state officials.

This was in sharp contrast to courts elsewhere in Europe, where lawyers argued before a judge or a panel of judges, who determined the facts and the outcome of the case. Thus in most of Europe the facts and outcome of a court proceeding were determined solely by experts who held official appointments and authority. In England (and the United States and other countries with English-based law), it was not state-appointed officials but ordinary people serving on the jury who decided on the facts and determined the outcome of a legal proceeding. This made it much harder for the state simply to accuse and imprison people: whereas in European states this could be done simply on the authority of a state-appointed judge, in England it required the agreement of a jury.

Another fruit of the British civil wars was the survival of an elected assembly—the Parliament—as a counterbalance to the power of the king. This too was rooted in the common law, dating from medieval struggles between English nobles and kings and documents such as the Magna Carta, which limited the power of the king to levy taxes or to seize property or persons unless these actions were in accordance with laws passed by the Parliament. Although the Stuart kings also tried to do away with Parliament or make it a subservient tool of the king, they failed in their attempts, and Parliament—unlike most of the elected assemblies of medieval and early modern Europe, which faded away—remained an ever-present obstacle to any British monarch's efforts to exert absolute authority.

One might easily believe, given the unique nature of juries and Parliaments that limited the power of rulers, that the English would enjoy the privilege of being the most lightly taxed and ruled people in all of Europe or Asia, and that this might have been responsible for England's early economic success. After all, no less an authority than Adam Smith argued that light taxes, low or no tariffs (taxes on trade), and freedom to pursue one's trade and commerce would bring riches to societies that did not interfere with the workings of the market. Many economists have been tempted to believe this was the secret of England's success. By contrast, one might expect that the Chinese emperors or Turkish sultans, whose authority was not limited by laws granting rights to citizens, would oppress and drain their subjects and heavily tax and suppress production and trade. It is therefore something of a shock to find out that eighteenth-century England was the most heavily taxed state in Europe, and probably the world, and had the highest tariffs as well!

In Ottoman Turkey, after 1660 the government increased its tax collections of cash to pay for its expanded janissary infantry forces, but in return it gave more autonomy to local governors and landed elites, even allowing them to protect their family property in perpetuity by setting up religious foundations that were exempt from taxation and from state control. In China, prosperous associations of merchants were protected by the government, and they freely carried large amounts of silver and goods throughout the country with virtually no internal taxation. Both China and Turkey maintained flourishing production of textiles and ceramics and supported communities of wealthy merchants who engaged in local and international trade in a wide variety of commodities.

The same was true in India, which in the 1600s and 1700s was the world's leading producer and exporter of cotton goods. In India, China, and Turkey, rulers viewed merchants as necessary evils but encouraged them to conduct their business and protected their property—because the rulers relied on merchants to supply cities and troops with food, horses, armor, and other provisions. Rulers also tried to keep taxation to moderate levels to protect the welfare of the peasant farmers who produced the ultimate resource—the staple food grains and agricultural raw materials such as cotton, silk, tea, and other products—at the heart of these agrarian economies.

Thanks to recent research, we can estimate how much China taxed its peoples and compare this with European governments. In the nineteenth century, the imperial government of Qing China is estimated to have collected about 10 percent of China's gross domestic product (GDP) in taxes. The total value of rents and local taxes was higher of course, as local elites also took their share; but total rent and tax payments by peasants were around 40–50 percent of their output.

This seems high, but it was also fairly typical in those parts of Europe (mainly western France, parts of Italy, and eastern Europe) where sharecropping was practiced; there too tenants gave landlords roughly one-half of their product. In other parts of France, the combination of rents, royal taxes, and tithes to the church were highly uneven—the church receiving perhaps a tenth of output in tithes and rents, landlords one-third, and royal taxes amounting to only 5 to 8 percent. But the total extraction from those who farmed and produced was still between 40 and 50 percent.

Britain had a very different system. In China and France, most of the farmland was worked by peasant families who owned or leased their land in family-sized plots and used little or no hired labor. In Britain, by the eighteenth century perhaps half of the farmland was managed as large commercial farms, in which the farm manager leased or owned dozens or hundreds of acres and relied heavily on wage labor to do the farm's work. Yet when we look at accounts of how much of Britain's income was taken by those who did *not* do farming or manual labor—the royal court, the nobility, gentlemen, professionals, and the navy and military—we find that they absorbed roughly 40 percent of Britain's total output around 1700; thus the total tax and rent burden in England at this time was similar to that in other agrarian societies.

Even more striking is the share of taxation taken by the central government. We observed that central government taxes in China took roughly 10 percent of GDP, while in France in the eighteenth century, before the French Revolution, it was only 5 to 8 percent. But in Britain by 1789, the central government took over 18 percent of national income in taxes, roughly twice as much as France or China.

The burden of taxes in China and France fell mainly on agriculture. Taxes on trade and manufactured goods were modest. In France, taxes on trade and industry brought in about 11 percent of the value of goods and services in that sector. In China, most trade was not taxed at all by the central government. The major exception was salt; the government sold merchants a salt monopoly in exchange for their help in supplying food to imperial troops on the distant northern frontiers. In Britain, if we look only at agricultural taxes, they were similar to those in other agrarian economies; in 1789, British taxes on agriculture brought in roughly 7 percent of the value of agricultural output. What made Britain an unusually highly taxed nation was the extremely high level of taxes on trade and consumption (mostly tariffs), which brought in 28 percent of the value of manufacturing and trade and provided a whopping 82 percent of all royal taxes.

Britain's tax system was in fact the envy of other monarchs. A vast army of customs inspectors assessed tariffs at all the major ports of the country. The most lucrative taxes were on alcoholic beverages (mainly French wines). However, high tariffs were also imposed on cotton cloth (which sheltered a small but growing industry devoted to producing and dyeing cotton textiles in Britain) and on grain imports. A variety of tariffs and taxes on Britain's major imports and exports were maintained at high levels until well into the nineteenth century. In addition, strict regulations on shipping ensured that only British merchants and shipping were allowed to engage in trade from British ports and with Britain's colonies.

Thus the notion that an industrial revolution grew up in a British economy that was based on low taxes and free trade is quite mistaken. The Industrial Revolution developed in a British economy that managed to grow at remarkable rates despite facing the highest tax rates, the highest tariffs, and one of the stiffest regulatory regimes on shipping in Europe, if not the entire world!

The big difference in Britain's economy was not the level of taxes or tariffs, but how they were spent. After 1688, the Parliament—and the Bank of England, which Parliament established to manage the royal debt—was able to make sure that these high tax revenues were not squandered on palaces and playthings for the king and queen, but were instead directed to payment on state debts and funding for the Royal Navy. The assurance that taxes would be both high and directed to debt payment allowed the state to borrow tremendous amounts of money relative to the size of the British economy—money that was put to use mainly to win victories against Britain's opponents on the battlefield. The Royal Navy, swollen to become the largest and most formidable force in the world, was then able to protect British shipping and give British merchants secure passage around the world. The result was a virtuous circle ("virtuous" in the sense of self-reinforcing), in which taxes paid on trade were used for naval and military expenses that cleared the way for safer and more extensive trade. By the mid-eighteenth century, a large portion of the silver mined in the New World was finding its way to British merchants, who handled much of the trade for slaves, sugar, tobacco, gold, and silver in the Atlantic and much of Europe's trade for tea, spices, ceramics, and cotton and silk cloth with China and India.

And yet, as we have seen above, we should not confuse success in trade with automatic progress to industrialization. The Dutch East India Company also had considerable trading success, even in competition with the British East India Company. Both of these trading organizations benefited from laws that allowed them to become corporations—bodies authorized to act legally with autonomy and to raise funds from investors.

Yet neither of these corporations was successful in gaining more than a small fraction of the rich Asian trade, most of which remained in the hands of native Arab, Indian, and Chinese merchants. Both companies therefore turned their eyes to territorial conquest (the British in India and the Dutch in Indonesia), so that instead of merely trading, they could also reap taxes from subject territories and impose the terms of trade in their favor.

Did the later world of railways and steamships, iron foundries and cotton mills, owe their origins to these early trading companies and to the forms and laws of corporations or the Bank of England? Some economists, noting that these new forms of production sprang up during or shortly after the success of the trading companies, assumed that there had to be some kind of link between them.

But such links are extremely hard to uncover. The riches made by merchants in the slave and sugar trades or in Asian commerce were spent on country homes and invested in government bonds (loans to the government) or paid in taxes—the latter of which, as we just observed, went mainly to reinforce the army and the navy and to protect British trade. The Bank of England raised money mainly from wealthy landlords and merchants for the state; it did not engage in any commercial lending to manufacturers. Indeed the bankers of the City of London specialized almost exclusively in services (insurance, brokerage) and foreign investment (especially managing foreign bonds and currencies) and kept wholly out of what they saw as the risky and low-margin business of lending to domestic businesses. The capital investments for early cotton manufacturers, mining enterprises, and iron works came almost entirely from the savings of early manufacturers themselves and their friends and families (almost all of whom came from the ranks of domestic merchants and businesspeople) or from profits reinvested in their industries.

In short, neither among the European overseas merchant enterprises nor in the activities of London bankers can we find a clear path to the origins of the new industries and production processes that would start the process of industrialization. If we look across the world in the mid-eighteenth century, European laws did not produce especially favorable conditions for the accumulation of capital, nor would most European governments be turned into democracies with secure individual rights for another century or more. Perhaps most surprising, the economy that would lead the way in productivity improvements in the following century labored under relatively high taxes, high tariffs, and high regulation of trade and shipping and supported a government that was heavily in debt from financing military and naval expansion.

It is true that the success of European (and especially British) merchants, by flooding their home markets with marvelous Asian products, increased the appetite of European consumers for quality fabrics, ceramics, and other goods. The existence of such thriving markets in turn encouraged European rulers and inventors to look for ways to produce similar products at home. Yet the ability of the British to surpass all other regions of Europe in finding ways to cheaply manufacture quality substitutes and to transport the raw materials and finished products to markets, still needs to be explained.

Tolerance and Pluralism versus State-Imposed Orthodoxy

We have mentioned that the British legal system was in many ways unique in Europe by around 1750. It held trial by juries, relied on the common law to guide most judicial decisions, and had an active Parliament as a check upon the arbitrary conduct of the ruler. Perhaps most important, Britain also provided protection under the law for those who followed a different faith than the official Anglican religion. Dissenting Protestants of many different sects were thus able to follow their reasoning and their faith wherever it might lead.

In Scotland, religion and culture grew out of the inquiring ideas and discipline of Calvinism. By the eighteenth century, leading Scottish thinkers, though devoutly religious, were less concerned with matters of ritual and doctrine than with understanding nature, developing trade and manufacturing commerce, and promoting the improvement of all human activities as a way to increase both the virtue and prosperity of society. Scotland was permitted to have its own established church—the Presbyterian Church of

Scotland—quite distinct from the Anglican Church, which was dominant in England. The result was a fruitful tension, as intellectual life in Britain was neither subverted to preserve the established orthodoxy of one particular church nor forced to disregard or prohibit alternative views. Instead, there were widespread and continuing debates on the nature of man, society, the universe, and the place of God within it.

The universities of Scotland—Glasgow, Edinburgh, Aberdeen, and St. Andrews—joined with such institutions as the Royal Society in London and a host of provincial clubs in towns such as Birmingham, Bristol, and Manchester to promote all kinds of inquiries in science, mechanics, industry, moral philosophy, history, epistemology, and political theory. In the course of the eighteenth century, the established universities of continental Europe fell more and more under the sway of church authority (in Spain and Italy) or Renaissance humanism (in France and Germany), and the main universities of England (Oxford and Cambridge) served mainly as finishing schools for the elite, employing few serious scholarly researchers. In contrast, the Scottish universities brought serious new research to light on medicine, physical science, and engineering. Their methods, their research, and their graduates spread widely throughout Britain and North America.

If there was one key ingredient to creating a new level of productivity growth and new kinds of economic activity that broke from the cycles of agrarian societies that had dominated the last 10 centuries, that ingredient was new ideas. As we shall see in Chapter 8, in 1500 most of the world still operated within intellectual frameworks that had been established 1,000 years earlier. Although much progress had been made in specific areas of agriculture, water management, and crafts, there had been no wholesale change in fundamental understandings of nature or methods of acquiring knowledge.

Previously, new ideas about the world or knowledge in general tended to be perceived as threats that would upset the social and political order. Where new ideas were stifled, technological progress tended to fade as well; and where challenges to orthodox thinking were punished as crimes, the opportunities for new research and new conceptions of nature were simply unavailable. We can see this tendency in much of the world outside of Great Britain—and in most of Europe, not only Asia—in the seventeenth and early eighteenth centuries.

We noted above that between 1500 and 1850, all the great civilizations of the temperate regions of the world—Europe, the Middle East, and China—had experienced parallel episodes of state breakdown, rebellion, and revolution, which peaked in at least two waves in the mid-seventeenth and the mid-nineteenth centuries. The disorders of the mid-seventeenth century in particular were quite terrifying to those who lived through them, and the main concern of rulers in their aftermath was to find ways to ensure social stability.

Rulers thus made substantial reforms to state institutions and social relations to better preserve political and social order. As we have noted, the Ottomans replaced the old system of rural-based soldiers based on land grants from the sultan with an expanded centralized force of paid infantrymen, known as the janissaries. In China, the new Manchu dynasty passed laws to keep Manchus separate from Chinese and to help the Manchus remain united and in control. In most of Europe, kings and princes strengthened their power and extended their bureaucracy at the expense of local notables. This stronger absolutist monarchy became the standard form of government after the mid-1600s, as monarchs dismissed or undermined independent courts and local representative assemblies, placed their own officials in charge, and made noble families more dependent on the royal court and the king's favor. Louis XIV of France, Peter the Great of Russia, Frederick William of Prussia, and their successors tightened their grip on power, expanded their realms, and dominated Europe in the late seventeenth and early eighteenth centuries. Their model of centralizing royal power was followed by other monarchs, including Christian IV of Denmark, Charles XI of Sweden, and Maria Theresa of Austria, as well as lesser princes and rulers throughout Europe.

In addition, rulers throughout Europe and Asia came to believe that solidifying social and political order depended on ridding their countries of religious divisions and controversies. Indeed, many believed that the upheavals of the mid-seventeenth century had come upon them because their civilizations' fundamental beliefs had been abandoned or obscured by heterodoxy in the previous decades.

Ottoman scholars and bureaucrats argued for the need to restore the "circle of virtue," in which rulers and subjects all faithfully followed the precepts of the Koran, particularly its Sunni tradition of deference to state authority. The Ottoman reform movements of the seventeenth and eighteenth centuries therefore stressed a return to traditional beliefs as a cure for political and economic ills. In contrast to their tolerant early years, in which the Ottomans had borrowed and improved Western weapons and studied Western scholarship and religion, the later Ottomans arrogantly maintained the absolute superiority of Islam and turned away from the outside world, heaping scorn upon Christian thought. The circle of virtue became the basis for a rigid social order in which it was the sultan's task to keep everyone in their proper place. Innovation became a particular object of the religious reformers' wrath, which condemned new ideas as leading only to error and decay. Under these stringent conditions, social stability was achieved, but the great achievements of Islamic science and scholarship of the previous centuries (which we will discuss in more detail in Chapter 8) came to a virtual halt.

In China, the new Manchu rulers attempted to prove their credentials as authentic Chinese rulers by sponsoring a program of orthodox Confucian scholarship and enforcing traditional ideas within China. China under the previous Ming rulers had followed mainly Confucian practices, but Ming intellectual life was rich in variations that ran outside of state control, including populist, puritan, and individualist schools of thought. Under the Manchus, however, scholarship became a state-sponsored and tightly controlled endeavor. Vast teams of scholars were assigned to the task of purifying Confucian texts by studying their histories and purging them of recent and false modifications. The tests for official positions became more rigid and more dependent on extensive memorization of the Confucian classics. It was thus only after the 1660s, under the alien Manchu rule, that China became a strictly orthodox Confucian state. In fact, much of what we regard today as typically Confucian Chinese government and social practices was not typical of earlier Chinese dynasties, but developed under Manchu rule.

The enforcement of rigid orthodoxy led to stagnation and even the loss of knowledge. Previous advances in mathematics were lost and—despite the ending of serfdom, the growth of market towns, the expansion of manufacturing, and the substantial agricultural growth in China that had occurred under the Manchus—new scientific and mechanical inventions, which had marked every previous dynastic period in Chinese history, were almost entirely absent.

In Spain, Portugal, and Italy, the Catholic Counter-Reformation too began to set itself against innovation in thought and learning. Before the seventeenth century, the Catholic Church had in fact sponsored broad learning, supporting even such original scholars as Copernicus. But once the Catholic faith came under attack by Protestant leaders and found its position slipping, and when Catholic leaders inferred that new scientific findings were threatening their control of popular belief, the papacy and other Catholic leaders sought to suppress the new knowledge. Jesuit priests, who ran major academic institutions and schools, avoided teaching the new solar system and Newtonian physics, finding compromises that preserved the ideas of a stationary earth at the center of the universe. Even in Holland and France, the bands of orthodoxy were tightened in the later seventeenth century. The Dutch Reformed Church obtained strict prohibitions or restrictions on the practice of other faiths in the Netherlands. In France, Louis XIV used his absolute decree to expel the Protestants from his kingdom and ban Protestant worship in France.

It is no wonder that in the eighteenth century the British—with their still-independent common law courts, active Parliament, laws that protected religious dissenters, and multiple official churches—looked across the English Channel and tended to see the entire continent, from France to Turkey to China, as a sea of despotism and absolute rule and to judge themselves a fortunate island of freedom and individual rights. This was a distinctive mix that had surprising and unexpected results in the following centuries.

We examine them in the next two chapters.

Additional Reading

Berman, Harold. *Law and Revolution: The Formation of the Western Legal Tradition.* Cambridge, MA: Harvard University Press, 1983.

Goldstone, Jack A. *Revolution and Rebellion in the Early Modern World.* Berkeley: University of California Press, 1991.

Jones, Eric. *The European Miracle: Environments, Economies, and Geopolitics in the History of Europe and Asia.* Cambridge: Cambridge University Press, 2003.

North, Douglas C., and Robert Paul Thomas. *The Rise of the Western World: A New Economic History.* Cambridge: Cambridge University Press, 1976.

Wong, R. Bin. *China Transformed: Historical Change and the Limits of European Experience.* Ithaca, NY: Cornell University Press, 2000.

CHAPTER SEVEN

Changing the Pace of Change: Was There an Industrial Revolution?

CHAPTER PREVIEW: In the seventeenth century, the pace of technological innovation in Europe suddenly increased, and then it accelerated—particularly in Britain—in the eighteenth and nineteenth centuries. These changes did not immediately raise living standards, as it took a century or more for changes to spread to most of the economy. However, beginning with a few industries (such as coal mining, iron works, potteries, metal products, and cotton spinning) concentrated mainly in the midlands and Scottish lowlands of Britain, new energy sources and processes began to be applied to production. By the end of the nineteenth century, these new energy sources and processes had increased output while cutting costs in important industries by tens or hundreds of times.

The invention of the steam engine, railroad, steamship, and a wide range of factory and machine processes were the most striking innovations, but they were just a tiny number among thousands of innovations that gradually transformed economic life. What had really changed was that innovation became common and widespread, even expected, because a British culture of innovation gave people the outlook and the intellectual and material tools to search for their own new ways of working. By the beginning of the nineteenth century, this culture of innovation had become widely established in Britain, and by the end of the century, it had spread throughout Europe.

Our comparisons of European and Asian societies have shown that Europeans were not particularly privileged or advanced as late as the early 1700s. At that time, a few areas in Europe (England, the Netherlands, Belgium) were as productive as the core areas of China and India, but most areas of Europe lagged behind, as shown in Figure 5.2 (p. 86). European nations were still relatively late and small-scale competitors in the great Asian trading sphere that spanned the area from Japan down to the South China Sea and Indonesia, then across the Indian Ocean, up the Persian Gulf, and down the eastern coast of Africa. Europeans were forced to confine their trading with Japan and China to only a handful of sites distant from the capitals and had barely begun to penetrate the interiors of India and Southeast Asia. Only the Atlantic trade was dominated by Europe, and that trade provided mainly silver and gold that Europeans carried to Asia to obtain the fabulous manufactures (ceramics, silks, cottons) and vital natural resources (pepper, spices, gems, and dyestuffs) of the far East.

By the early 1700s, all of the great Eurasian civilizations had long followed one or more of the major salvation religions launched in the axial age 1,000 or more years earlier (see Chapter Three). They also had developed agrarian bureaucracies whose hereditary rulers collected taxes and paid officials to maintain order and manage their empires or kingdoms. These bureaucracies were recovering from the widespread crisis of the seventeenth century, during which high prices and population growth had led to problems raising sufficient revenues and eventually to elite and popular rebellions. In most kingdoms and empires, the early 1700s was a period of retrenchment and conservatism in which rulers sought to enforce religious orthodoxy and conformity, and sacred and classical texts from centuries earlier were revered and elevated as guides to recapturing past glories.

Although material progress continued and in some places accelerated—as with China's development of more widespread and sophisticated multicropping, use of new beancake fertilizers, and development of government-run granaries to provide public relief in case of famines—the rate of technological progress and invention slowed down. Indeed, the orthodox and conformist regimes of Manchu China and Ottoman Turkey practically halted their previous pace of innovation and change. Table 7.1 shows the number of important technological and scientific innovations in China from the tenth to the nineteenth centuries. It is clear that a long period of innovation, which had led to China's technical leadership, ended abruptly with the Manchu conquest in the late 1600s.

In Europe, however, which had been a technological laggard, this was not the case. Indeed, quite the reverse. From the early 1600s onward Europe experienced a striking increase in the number of scientific and technological innovations, becoming the world's leading center of technical change. The earliest changes appeared in the discovery and widespread use of new scientific instruments—telescopes, microscopes, barometers,

Table 7.1 Number of Innovations in Science and Technology in China, Tenth to Nineteenth Centuries

Century	Number of Innovations
Tenth	29
Eleventh	38
Twelfth	27
Thirteenth	34
Fourteenth	37
Fifteenth	18
Sixteenth	36
Seventeenth	43
Eighteenth	7
Nineteenth	2

Source: Li Chen and Ugurlu Soylu, "Innovations in the Chinese History of Science: Compiled from Joseph Needham's *Science and Civilization in China,*" in *Political Competition, Innovation and Growth in the History of Asian Civilizations,* edited by Peter Bernholz and Roland Vaubel (Cheltenham, UK: Edward Elgar, 2004), p. 92.

thermometers, vacuum pumps, pendulum clocks, and more. Then, at first mainly in the Netherlands, but soon thereafter in England, improvements appeared in shipbuilding, warehousing, brewing, fishing, breeding and raising of animals, use of windmills, flood drainage, crop rotations, and food processing. There were also administrative improvements in such areas as public finance (lending to governments), tax collection, and bureaucratic organization that strengthened central governments. These improvements were reflected in rises in agricultural productivity and living standards in the Netherlands and England after 1600, as we observed in Chapter Five (see Figures 5.1 and 5.2, pages 80 and 86).

These improvements were hailed for many years by Western historians as launching a new age of modernity in Europe. In particular, some of the leading technical innovations of the eighteenth century—the use of coal to smelt iron ore in 1709, the invention of the first steam engine in 1712, the development of machinery to roll iron in 1783 and to spin cotton in 1769–1779—were said to constitute an Industrial Revolution that made Europe, and especially Britain, into the "workshop of the world."

Yet as Chapter Five also showed, these changes did not mark any great divergence in living standards between Europe and other parts of the world or even from Europe's own past. Most of these changes simply allowed the more advanced parts of Europe to catch up to the more advanced parts of China and other regions of Asia. In 1750, real wages in England were still not much higher than they had been in 1600 in England—or in India, for that matter—and were not significantly different than real wages in China or Japan (see Table 5.2, page 82). In 1800, the largest and richest cities in the world were still overwhelmingly in Asia, not Europe. Agricultural productivity in China remained about the same as that in England and the Netherlands. And these positive changes in Europe's living standards did not even continue, because from 1700–1749 to 1800–1849, real wages in Europe's leading cities stagnated or declined, even in England and the Netherlands.

It is thus not surprising that many economic historians, looking at the slow pace of change in living standards in Europe prior to 1850, have questioned whether there was anything that deserves to be called an Industrial Revolution before that date. And in fact, we would have to say that if the term "Industrial Revolution" is taken to mean "a rise in living standards to higher levels than anything seen in previous world history," then no such thing occurred before 1850. In was only from about 1850 onward that steam-powered factories, farm machinery, construction equipment, railways, and steamships so changed the face of production as to create widespread improvements in living standards in Europe, while out-competing manufacturing and production elsewhere. Also, it was only from about 1850 onward that new inventions in chemistry, communications (the telegraph and telephone), electrical and gas power, and new construction materials and techniques changed our sense of what was possible in material life. Finally, it was only from about 1850 onward that steam-powered warships made it possible for European states to project their power over the Asian societies of China and Japan and that railways made it possible for Europeans to project their power into the interior of Africa and Asia, thus creating the global military superiority of European states.

Nonetheless, *something* important must have happened between 1700 and 1850: At the beginning of that period, even the leading areas of Europe were only just beginning to catch up with the techniques and productivity of the more advanced societies of Asia, and by the end of it they were launched on a path to economic and military domination. So if by the "Industrial Revolution" we do not mean an outcome, such as achieving the highest incomes in history, but a process, such as an increase in the rate of technological innovation and the onset of a pattern of more and more areas of material life being affected by new sources of power, new machines, and new inventions and techniques, then an Industrial Revolution definitely occurred in Europe, and more particularly in Britain, between 1700 and 1850.

Indeed, if we looked at Europe ca. 1700, we would identify its center of power as the French royal palace in Versailles, where the "Sun King" Louis XIV ruled over the largest and most powerful kingdom in Europe. Britain, by contrast, was a small and troubled region, still divided into separate kingdoms of England, Scotland, and Ireland, and struggling to help the Netherlands remain independent in the face of Louis's power.

Yet the Sun King's capital city of Paris held only 500,000 people, and in terms of its public buildings, sewage, and sanitation, it lagged behind the glory of the city of Rome at its peak—which housed perhaps 1 million inhabitants some 1,500 years earlier. Louis himself described the elaborate wall of a Roman theater still standing in the southern city of Orange as the grandest wall in his entire kingdom, and the Pont du Gard, the great Roman aqueduct near Nîmes, remained one of the largest bridges in France (see Figure 7.1).

All travel was by horses, agricultural and production technology was largely unchanged from what it had been for many centuries, and most power was provided by water mills. Although France produced the most luxurious furniture, paintings, and fine fabrics in Europe for its wealthy royal court and nobles, the living conditions of the average French peasant had not changed much for hundreds of years. A Roman nobleman who had lived in Gaul (the Roman name for France) 15 centuries earlier could

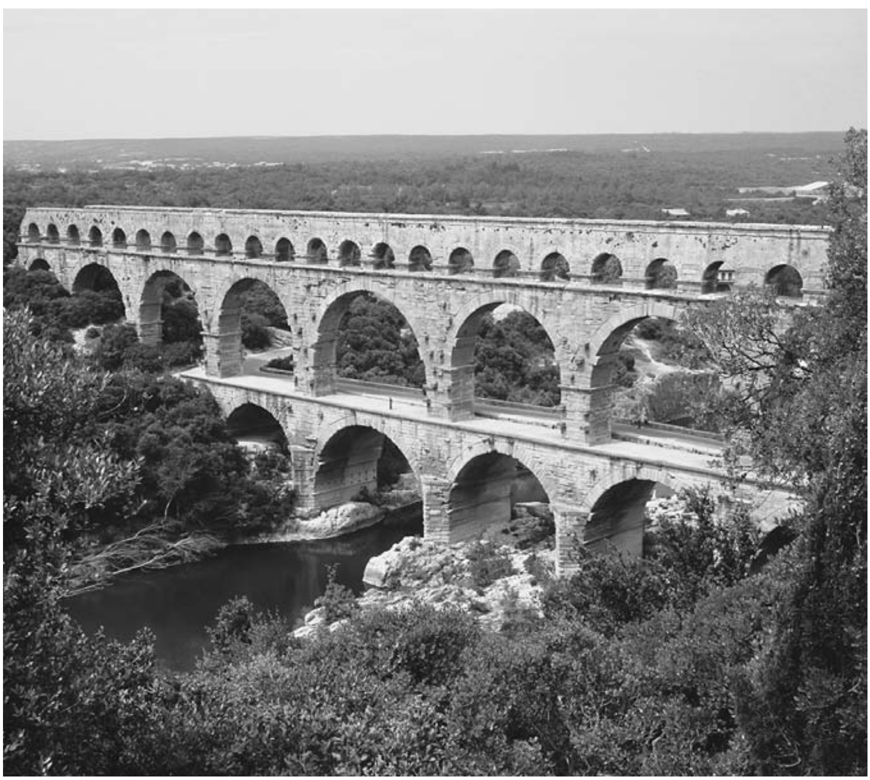


FIGURE 7.1 ROMAN AQUEDUCT, BUILT CA. 100 BC, OVER THE RIVER GARD NEAR NÎMES, FRANCE

have returned to southern France and found things still looking quite familiar—and indeed "good taste" was still mainly a matter of imitating Roman painting and sculpture.

Now let us move just 180 years forward, to London in 1880. Britain's capital is now a teeming metropolis of nearly 4 million people, far eclipsing any city in any region of the world from earlier times. Its skyline is marked by vast new buildings and bridges of iron and glass as well as brick and stone. Its gleaming railway stations handle tens of thousands of passengers and millions of tons of goods, while its harbor is filled with steamships as well as sailing vessels. Its streets are lit with gas lighting, and its homes, factories, and businesses are filled with people enjoying a higher standard of living than was reached by any large society in the world before 1800.

Overseas, Britain's steamships and iron-clad navel vessels control the ports of China, and its civil service rules all of India. Railways move people and goods across continents at the amazing speed of 50 miles per hour, while telegraph lines can send messages across the oceans in seconds. France, although now lagging slightly behind Britain in naval power and imperial glory, is extending its empire in Africa and in 10 years will build the magnificent Eiffel Tower wholly out of wrought iron. The costs of basic items such as cotton, iron, energy, and food have fallen by factors of from 10 to 100.

How did the world change so much so fast?

Innovation as the Source of Industrial Growth

The changes began in a handful of industries that were concentrated mainly in the northern and midlands counties of England; then extending to Scotland, Cornwall, and Wales; and later to Belgium, Switzerland, France, and other parts of Europe. These industries included producers of cotton textiles, iron and steel (including metal products from knives to buckles to engines and railways), and pottery; companies that mined coal and other minerals; and transportation firms that built and operated canals, railroads, steamboats, and steam engines. For all of these items, new technology changed one of the basic tenets of economics—the law of diminishing returns.

Throughout most of history, as the production of something increased, so did its cost. Anything that used raw materials produced in farming, mining, or forestry—which was almost everything in preindustrial eras—tended to cost more as output rose: Farms had to invest more or expand to less productive land, mines had to be dug deeper, and timber had to be cut from farther in the forest. But in England in the late eighteenth and early nineteenth centuries, this law was repealed for a small number of industries, where output doubled, tripled, and quadrupled, while costs of production fell by half, then by three-quarters or more. As we have already noted, the development of these new and transformed industries in the northern and midlands regions of England created changes in the local economy powerful enough to raise agricultural wages there by 50 percent from 1700 to 1850, while they were falling elsewhere in England.

Yet before 1850 these industries formed only a small part of the British economy. Despite the massive growth of the cotton industry from almost nothing to a large-scale factory enterprise from 1750 to 1800, in 1800 the centuries-old woolen industry still was twice the size of the cotton industry in its consumption of raw materials. In that year, water wheels still provided more than three times as much power to mining and industry as did steam engines.

What created real change during the nineteenth century was that, as these new and transformed industries spread their impact throughout Britain, further innovations spread to other industries (agriculture, food processing, construction), and then whole new industries (chemicals, electricity, telephone and telegraph, rubber) arose. These were then complemented by improvements in insurance, financing, security, and information exchange that further expanded the scope of trade and lowered the costs of transactions, creating worldwide markets for legions of products. As these new industries spread through Europe and then the world, they changed the character of the global economy and raised living standards wherever they came to dominate.

Some of these changes are shown in Table 7.2, which shows the remarkable growth in output in the new and transformed industries of cotton, coal mining, iron, transportation, and steam engines between 1700 and 1900. The table also shows the slower growth in more traditional industries, such as woolens and linen, and the growth in population during this period.

Looking at the lower part of Table 7.2, we can see that some industries grew enormously. Cotton production expanded by more than 700 times between 1750 and 1900, coal output by more than 50 times, and production of pig iron (the crude iron output of blast furnaces) by over 300 times. Steam engine usage grew by nearly 2,000-fold, providing about 5,000 horsepower in 1750 but nearly 10 million horsepower by 1900. Steamships and railways, newly invented in the early nineteenth century, went from nothing to millions of tons of shipping and thousands of kilometers of railways. The same period also saw a huge expansion (not shown in this table) in Britain's production of pottery (most famously by Spode and Wedgwood); of dyeing, bleaching, and printing factories to process cotton cloth; and of

TABLE 7.2 PRODUCTION GROWTH IN THE BRITISH INDUSTRIAL REVOLUTION, SELECTED INDUSTRIES

Output of various sectors in the British economy, 1750–1900 (physical units)

Year	Cotton	Coal	Pig Iron	Steamships	Railways	Steam Engines	Water Wheels	Woolens	Linen	Population
1700	–	2.7	24	–	–	–	–	–	–	5.06
1750	1	4.7	27	–	–	5	70	37 [d]	26	5.77
1800	24	10.0	180	3 [a]	157 [b]	35	120	50 [e]	78	8.66
1850	267	50.0	2,250	168	9,797	574 [c]	195 [c]	82	189	17.93
1900	788	250.0	9,104	7,208	30,079	9,659	178	267	141	32.53

Output of various sectors in the British economy, 1750–1900 (indexed to 1750 or 1800 = 1)

Year	Cotton	Coal	Pig Iron	Steamships	Railways	Steam Engines	Water Wheels	Woolens	Linen	Population
1750	1	1.0	1.0	–	–	1.0	1.0	1.0	1.0	1.0
1800	24	2.1	6.7	1.0	1.0	7.0	1.71	1.4	3.0	1.5
1850	267	10.6	83.3	56.0	62.4	114.8	2.79	2.2	7.3	3.1
1900	788	53.2	337.2	2,402.7	191.6	1,931.8	2.54	7.2	5.4	5.6

Notes and Sources

Cotton: Thousands of metric tons of raw cotton consumed. From B. R. Mitchell, *European Historical Statistics 1750–1970* (New York: Columbia University Press, 1978), pp. 251–254.

Coal: Millions of metric tons mined. From http://www.historylearningsite.co.uk/coal.htm (March 23, 2008).

Pig Iron: Thousands of tons produced. Data for 1700–1850 from P. Riden, "The Output of the British Iron Industry before 1870," *Economic History Review* 30, 1977, pp. 443, 448, 455; for 1900 from B. R. Mitchell, *European Historical Statistics 1750–1970* (New York: Columbia University Press, 1978), p. 218.

Steamships: Thousand tons displacement. From Simon Ville, "Transport," in R. Floud and P. Johnson, *Cambridge Economic History of Modern Britain, 1700–1860* (Cambridge, UK: Cambridge University Press, 2004), p. 303. [[a]1820]

Railways: Kilometers of railway. From Simon Ville, "Transport," in R. Floud and P. Johnson, *Cambridge Economic History of Modern Britain, 1700–1860* (Cambridge, UK: Cambridge University Press, 2004), p. 305. [[b]1830]

Steam Engines and Water Wheels: Thousands of horsepower installed (mainly in mining and manufacturing). From Alessandro Nuvolari, *The Making of Steam Power Technology* (Eindhoven, Netherlands: Eindhoven University Press, 2004), p. 8. [[c]Interpolated from 1830–1870]

Woolens: Thousands of metric tons of raw wool consumed. From B. R. Mitchell, *European Historical Statistics 1750–1970* (New York: Columbia University Press, 1978), pp. 260–262. [[d]1775; [e]1810]

Linen: Thousands of metric tons of flax and hemp consumed. From B. R. Mitchell, *European Historical Statistics 1750–1970* (New York: Columbia University Press, 1978), pp. 268–269.

Population: Millions of people in England and Wales. From E. A. Wrigley and R. S. Schofield, *The Population History of England, 1541–1871* (Cambridge, MA: Harvard University Press, 1981), pp. 528–529.

canals and bridges. Woolens and linens, by contrast, grew by not much more than the population increased. Thus the increase in output per capita was fed mainly by the new and transformed industries.

Yet it would be wrong to see this leap in output in certain industries as sufficient to suddenly transform the entire economy. The bulk of peoples' spending in early nineteenth-century England still went for food, heavy warm (mostly wool and leather) clothing, and housing—all industries that were hardly affected by major changes in power sources or production technology until well after 1850.

Through the early nineteenth century, the production of hats, shoes, gloves, and clothes were all accomplished entirely by hand, as was planting and harvesting and most construction. Lighting was still a matter of oil lamps and candles, and travel was mainly by horse-drawn carriage. As you can see from Table 7.2, even in the leading new industries, the really large-scale changes don't appear until 1850. Then in the following half-century, from 1850 to 1900, steam and diesel power, electricity, and steam turbines combined to generate seemingly limitless energy; cheap iron, steel, copper, and industrial brick-making allowed massive new construction; trains and steamships became the major modes of transport; and most of the materials of daily consumption came to be produced in factories filled with automatic machinery, instead of in the shops of artisans and craftspeople using only hand tools.

What was common to this entire process, beginning around 1700, was the acceleration of innovation. The powers behind this vast army of industrialization were many—improvements in the education and training of workers, the use of finance and capital to fund new industries, and new legal and corporate forms for business entities. But behind every major improvement in technique lay successful innovations—the results of searching for more efficient, powerful, and novel ways of making and moving goods.

Of course, innovation and advances in technology have often occurred in history. The Romans invented concrete and perfected the arch and the aqueduct. The Chinese invented paper, the compass, the canal lock, and the abacus. The Indian and Islamic societies invented the windmill, the clock, the university, and the observatory. Yet in each of these cases, a cluster of inventions marked a golden age or a period of economic growth, which then petered out and left society in a stable or even declining position.

Continuous expansion requires more than a few bright ideas. As the economist Nathan Rosenberg observed, "improvements in performance in one part [of a system] are of limited significance without simultaneous improvements in other parts."[1]

What transformed Europe, and then the world, was a constantly growing and linked set of innovations in agriculture, transport, manufacturing, financing, machining, education, and marketing. The pace of change not only began to increase in the later eighteenth and early nineteenth centuries, but it has continued to increase to the present day. When we think of the pattern of innovation responsible for the rise of the West, we should not think in terms of a series of discrete inventions, but instead of waves of continually advancing change in many fields, each amplifying the effects of other changes. As the economic historian Abbott Usher wrote, the Industrial Revolution was characterized by "continuously emergent novelty."[2]

Nor may we allow ourselves to think of innovation as only being concerned with new products or industries. Innovation was general, applying even to the humblest pursuits. In Britain, the number of patents issued for agricultural tools had risen from perhaps 5 or 6 per decade prior to 1760, to 15, to 40, 60, then 80 per decade by the 1830s. In America, where the acceleration of innovation occurred later, the change in the rate of innovation is no less clearly marked: The number of patents for horseshoes shows a sudden leap around 1840, growing from less than 5 per year before 1840 to 30–40 per year in 1890–1910. The economic historian William Parker observed that the Industrial Revolution was marked by "invention [that became] a kind of folk activity, done repeatedly, on a very small scale, by very many different operators."[3]

This growth of invention as a widespread, general activity first emerged clearly in Britain. Through the early nineteenth century, Britain was the most successful country in the world in applying new inventions to improving production—even inventions made elsewhere. For example, chlorine bleaching, invented by the Frenchman C. L. Berthollet (1785); the soda-making process, invented by the Belgian Nicholas Leblanc (1787); gas lighting, co-invented by the Frenchman Phillippe Lebon and the Scotsman William Murdock (around 1798); the mechanical linen-spinning process, invented by Philippe De Girard (about 1810); the famous Jacquard loom (patented in 1802); the technique of the preservation of fresh fruits and vegetables, invented by François Appert (in 1795); and the continuous paper mill, invented by N. L. Robert (1798) all found their first large-scale application in Britain. Britain's leadership over this century was, it must be emphasized, "not in its possession of a best technique but in its early forging of a culture which, through innumerable minor innovations . . . induced the best techniques" to become widespread.[4]

In sum, to explain the rise of the West, we cannot identify any overall "European advantage" prior to 1700 in material well-being or technology. Nor can we point to a handful of significant inventions. Rather, economic and industrial advance was broader and deeper, sweeping away older ways of doing things.

What we need to explain is the emergence of a remarkably widespread desire and ability to innovate, resulting in thousands of innovations whose combined result was a dramatic shift of economic possibilities. And we need to explain particularly how this developed and took root in Britain between 1700 and 1850.

Were Factories a Crucial Innovation?

Some authors of the eighteenth and nineteenth centuries, from Adam Smith to Charles Dickens, were struck by the emergence of large numbers of factories in Britain for the production of everything from cotton cloth to metal goods to pottery. It seemed like factories themselves were the key innovation that made the industrial revolution possible.

Yet this would be a mistaken conclusion. The factory was not a new form of economic production; rather, hundreds of other technological innovations in production processes made factories increasingly common as a way to manufacture an increasing number of goods. Factories (places where dozens of workers combined their efforts, each specializing in a portion of the production process, to produce a finished good) had been around for many hundreds, if not thousands, of years. The large quarries of ancient Egypt and the shipyards of imperial China had employed hundreds of workers in complex, coordinated tasks.

What arose in England by the late 1760s was the industrial factory, which used new machinery, new processes, or new power sources to manufacture things that had traditionally been produced either in households or in much smaller workshops. It substituted the action of machines for the action of human hands.

Thus the invention of a machine (the Arkwright water-frame, invented in 1769) to twist cotton fibers into thread by the use of rollers instead of twisting the yarn by human fingers gave rise to the first cotton-spinning factories. Within a few decades, continuous improvement in the machinery and sources of power led to hundredfold increases in output and tenfold drops in prices.

The use of rollers to squeeze the impurities out of molten iron instead of the hammering by individual blacksmiths also led to large increases in output and reduction of costs in producing iron; rolling was 10 to 15 times as fast as hammering. Water-powered sawmills, using newly developed rotary blades and new machines for planing and boring wood, developed from the 1790s to the 1820s; they replaced the hand-sawing of lumber and turned the production of wood for the construction industry into a factory process. By the mid-1800s, the invention of various new kinds of machinery led to hundreds of new factories throughout Britain.

Yet factories remained only part of the story of industrialization. Let us consider the history of just one innovation, the steam engine, to trace how an innovation transformed even nonfactory operations. When first invented in 1712 by Thomas Newcomen, the steam engine was a large, clumsy, and inefficient machine. It was wasteful of fuel, but it was a breakthrough that allowed the use of coal—which had previously been used only as a source of heat—to produce mechanical motion. For the next 75 years, steam engines improved the output of mines and forges but had almost no use in factories because they were too weak and inefficient to replace water wheels for driving machinery. Then in the 1770s, James Watt improved the basic steam engine, making it far more efficient and capable of generating smooth, rotary power. Watt's engine became (literally) the main driving force for British factories in the nineteenth century. Then from 1830 onward, new improved high-pressure engines became available. Lighter in weight and more powerful, these new engines were used not only in factories but also in railways, shipping, mining, military warships, and agricultural and construction machinery. In other words, the steam engine wasn't simply a single invention, nor was its impact mainly on factories. Rather, *uses* for the steam engine had steadily grown and changed over the 200 years from 1712 to 1900, and factories were just one place in which Watt's invention changed the economy.

It is important to recognize what was revolutionary and what was gradual in the adaptation of steam engines to industry and transportation. In its concept, the steam engine was a unique breakthrough in human history, almost as critical in its own way as the invention of fire. Before steam engines, people relied on wind, water, and muscle for all the tasks that required mechanical energy. Burning coal or wood created heat but was useless for moving objects. The steam engine allowed the burning of wood or coal to be used to create mechanical motion—in this way, it enormously expanded the number of useful things that people could do with fire. Fire now was not only a source of heat and light, but also of mechanical energy to pump water, raise heavy loads, move goods over land and water, and run machinery in factories.

Moreover, because the steam engine was, when used in coal mines, a cheap way to pump water, circulate air, and haul coal to the surface, the engine reduced the cost of mining coal and thus unlocked huge new sources for its own fuel. This created a virtuous circle in which steam engines allowed great increases in the output of coal at low prices, and the availability of cheap coal for fuel allowed the use of steam engines to spread throughout the economy, so that the energy from coal could be used for all kinds of mechanical processes. In this way, the combination of steam engines and coal power broke all prior barriers of energy use in earlier societies. The distinguished economist E. A. Wrigley has hailed this transition as a shift from organic economies (in which all energy came from wind, waterpower, and living or recently living things), to inorganic economies (in which most of the energy for manufacturing and transportation and construction came from mining inorganic sources, mainly coal but also oil and gas). This was one of the great transitions in human history.[5]

Yet even though the adoption of steam power proved to be revolutionary in its impact, this was not a single, sudden event. Rather, greater and greater energy resources gradually became available as the steam engine was developed and improved over time and applied to an expanding set of activities; that development took almost two centuries! In short, when we look back today and compare the use of steam engines—and of trains and steamships and the output of goods such as cotton cloth, iron, and coal that were produced with steam engines—in 1900 with that in 1700, we can see that the Industrial Revolution was staggering in its magnitude and impact. Yet for the people living in the seventeenth and eighteenth centuries, when these changes were first starting to occur, their progress was so slow as to be almost imperceptible to most of the population.

Just as the steam engine was used not only in factories, but also in mining, transportation, and agriculture, a huge number of the other innovations that revolutionized economic life took place in areas that had nothing to do with factories. To note just a few examples: The process of resurfacing roads with crushed rocks enormously increased the speed and safety of travel by horse-drawn carriages. The use of iron to construct bridges and canals opened new directions for roads and shipping. The invention of the telegraph changed the speed of communication in the nineteenth century. All of these changes tied Britain together and connected it to the world in new ways, making the movement of goods and messages faster and cheaper.

Thus the rise of industrial factories was but one part of the much broader changes in processes and technologies that changed economic life in the two centuries after 1700.

Was the Industrial Revolution Related to Scientific Advances?

This is a more complicated question than it first might appear. For many years, scholars assumed that the Industrial Revolution must have been a response to basic economic factors, such as changes in supply and demand. They made this assumption because it seemed that most of the key breakthroughs—Newcomen's steam engine, Arkwright's waterframe, and Watt's rotary engine—were developed by mere craftsmen without using any new scientific theories or knowledge that could have driven technical change. And it is certainly true that what seemed like the big scientific discoveries from 1600 to 1700—from Galileo's telescopic discoveries about the surface of the Moon or the phases of Venus to Newton's laws of gravity and explanation of the solar system—had little or no connection to cotton mills and ironworks.

What's more, for most societies, the study of nature (called "natural philosophy") was the pursuit of the leisured class, who kept their distance from the messy world of manual work and production. Natural philosophy was a matter of argument and proof, not of building machines or engineering. Manufacturers, for their part, were interested mainly in securing supplies of raw materials and disciplined laborers, leaving it to merchants to buy and sell their goods at the best prices.

Yet this view of the Industrial Revolution as having nothing to do with changes in scientific knowledge is false. In fact, the diffusion of new scientific discoveries and techniques was essential to almost every step of British industrialization. As the eminent economic historian Joel Mokyr has written, "the true key to the timing of the Industrial Revolution has to be sought in the scientific revolution of the seventeenth century."[6]

Let us again begin with the steam engine. The Newcomen engine was specifically designed to capture the force of atmospheric pressure to do useful work, exploiting the scientific discoveries made in the seventeenth century by Robert Boyle and Denis Papin, both members of Britain's Royal Society for natural philosophy. Then in the eighteenth century, James Watt improved upon Newcomen's steam engine by creating a separate condenser (to cool the steam without cooling the entire cylinder) and developing the gearing for rotary motion. Yet these ideas were not the result of simple tinkering; Watt was deeply involved in building and maintaining scientific instruments, and his inventions depended on new ways of measuring heat and work. Watt was in frequent contact with the leading scientists of his day, and he was elected to the Royal Society in 1785.

Many of the other major advances of the Industrial Revolution came from experimental programs that were modeled on the investigative practices of the Royal Society but applied to industrial processes. For example, Arkwright, inventor of the cotton-spinning machine, did not simply happen onto this invention. Rather, by the mid-1700s, a large number of British clockmakers and instrument-makers were actively looking for ways to make machines to improve the spinning of cotton, experimenting with different kinds of machinery to produce a strong and stable thread. Arkwright sought out one of the most promising (John Kay) and offered him financial backing for his work on spinning machinery. Together they succeeded in developing the twisting rollers that were essential to the machine.

What was remarkable is that from the late seventeenth century through the eighteenth and early nineteenth centuries, Britain created a social milieu in which the ideas of natural philosophers, the skills of instrument makers and craftspeople, and the goals of entrepreneurs and industrialists were not separate but actively exchanged and combined.

A Culture of Innovation

The range, pace, and accelerating scope of innovations in eighteenth- and early nineteenth-century England and Europe were too great to be explained by any specific stimulus, such as the desire to create substitutes for imports or to resolve bottlenecks in specific industries. Such motivations had been around for centuries without creating any major change. Rather, what transformed production was a generalized belief in the possibility, even the inevitability, of progress and the conviction that such progress was in reach of anyone who pursued a systematic program of careful observation and experiment and drew on the latest scientific knowledge. This culture of innovation is what made possible Usher's "continuously emergent novelty."

To be effective, this culture of innovation had to spread beyond any one social group or class. Innovations depended on the skills of literate, educated technicians and craftspeople and the interplay of such skills with the ambitions of entrepreneurs and the new findings of science. In fact, what is striking is the way that the longstanding traditional barriers between upper-class philosophers, market-driven entrepreneurs, large-scale industrialists, and skilled craftspeople and technicians dissolved, so that all of these groups came together to initiate a culture of innovation that produced continuous, accelerating change.

Thus, in late seventeenth-century Britain, a new and distinctive pattern of social relations and interactions arose. Natural philosophers aimed to unlock the secrets of nature, not by secret procedures like the alchemists, but by publicly presented demonstrations with instruments that reliably revealed regular relationships in nature. Craftspeople sought to learn the latest news of chemistry and mechanics—visiting "mechanics' libraries," which sprang up all over Britain—and to use these insights to create new tools and machines or improve existing ones. Entrepreneurs and industrialists sought to join with craftspeople and scientifically trained or literate engineers to create new products or production processes. Indeed, what we see is the spread of techniques, approaches, and understandings informed by an appreciation of science and commitment to the scientific spirit.

Throughout the 1700s and early 1800s, these interactions produced an accelerating stream of technical innovations, in everything from humble agricultural implements and screw-cutting lathes; to wholly new inventions such as cotton-spinning machinery; to new sources of power and transport such as steam engines, steamships, and railways. The number of important inventions in these years runs into the hundreds or even thousands and includes major improvements in mining and drainage and agricultural technology, bridge and road building, mass production of chemicals such as soda and sulfuric acid, new and improved machine tools for working wood and metal, heavy construction and earth-moving equipment, and many more. Although important inventions, from the lightning rod to chlorine bleaching, were made in other countries, the center of industrial innovation from 1700 to 1850 remained in Britain, with other European countries only catching up from 1850 to 1914. Particularly in the crucial area of the invention, improvement, and application of steam-power technology, Britain remained the world leader through the mid-nineteenth century.

We can thus describe the Industrial Revolution that transformed the West as driven by an accelerating rate of technical innovations between roughly 1700 and 1850. But we have not yet made clear how and why this occurred. Certainly, it depended on the spread of a culture of innovation so that large numbers of people, in a variety of professions, expected innovation to occur and so actively pursued it. But how did this culture of innovation arise and become widespread? How did it displace the more traditional patterns of economic and intellectual life?

Particularly at a time when most major civilizations around the world, after the widespread rebellions and crises of the mid-seventeenth century, were strengthening traditional beliefs and reinforcing orthodoxy based on classical texts, how did Europe—and Britain in particular—become obsessed with discovering new technological processes and inventions and develop the skills and tools to do so?

To answer these questions, we need to look more closely at world patterns in the production and use of new knowledge and ideas.

Additional Reading

Jacob, Margaret. *Scientific Culture and the Making of the Industrial West*. New York: Oxford University Press, 1997.

Mokyr, Joel. *The Gifts of Athena: Historical Origins of the Knowledge Economy.* Princeton, NJ: Princeton University Press, 2002.

———. *The Lever of Riches: Technological Creativity and Economic Progress.* New York: Oxford University Press, 1992.

Wrigley, Edward Anthony. *Continuity, Chance, and Change: The Character of the Industrial Revolution in England.* Cambridge, UK: Cambridge University Press, 2002.

CHAPTER EIGHT

TRAJECTORIES OF SCIENCE IN ASIA AND EUROPE

CHAPTER PREVIEW: In 1500, the most advanced science in the world was found in Asia, especially in the Islamic lands. Yet over the next two centuries, Asian societies saw no great acceleration of scientific advance, nor any fundamental breakthroughs to new systems of thought. Rather, after 1600 the sciences in China, India, and the Ottoman Empire were increasingly limited by the state-led reinforcement of traditional beliefs.

By contrast, in Europe the discovery of the New World and new findings about the Moon, comets, and the planets (in part produced by new tools, like the telescope) overturned traditional ideas about the world, and led scholars to develop new systems of knowledge. Europeans built on Islamic advances in mathematical and experimental sciences, yet after 1500 they went further by using these methods to test and reject the basic assumptions about nature in ancient Greek and medieval philosophy. Putting aside the authority of Aristotle, Europeans developed new ways to think about and measure the pressure of the atmosphere, the motion of earthly and heavenly bodies, heat, and mechanical power.

In addition, especially in Britain, programs of experiments and public demonstrations with scientific instruments found a broad public audience. Drawing on the popularization of the latest scientific methods and findings, British craftspeople and instrument makers became “engineers,” developing their own experimental programs to search for improved methods of mining, manufacturing, and transport. One of their most important efforts was the development of practical steam engines, which could convert heat into useful work. Joining with businesspeople who sought to apply the latest scientific methods and knowledge to their operations, these new engineers transformed British industry and launched the Industrial Revolution.

New technologies and innovations are the products of new knowledge and techniques. If we ask how new knowledge is discovered, we naturally turn to the study of science. Science is not something new, however, but is the product of a long and global history.

World Science and the Islamic Achievement Before AD 1500

There has been a tendency to see modern science and mathematics as a European invention based on ideas originated by the ancient Greeks between 500 BC and AD 200. The work of famous Greeks from this period—like Euclid, Ptolemy, Aristotle, and Galen—dominated European scientific and mathematical thought from ancient times through the Middle Ages. After 1500 a new wave of great scientists emerged: Copernicus, Galileo, Kepler, Descartes, Pascal, and Newton. The development of modern science was thus thought to be a straight path from Greek breakthroughs to modern European science.

We now realize, however, that this picture is almost entirely false. Much of what the Greeks developed was built upon borrowings from Egypt, Babylonia, and India, where geometry and arithmetic developed as far back as 2500 BC. India and China also developed astronomy of great sophistication, as did the Mayans in the New World.

As just one example of the sophistication of non-Western science, consider the map of China shown in Figure 8.1. This map, discovered engraved on a stone tablet dated to AD 1137, shows the major river systems of China with astonishing accuracy. This map required skills in arithmetic and geometry and in surveying and measurement beyond anything attained by the ancient Greeks.

Moreover, many basic elements of modern mathematics remained well beyond Greek knowledge. The numbers we use now—from one to nine and zero—were developed sometime before the fourth century AD in India. From there, they were adopted by Arab mathematicians by the ninth century AD, and then passed on to Europe some 400 years later, becoming known as "Arabic numerals."

Indian mathematicians, benefiting from the early use of this number system, made remarkable progress in the study of arithmetic. They developed methods of calculating the sums of infinite series and computed the value of pi (π) to 10 decimal places roughly 300 years before similar findings were developed in Europe. Chinese mathematicians too made greater progress than contemporary Europeans—having by the thirteenth

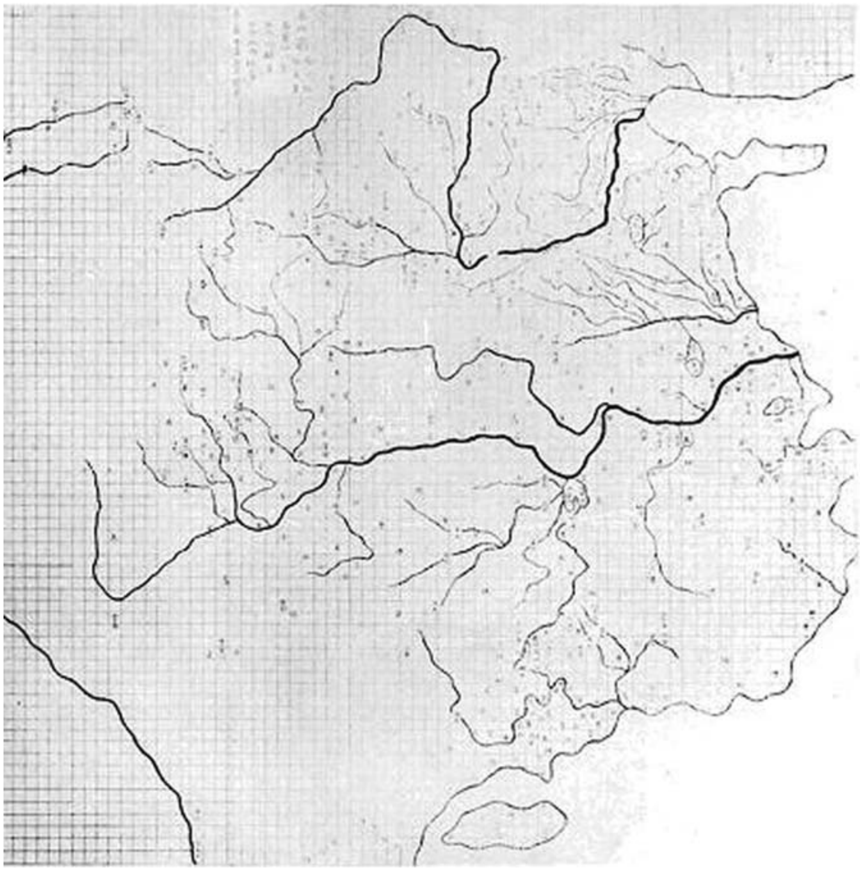


FIGURE 8.1 "MAP OF THE TRACKS OF YU THE GREAT," AD 1137
Chinese mapmakers produced remarkably precise maps long before Europeans did. This example shows a gridded map displaying the Yellow and Yangtze Rivers and their tributaries with extraordinary accuracy. This map was carved in stone and is about 1 square meter in size.

century solved higher-order polynomial equations—and they used algebra to solve geometric problems in the manner not discovered in Europe until some four centuries later by Descartes.

Before 1500, the greatest mathematicians, astronomers, chemists, and physicists in the world were probably the Arabs and other Muslims who lived in the great region of Muslim conquests stretching from Spain in the west, across North Africa, and through the Middle East all the way to central Asia. Indeed, "many of the ideas which were previously thought to have been brilliant new conceptions due to European mathematicians of the sixteenth, seventeenth, and eighteenth centuries are now known to have been developed by Arabic/Islamic mathematicians around four centuries earlier. In many respects the mathematics studied today is far closer in style to that of the Arabic/Islamic contribution than to that of the Greeks."[1]

Mathematics in China, India, and the Muslim world was often shaped by the practical concerns that arose in these highly commercial societies. The inventor of modern algebra, the ninth-century Iraqi mathematician Al-Khwarizmi, tells us that he developed his methods for solving equations to help men who "constantly require [solutions] in cases of inheritance, legacies, partition, lawsuits, and trade" or in surveying land and digging canals.[2]

Al-Khwarizmi's work (including his treatise on *al-jabr,* from which we get the English word "algebra") was part of a vast body of research by Muslim mathematicians working on prime numbers, binomials, decimal fractions, trigonometry, and algorithms (another Arab word, taken from Al-Khwarizmi's name). Their discoveries laid the foundations for almost all higher work in mathematics in Europe since the Renaissance.

Muslim scholars also did innovative work in the natural sciences. In the ninth century, Jabir Ibn Hayyan of Syria revolutionized the study of chemistry. Jabir was the first to recognize that elements always combined in exactly the same proportions in chemical reactions, anticipating the European discovery of the same principle by perhaps 1,000 years. Jabir wrote treatises on distillation, crystallization, and evaporation; discovered citric, nitric, and hydrochloric acids; and pioneered a number of practical applications of chemistry, including dissolving gold, preventing rust, and improving the quality of glass and steel.

Jabir insisted that knowledge must be gained by experiment and that experiment must be used for practical work. Unfortunately, when Jabir's work was translated into Latin, Europeans were mainly interested in finding ways to create wealth by turning common metals into gold. His major book—*Kitab al-Kimya*—gave its name to the European practice of "alchemy." However, as we shall see below, his emphasis on experiments eventually became a key element of the world scientific tradition.

In the tenth and eleventh centuries, Arab astronomers and geographers working in Syria, central Asia, and Spain measured the Earth and heavens with unprecedented accuracy. For example, in 1079, the astronomer Omar Khayyam measured the length of the year (correctly) as 365.2421986 days. Khayyam also developed the Persian calendar, which was more accurate than the Gregorian calendar developed in Europe 500 years later.

Arab scholars such as Al-Battani, Al-Biruni, and Al-Zarqali corrected the errors of Ptolemy on the motion of the Moon, the tilt of the Earth's axis, and the size of the Mediterranean Sea. Their works, later cited by Copernicus, also influenced Kepler and Galileo. From the twelfth through the fifteenth centuries, Muslim astronomers including Al-Urdi, Al-Tusi, Ibn Al-Shatir, and Al-Shirazi worked at the finest observatories in the world and developed new mathematical theorems that were essential to Copernicus's astronomy. Al-Haytham and Al-Farisi made path-breaking studies in optics, developing mathematical treatments of reflection and refraction and explaining the colors of the rainbow.

The Muslim world also led the way in creating institutions for learning and applied knowledge. Islamic scientists and scholars developed the first universities as centers for scholarship in North Africa and Egypt; the universities of Al-Azhar in Cairo, founded in AD 988, and of Al-Karaouine in Fez (Morocco), founded in 859, are the world's oldest ongoing universities. Al-Karaouine was founded by a woman, Fatima al-Fihri, who used her family fortune to further Islam and scientific learning.

The university of Al-Karaouine played a pivotal role in both Muslim and European scholarship. Pope Sylvester II, who is credited with introducing Arabic numerals into Europe, studied there. Al-Karaouine was home to the cartographer Mohammed al-Idrisi, maker of the first known globe of the world, whose maps aided European explorers, and to Ibn Khaldun, the founder of sociological history. Al-Karaouine was also famous for the teaching of the Muslim mathematician Ibn al-Banna, who wrote dozens of mathematical treatises and taught a full curriculum of arithmetic, algebra, geometry, and astronomy. Al-Banna was the first to consider fractions as the ratios of two whole numbers and was first to use the term "almanac" (from the Arab word for weather) for a compendium of astronomical and weather data.

The Muslim world also developed the first true hospitals to treat patients in a clean and professional setting, and Muslim physicians were the first to develop and apply quarantine procedures to control contagious diseases. Muslim societies were the first to license pharmacologists by examinations on their knowledge of herbs and medicines. Baghdad had at one time as many as 862 registered pharmacists, all of whom had passed formal examinations.

In short, from roughly 1000 to 1500, Islamic scientific knowledge and practice were far ahead of Europe. It is therefore a critical and puzzling question to ask: Why did European science, which had lagged so far behind, eventually produce the technological changes that led to industrialization, while Islamic science—and for that matter Indian and Chinese science—did not?

Trajectories of Science: From Advance to Stagnation

We have already observed that it is wrong to believe that science always moves forward, and that Western science in particular is just a product of steady advances from Greek thought to the Renaissance to modern science. The reality is much more complex. In fact, scientific thought, like other elements of history, can have various trajectories, including reverses, with long periods of stagnation and periods in which much is lost.

For example, in Europe science made no major advances for over 1,000 years, from roughly AD 200 to 1400. Moreover, a great deal of important work in mathematics and science from the years before AD 200 was simply lost and forgotten during the centuries of barbarian conquests that followed the fall of Rome.

Indeed the most typical trajectory for science is for substantial advances to occur during periods when different cultural and philosophical traditions are allowed to mix, but then for scientific change to be halted, or even reversed, with important advances sometimes being lost entirely, when periods of conflict and disorder follow. As we have seen, rebellions and civil wars were often ended only when powerful central governments imposed order by silencing opposition and by enforcing orthodox beliefs that supported the state but stifled independent thought and innovation.

Of all the premodern scientific traditions, that of the Islamic world around AD 1000 was the most advanced and the most likely to lead to something like modern experimental science and scientific technology. Yet like many others, it was overturned by the combination of internal war, external conquests, and the conflicting demands of religious orthodoxy.

For 200 years, from AD 750 to 950, most of the Muslim world was unified under the rule of the Abbasid Caliphate, with its magnificent capital in Baghdad (in modern-day Iraq). There, the caliphs, or rulers, had assembled not only great wealth and outstanding craftspeople, but also the foremost scholars of the Muslim world.

Muslim scholarship benefited from vast libraries, as the Arabs learned the art of making paper from the Chinese and created a vast book publishing industry. Books were widespread in the medieval Muslim world; Baghdad alone had 36 major public libraries, and booksellers were part of every major market. One bookstore whose records survive listed over 60,000 titles in its holdings, including works on religion, law, mathematics, science, astronomy, medicine, the Greek classics, Indian literature, poetry, fables, travel, and other topics. In Spain, conquered by the Muslims in the eighth century and ruled by Muslims for nearly 400 years, the capital city of Cordoba boasted over 70 major public and private libraries, the largest of which held some 400,000 manuscripts.

Muslim rulers also built observatories and paid scholars to travel to India and Byzantium to acquire Sanskrit and Greek texts and translate them into Arabic. Arabic became the universal language of scholarship from Spain to India, much like Latin in Renaissance Europe or English today. This cross-fertilization of cultures and ideas—with Baghdad bringing the finest minds of the Mediterranean, Middle Eastern, and central Asian world together to study the scholarship of the Greek, Persian, and Indian traditions—launched the great golden age of Islamic science. It was an age of pluralism and tolerance in matters of religion—as Muslims of many different sects and even Christians and Jews worked together and communicated in a common language—and of great discoveries.

Islamic science developed into a powerful tradition, using mathematics, observation, and experiment to make discoveries and test ideas. Islamic scientists continued to use, comment on, and surpass the works of their predecessors into the fifteenth century.

This scientific research tradition survived through centuries of division and conflict in the Islamic world. In the 900s, internal revolts arose against Abbasid rule, and violent conflicts broke out between the Sunni and Shi'a sects of Islam. In 1055, the Seljuk Turks attacked Baghdad and ended the Caliph's political power. Nonetheless, the Seljuk ruler built the magnificent observatory in Esfahan, Iran, where Khayyam worked 20 years later.

Outside of Iraq, the remainder of the Islamic world split into many feuding regional dynasties, with separate rulers arising in Spain, North Africa, Egypt, and Syria. The great unity of the Muslim world had been broken. Moreover, these separate dynasties were occupied with external invaders, as the Christian crusaders invaded Palestine and Spain, and the Mongols attacked from the east. Still, these varied dynasties continued to build observatories and support outstanding scholars.

In 1258, the Mongols sacked Baghdad and massacred much of its population. Over the next 200 years, additional waves of Mongol and Turkish conquerors, plus the Black Death, would devastate the Muslim world. Many of the major scientific institutions, laboratories, schools, and even roads and waterways in leading Muslim centers of civilization were destroyed. It is said that during the first Mongol sack of Baghdad, so many books were dumped into the Euphrates River that the waters turned black from their ink.

The destruction of Baghdad as an imperial capital removed one center of support for learning in the Muslim world, but even this did not end the advance of scientific research. Instead, from the thirteenth through the sixteenth centuries, other centers arose in North Africa, Syria, Persia, and central Asia, where scientific advances in medicine, optics, and astronomy continued. Many manuscripts from Baghdad were saved and moved to libraries in Persia and elsewhere. Wherever enlightened sultans or other leaders ruled, they continued to provide patronage to scholars and scientists. In many areas, these later centers of scientific research made advances that surpassed even the achievements made under the Abbasid caliphate in Baghdad.

Then after more than 500 years of disunity from the tenth through the fifteenth centuries, three major empires came to rule much of the Islamic world after 1500: the Ottoman Empire, which ruled most of North Africa, the Balkans, Asia Minor, and the Middle East; the Safavid Empire, which ruled Iran and parts of central Asia; and the Mughal Empire, which ruled northern and central India (see Figure 6.1 on page 100, areas 16, 17, and 18).[3]

At first, the Ottomans confidently supported a wide range of scientific learning, including borrowing and adapting military technology from Europe. However, after a series of rebellions in the early seventeenth century, the Ottoman rulers focused on promoting Sunni orthodoxy to bolster their rule. This quest for orthodoxy was raised to a dominant feature of the Ottoman Empire, and innovations in thought that would lead to questioning of religious faith became forbidden. From roughly 1650 to 1800, the Ottomans turned away from both the Muslim tradition of innovation and from the new ideas emerging in Europe, preferring instead to secure political and social stability by enforcing conformity to a revived traditional approach to knowledge based on Islamic religious texts.

Similar tendencies arose among the Safavids in Persia and the Mughals in northern and central India. Under the Ilkhanids and other earlier rulers, Persia had enjoyed considerable religious pluralism and tolerance and for many centuries had been a center of advanced scientific scholarship. However, just as the Ottomans came to rely on enforcement of an orthodox Sunni religion to uphold their rule, the Safavids came to rely on enforcement of the major alternative sect of Islam—Shi'a—to bolster their authority. The Safavids made Shi'a their official state religion; conversion to Shi'a became mandatory, and the Sunni clergy were killed or exiled. Shi'a religious leaders were granted land and money in return for loyalty and steadily increased their power over learning and government.

In the Mughal Empire, as we discussed in Chapter 3, the initial flowering of arts and scholarship under religiously tolerant rulers was followed by the ruthlessly intolerant reign of Aurangzeb, who sought to enforce strict Sunni orthodoxy. Thus by 1700, the major rulers in the Muslim world—much as did China's rulers after the Manchu conquest—generally promoted the restoration of centuries-old orthodoxy as the means of enforcing their political rule.

Still, one must ask, given the glorious achievements of Islamic and other scientific traditions that were sustained over many centuries: Why did they not develop the same kind of advances leading to industrialization as did the modern European sciences?

Varieties of World Science and Different Approaches to Understanding Nature

Approaches to natural science varied across time and across different civilizations. Some traditions, such as that of China, made enormous advances in herbal medicine but remained weak in basic anatomy. Other traditions, like that of the Mayan Indians of Central America, were extremely accurate in observational astronomy but very weak in physics and chemistry.

Nonetheless, most premodern scientific traditions shared several common elements. First, their scientific understanding of nature was generally embedded in the framework for understanding the universe laid out in their society's major religious or philosophical traditions. Although there was potential for great conflict if scientific studies of nature should contradict elements of religion, this was usually avoided by making the religious views dominant, so that scientific findings would have to be reconciled with or subordinated to religious beliefs. This does *not* mean that religions were opposed to science—quite the opposite! Most political and religious leaders sponsored both scientific and religious studies, believing that each supported the other. Many distinguished Confucian scholars, Islamic judges, and Catholic priests were also outstanding mathematicians and scientists. For the most part, detailed observations of nature, including accurate measurements of planetary motions and natural phenomena, were considered valuable as privileged knowledge to political and religious elites or socially useful for improving architecture, farming, and medicine.

However, science generally remained intermingled with religious and philosophical beliefs, and any inconsistencies were generally resolved in favor of preserving the established religion. This meant that truly novel work risked being suppressed by political and religious authorities, especially during periods of religious conservatism or state enforcement of orthodox religious views.

Second, most premodern sciences maintained a separation between mathematics and natural philosophy (the study of nature). Mathematics was considered useful for exploring the properties of numbers (arithmetic) and relationships in space (geometry). It was also useful for a host of practical problems, such as surveying; compiling tables of planetary positions in the skies for navigation, calendars, and astrology; and accounting. But most premodern scientific traditions—including those of the ancient Greeks, medieval Europeans, Arabs, and the Chinese—held that mathematics was *not* useful for studying the basic constitution of the universe. This was the main subject matter of natural philosophy (the study of the natural world) and theology (the study of religious issues, including the relationship of humans and the natural world to the creator).[4]

If one wanted to know the nature of God or the soul, or the relations between humankind and God, or the purpose of animals, or the nature of the stuff that composed the world—plants, stones, fire, air, liquids, gases, crystals—well, these were problems for reasoning based on experience and logic, not on mathematical equations. The task of philosophy was to comprehend the essential nature of things and their relationships. Measurement was a practical matter, useful but best left to surveyors, craftspeople, moneylenders, and other practical folks.

Thus the Chinese and Indian traditions believed in a basic hidden force of nature—*qi* in China and *prana* in India—that animated and infused the world. For Chinese scientists, the world was always changing, and these changes formed complex cycles and flows of opposing forces that operated to maintain an overall harmony. Thus despite their enormous skill and use of detailed mathematics and observation in areas from canals and irrigation works to astronomy and clocks, it never occurred to orthodox Chinese scientists to regard the universe as a mechanical clockwork or to apply mathematical equations to understand why natural processes occurred. What mattered was understanding signs of the ever-shifting flows of *qi* between opposing conditions—*yin* and *yang*—to avoid excesses and to maintain the harmony of the whole.

The Greeks too, since the time of Aristotle, similarly maintained a separation of mathematics from natural philosophy. Aristotle's philosophy of nature, which by the Middle Ages had become the dominant natural philosophy in Europe, analyzed nature by identifying the basic elements that composed all things. For Aristotle, there were four basic elements—earth, fire, air, and water—which were defined in terms of how they behaved. Things made of earth are solid and naturally tend to fall to the center of the universe, which is why the solid earth beneath us consists of a sphere, and all solid things fall toward it. Fire naturally rises, so things infused with fire rise. Air is transparent and moves across the surface of the Earth as winds; water flows and moves in currents and puddles and fills the seas and oceans. Since the Moon and Sun and stars and planets neither move up nor down but remain in the heavens, moving in circles in the skies, they must be composed of yet another, distinct element that was perfect and unchanging, which the Greeks called the "aether."

The way these principles were discovered and proved was through logic and argument based on experience, not through mathematics. Although mathematical forms and principles could help identify and measure relationships in nature, the true "essence" of reality was set by philosophy. For example, even though the planets actually move at varying speeds in elliptical orbits around the Sun, for over 1,000 years Islamic and European astronomers sought to describe their orbits solely in terms of combinations of uniform and circular motions, because Aristotle's natural philosophy had decreed that this was the only way that heavenly bodies could move.

In the Middle Ages, European scholars continued to treat mathematics as mainly a practical field, while focusing their attention on logic and argument as the keys to advancing knowledge. Although medieval scholars in Europe did make significant advances in the study of motion and absorbed much of the critical commentary on Greek science and philosophy from the Islamic world, they did not reject or replace the major tenets of classical Greek science or their own religious theology. Rather, much of the effort of European thought in the Middle Ages consisted of efforts to reconcile and synthesize the writings of the Greek authors on science and politics with the precepts of the Christian Bible and other religious texts, culminating in the work of St. Thomas Aquinas.

The Islamic scientific tradition went further than any other in using experiments and mathematical reasoning to challenge the arguments of Ptolemy, Galen, and others of the ancient Greeks, creating new advances in medicine, chemistry, physics, and astronomy. Yet within Islam, the discussion of the fundamental relationships and characteristics of nature was separated into the teachings of the Islamic sciences, based on classical religious texts, and the teachings of the foreign sciences, including all the works of Greek and Indian authors. After the writings of the philosophical critic Al-Ghazali in the eleventh century, who championed the value of the Islamic sciences on truly fundamental issues, this division was generally maintained, and even the most remarkable advances and findings with regard to revisions of Greek learning were not permitted to challenge the fundamental views of the universe as expressed in Islamic religious works.

Thus in all the major scientific traditions, whereas precise measurement and sophisticated mathematics were widely used, mathematical reasoning was not used to challenge the fundamental understanding of nature that was expressed in natural philosophy and religious thought.

Third, in most places, the dominant assumptions and traditions of science were so distinctive and so well established that they could hardly be shaken even by encounters with different notions and ideas. These scientific traditions tended to grow incrementally, with each successive generation modifying yet building on the works of their predecessors, so that over time a rich and longstanding tradition of scientific methods and findings grew up, intertwined with an established religious tradition. These structures of thought tended to resist wholesale change or replacement and to marginalize heterodox or conflicting views.

Thus by 1500, there were many different varieties of science in the world, each with their own strengths and distinctive characteristics. Most had developed precise observations of the Earth and heavens and had systematized a great number and variety of discoveries about nature. Most had developed a classification of essential relationships or characteristics of natural things. Most were linked in some fashion to one of the great axial age religions and over many centuries had worked to accumulate knowledge while building frameworks that were compatible with those religions. And in the next century or two, most scientific traditions would be driven to greater subordination to classical and religious orthodoxy by rulers who were responding to the political and social conflicts that struck over almost all of Europe and Asia.

How then was it possible that any culture could develop the technical innovations, based on new instruments and mathematical natural science, that we discussed in Chapter 7? To understand this, we have to grasp the unusual events and discoveries that led to unexpected changes in Europe's approach to science.

Europe's Unusual Trajectory: From Embracing to Escaping Its Classical Tradition, 1500–1650

The study of ancient schools of thought was given a new direction by the realization, by the early 1500s, that the Spanish voyages to the west had discovered not just an alternate route to India, but in fact a whole new continent, a "New World" unknown to ancient geographers and scientists. Navigators came to realize that practically all of Greek geography was badly mistaken. Also in the early 1500s, the research of the Belgian anatomist Andreas Vesalius (who was building on the prior work of Arab scholars) demonstrated to Europeans that Galen's knowledge of human anatomy was, in many respects, inaccurate or deficient because it was based on deductions from animal dissections rather than on empirical study of human cadavers. Vesalius showed that many of Galen's (and Aristotle's) statements about the heart, the liver, the blood vessels, and the skeleton were wrong.

Then in 1543, Copernicus published his new methods for calculating the movements of the planets based on a solar system with a moving

Earth circling the Sun. Although some supporters, trying to avoid conflict with the church, argued that his work should only be taken as a new method of predicting planetary positions, Copernicus argued quite forcefully that the structure and dynamics of the solar system made more sense, logically and aesthetically, if the Earth and all other planets revolved around the Sun. If so, then the system of Ptolemy and Aristotle, with the Earth as the center of all motion, was in error.

In 1573, the Danish astronomer Tycho Brahe published his account of the supernova that had suddenly appeared near the constellation of Cassiopeia in 1572. This was a phenomenon that had never been recorded in European astronomy. Indeed, since the time of Aristotle, it was assumed that the skies were unchanging and constant in their perfection. Comets and meteors were known, of course, but they were considered weather phenomena, like lightning that occurred close to the Earth rather than in the celestial heavens. But the supernova was not a comet or meteorite, because it showed no motion: It was a new body that behaved like a fixed star—something that was, according to Aristotle's philosophy, impossible.

Five years later, Brahe showed by careful observation of the movements of the great comet of 1577 that this comet must be farther away from the Earth than the Moon and thus was moving through the celestial heavens, not the atmosphere, striking yet another blow against Aristotle's cosmic system. Supernovae that can be observed from Earth by the naked eye are rare, but as chance would have it, in 1604, yet another supernova made its appearance, thus showing conclusively that the heavens were not unchanging after all.

By the late 1500s and early 1600s, therefore, the wisdom of Aristotle, Galen, and Ptolemy, which had been accepted for over 1,000 years, was coming under widespread attack. European scholars sought out new observations and new instruments for studying nature that could help determine who was correct, or incorrect, in their description of nature and the universe.

In 1609, Galileo used the new spyglass or telescope—invented by Dutch lens-grinders and then improved by Galileo himself—to observe the heavens. Looking at the Moon through a telescope rather than only the unaided eye, Galileo saw what looked like giant mountains and craters on the surface, which through the telescope looked positively Earth-like! Jupiter was found to have its own moons circling it, implying that the Earth could not be the center of all celestial motions. In every direction were previously unknown stars, and even the Milky Way was revealed to consist of thousands of tiny stars. Though many critics at first dismissed the views through the telescope as false magic, enough people acquired their own telescopes and confirmed Galileo's discoveries that they were widely accepted. People came to realize that the universe in which they lived was nothing like that described by the ancient Greek authorities.

Copernicus was not the first astronomer to suggest that the Earth revolved on its axis and moved around the Sun, instead of being the fixed center of the universe; a few ancient Greek and Islamic astronomers had also suggested that this was possible. However, until telescopic observations of the moons of Jupiter demonstrated the fact of motion around a body other than the Earth, there was no evidence on which to base a successful overthrow of Aristotle's views. It was only after 1600, with so many new observations that contradicted the ancient Greeks' knowledge—of geography, of anatomy, and of astronomy—piling up in all directions, that it became possible, even imperative, to adopt alternatives to Aristotle in particular and to Greek science and philosophy as a whole.

From 1600 to 1638, a series of books presenting new knowledge or proclaiming the need for a "new science" made a compelling case that the knowledge of the ancients was seriously flawed.

1600: William Gilbert, *On the Magnet*

1620: Francis Bacon, *The New Organon, or True Directions Concerning the Interpretation of Nature*

1620: Johannes Kepler, *The New Astronomy*

1626: Francis Bacon, *The New Atlantis*

1628: William Harvey, *On the Motion of the Heart and Blood*

1638: Galileo, *Discourses on Two New Sciences*

Gilbert argued that compass needles pointed north because the whole earth acted as a giant magnet. Francis Bacon argued that Aristotle's mainly deductive logic (collected under the title *Organon*—which means "instrument or tool") could not be trusted as a guide to understanding nature; instead Bacon argued for the use of inductive logic, based on a program of experiment and observation, as a superior method for discovering knowledge of the world. Kepler showed that the planets actually traveled in elliptical orbits around the sun, not in circles. And William Harvey showed that, contrary to Galen's teachings, the supposedly separate veins and arteries were in fact one system through which the blood was circulated by the beating of the heart.

By the mid-1600s, therefore, European philosophers and scientists found themselves in a world where the authority of ancient texts was clearly no longer a secure foundation for knowledge. Other major civilizations did not suffer such blows. For the Chinese, Indians, and Muslims—accustomed to operating in a vast intercontinental trade sphere from

China to Europe and generally seeing themselves at the center of all that mattered—the discovery of new, lightly peopled lands far to the west made little difference. But for Europeans—who had long seen themselves on the literal edge of the civilized world with all that mattered lying to the east—the discovery of new and wholly unknown lands to the west changed their fundamental position in the world.

Similarly, Chinese and Indian astronomers had observed supernovae before (accurately recording observations of the heavens for thousands of years) and had long ago developed philosophies of nature that were built around ideas of continuous change as the normal course of things in the universe. Unlike the Greeks and Europeans, they had no rigid notions of perfect and unchanging heavens, separate from the Earth, that would cause their classical traditions to be fundamentally challenged by new observations of comets and stars.

Moreover, just when Europeans started their impassioned debates over these new observations and put forth their alternative ideas, the Ottoman, Mughal, and Chinese Empires were focused on internal concerns, seeking to recover from internal rebellions by closing off outside influences and strengthening traditional orthodox beliefs.

Thus the Europeans, more than any other major civilization, suddenly found that the classical tradition that they had sought to embrace now had to be escaped if they were going to understand the true nature of their world and their universe. This led Europeans to undertake a search for new systems of philosophy and new ways of studying and describing nature.

Searching for New Directions in European Science: Cartesian Reasoning and British Empiricism, 1650–1750

Prior to 1650, all major civilizations drew on four basic sources to justify knowledge and authority (which were generally closely connected). These were

1. Tradition—knowledge that was revered for its age and long use
2. Religion or revelation—knowledge that was based on sacred texts or the sayings of prophets, saints, and other spiritual leaders
3. Reason—knowledge that was obtained from logical demonstration, either in arithmetic and geometry or by deductive reasoning from basic premises
4. Repeated observation and experience—knowledge that was confirmed by widely shared and repeated observations and everyday

experience, such as that day follows night, the sun rises in the east, objects fall, heat rises. This also includes various agricultural and manufacturing techniques that were proven in use.

We have noted that in Europe by the early 1600s new discoveries, observations, and concepts about the Earth and the universe had already started to chip away at tradition and religious belief as guides to knowledge about the natural world. In addition, the seventeenth century was a period of sharp religious schism and conflict in Europe, capped by the Thirty Years' War (1618–1648). During these years Catholics, Lutherans, Calvinists, and other sects all claimed to be correcting the errors of others' interpretation of Christian faith, and various religious groups rebelled and embroiled Europe in massive civil and international wars. The lack of accepted religious authority and of any way to choose between competing claims seemed to offer nothing but the prospect of endless conflict.

The same problems, as we have noted, led Asian empires to promote a return to their traditional orthodox beliefs to suppress these conflicts. Some European states tried to do the same thing. In Spain and Italy and part of Germany and Poland, the counter-Reformation led to the suppression of heresies and unorthodox views and enforcement of traditional Catholic beliefs. These states banned books that threatened Catholic orthodoxy and sought to curtail the actions of "dangerous" authors, such as Giordano Bruno and Galileo (Bruno was burned at the stake for his heresies; Galileo, more prudent and better connected, was allowed to live under house arrest). France and the Netherlands, though less severe, and Britain through 1640, also tried to restore uniform state religions and force dissenters underground or into exile. However, in a few states—including Britain after 1689, Denmark, and Prussia—religious tolerance remained, and throughout western Europe, there was a checkerboard of different states following different varieties of religion—Catholic, Calvinist, Lutheran. Throughout Europe, the result of the rise and spread of Protestantism in the sixteenth and seventeenth centuries was that the authority of the Catholic Church—and of the philosophical and scientific work that was closely associated with the church's teachings—was seriously weakened. This provided an additional reason for philosophers to struggle to find a new basis for more certain knowledge.

European thinkers therefore turned away from the first and second major sources of knowledge and authority—tradition and religion—to seek new systems of knowledge. After 1650, two major directions were proposed to deal with this dilemma—rationalism and empiricism.

One way to set aside traditional and revelation-based assumptions was to try to get down to bedrock conclusions by reasoning purely from logic. The critical figure leading this approach was the French philosopher and mathematician René Descartes, who resolved to begin by doubting everything—the teaching of the ancients, the teachings of the church, and even his own experience. He extended his doubt until only one thing remained certain—the fact of his own doubt! This fact could then be the basis for logical deductions. After all, if Descartes could not escape the fact of his own doubt, he—as a doubting, thinking entity—must exist! This conclusion was rendered in his famous statement "I think, therefore I am."

Descartes continued this argument further. If he doubted, he could not be perfect. But if was aware of his imperfection, this could only be because a perfect entity existed, thus there must be a perfect being, or God. And because we can only conceive of God as perfect, and hence perfectly logical, the universe constructed by God must also follow perfect logic. Descartes further argued that we can only logically perceive space if something is there, extending through space (empty space, Descartes argued, was a logical contradiction). What must fill space, then, are invisible particles whose motions and interactions must cause all that we see.

In this fashion, Descartes built up a logically consistent model of a mechanical universe in which all phenomena are to be explained by the movements and collisions of moving particles. This led Descartes to numerous valuable insights, such as the notion that we see things because invisible particles of light move from the objects we see to strike our eyes. But it also led him to deduce things that we now know are simply not true, such as the idea that the planets travel around the Sun because they are caught up in vortexes or whirlpools of swirling invisible particles.

This Cartesian rationalism provided a very attractive alternative to Aristotelian philosophy, which was now in disrepute. It seemed to have the power of purely logical demonstration behind its ideas. Also, because all phenomena were reduced to the motions of particles, it held the promise of applying mathematical principles—already worked out by Galileo for many kinds of particle motion—to all of nature. Finally, it allowed one to explain almost anything by coming up with some characteristics of particles. For example, one could suggest that spicy or sweet flavors were the respective results of sharp or smooth particles hitting the tongue or that different colors of light were produced by particles of light spinning at different speeds.

However, Cartesian rationalism also had its defects. In putting reason above experience, Cartesians disdained experiments. This limited what could be learned or discovered and often led to significant errors. Descartes' assumptions led him to misjudge the way bodies acted in collisions and turned his followers away from studying the properties of vacuums (since empty space could not exist, they must be tricks or errors by experimenters). Descartes also flatly ruled out the possibility of forces acting directly across space between objects, such as gravity. For all of its virtues, Cartesian rationalism therefore saddled its followers with a variety of errors and false explanations of the mechanics of motion in nature.

The motion of the Earth, the weight of the atmosphere, and the properties of vacuums were all discoveries whose proof rested on the use of scientific instruments (telescopes, barometers, vacuum pumps) to capture information not ordinarily available to the senses. The use of such instruments was a prime feature of the Baconian plan of developing scientific knowledge by experiments.

The experimental program reached its most systematic organization in the work of the Royal Society of London, led by Robert Boyle and later by Isaac Newton. The Royal Society based its research on experiments with scientific instruments and apparatus publicly performed at meetings of the society, and accounts of those experiments were widely published. The Royal Society used air pumps, telescopes, microscopes, electrostatic generators, prisms, lenses, and a variety of other tools to carry out its investigations. Indeed, the society came to rely on specially trained craftspeople to supply the growing demand for scientific instruments for its members.

The fame of the Royal Society in Britain skyrocketed with the achievements of Isaac Newton. Newton was the first to demonstrate that both motion on the Earth—whether the movement of falling apples, cannonballs, or the tides—and the motions of the planets through the heavens could *all* be explained by the action of a universal force of gravity. This force acted to attract objects to each other with a strength that increased with their mass but decreased with the inverse square of the distance between them. Newton's theory of gravity made it possible, for the first time, to explain the precise path and speed that the planets followed through the skies, as well as the movement of the Moon and the tides.

Newton also discovered the correct laws of mechanical force—that force was needed for all changes in the direction or speed of motion of an object, in proportion to the mass of the object and the magnitude of the change. Newton's laws of force made it possible to easily figure out the amount of work provided by, for example, a volume of falling water based on the height that it fell, or the amount of work it would take to raise a certain weight a desired distance. Newton further discovered the key principle of optics: that white light was composed of a number of different colors of light, each of which bent slightly differently when moving through water or a glass lens, thus creating rainbows in the sky and color patterns in prisms and lenses.

Whereas in the early to mid-seventeenth century, both experiment and Cartesian rationalism had followers throughout Europe, by the late seventeenth and early eighteenth centuries, these conflicts between Cartesians and Newtonians had led to an increasingly clear difference in how science was pursued in continental Europe versus Britain. The Cartesian approach swept most of the intellectuals of continental Europe, who were persuaded that the powerful movement of vortices of particles kept the Earth rotating and the planets revolving around the Sun. A variety of other phenomena, such as heat, cold, taste, and pain were also explained by the motions, arrangement, and collisions of various kinds of particles—smooth or sharp, fast or slow.

The Cartesian approach, putting mathematical reasoning first as the source of knowledge, also encouraged a flowering of European mathematics joining algebra and geometry and number theory. This was useful where mathematical analysis of large numbers of particles moving through space really was an accurate model of the physical world—as with fluid mechanics or heat diffusion. French, Swiss, and German mathematicians made great progress in these areas and in such areas of applied mathematics as differential equations, infinite series, and many other topics.

The Bacon-inspired British empirical approach, by contrast, was highly unpopular outside of Britain and even widely mocked and criticized within. The rich empirical results of Boyle's experiments on the vacuum were lost in the continent's vigorous metaphysical arguments over whether a true vacuum could exist at all. Newton's findings were hardly taught on the continent through the eighteenth century. Even at home in Britain, philosophers such as Thomas Hobbes sharply rebuked Boyle and his followers, saying that philosophy required logical proofs and that doing experiments for the public was just a form of entertainment best left to vulgar craftspeople and performers.

In sum, northern Europe and western Europe were unique in the seventeenth century in not reinforcing traditional and religious knowledge but instead seeking new approaches to the use of reason and observation. Nonetheless, two very distinct approaches had emerged by roughly 1700. In Britain, the study of nature became a program of experimental discovery and measurement based on increasingly sophisticated apparatus and instruments and public demonstrations. On the continent, experiments retreated to the realm of private studies or became objects for entertainment, rather than the foundation of scientific work, while mathematics and logic formed the basis of scientific research.

We might say that on the continent Descartes created a new system of knowledge, based on logical and mathematical reasoning, that threatened to displace the entire body of knowledge that had rested on ancient tradition (the Greeks) and religion (the teachings of the Catholic Church). The combination of new discoveries and raging religious conflicts in the prior century and a half had undermined the authority of both tradition and religion as guides to knowledge; under these conditions the spread of Descartes' system proved irresistible.

In Britain, by contrast, the empiricists of the Royal Society had taken the fourth and allegedly lowest form of knowledge acquisition—everyday experience—and transformed it into something new. Following the teachings of Francis Bacon, they remained skeptical of deductive logic. Focusing their efforts to build scientific knowledge on programs of experiments with instruments and scientific apparatus, they developed a *fifth* source of knowledge that had never been given primacy before. That is, the British empiricists argued that publicly demonstrated observations with instruments such as telescopes, microscopes, prisms, vacuum pumps, and other apparatus provided knowledge that was more accurate and trustworthy than knowledge obtained from ancient times, from religious claims, from logical deduction alone, or from everyday observation. We take this for granted today. But in the context of world history, and in particular of seventeenth-century Europe, this was a highly novel and remarkable claim.

The Age of Ingenuity: From Engine-Driven Experimental Science to Engine-Driven Industry, 1700–1800

As it turned out, the Newtonian discoveries and the experimental program of the Royal Society were just what was needed to launch an Industrial Revolution. And in short order, they did so in Britain, leaving the rest of Europe—still under the spell of Cartesian rationalism—almost a century behind.

The separation of Cartesian science on the continent from Newtonian and experimental science in Britain was in part created, and certainly reinforced, by the actions of religious authorities in both places. When Descartes began publishing his works in the 1630s, religious authorities were immediately alarmed. The idea of a mechanical universe of particles in motion, without the active intercession of God, was distressing to them. Descartes had to move about Europe to avoid hostile authorities, both Catholic and Protestant. One thing that Italian, Spanish, and French Catholics, Dutch Calvinists, and German Pietists all had in common was a deep belief in the power of God and the accuracy of his story as written in the Bible. However, in a few decades, the intellectuals of Europe were deeply committed to Cartesian science, and by the late 1600s the French Royal Academy of Sciences (the continental rival of London's Royal Society) was thoroughly infused with Cartesian thought.

The Catholic Jesuits, who controlled much of the primary teaching in France, Spain, Italy, and southern Germany, decided to make their peace with Cartesianism. They were willing to teach Descartes' mathematics and some of his physics and adopted his logical approach. They did, however, insist that God could intervene in the universe as He wished to create miracles, and that the soul and the Holy Spirit were not part of the material, particle-driven world. The Jesuits also adopted a model of the solar system, first developed by Tycho Brahe, that accepted that all the planets travel around the Sun, but that kept the Earth at the center of the universe and had the Sun carrying all the other planets around the Earth. This was sufficient for the Catholic Church and became the model taught by the Jesuits for many decades.

The Catholics also found it convenient that Cartesians used logic, rather than experiment, to test hypotheses. The Jesuits became masters of logical argument and could readily reconcile many of the elements of the new mechanical science with the needs of the church. The Newtonian model, however, they roundly condemned. They found the mysterious force of gravity too close to magic and the experimental approach to discovery and knowledge production too unpredictable.

Almost the exact reverse reaction took place in Britain, where Newton was embraced by the Anglican Church. As we observed in Chapter 6, the political and religious struggles in Britain did not lead to a single established state church imposing a rigid orthodoxy, but to two distinct state churches—the Anglicans in England and the Presbyterians in Scotland—with toleration for Catholics and other dissenting Protestants such as the Quakers, Puritans, and others.

When Newton published his *Mathematical Principles of Natural Philosophy* in 1687, few people fully understood it. But within a few years, popularizations created a simple image of a clockwork universe, set in motion by a wise creator and maintained in harmony by all bodies following simple laws. Gravity was seen not as a magical or mysterious force, but as the provident creation of the all-wise creator, who used a single law of gravity to put the tides, Moon, planets, and all earthly bodies in their proper places. To promote harmony among people of different faiths under the king, the Anglican Church began using the Newtonian universe as a model of godly wisdom and harmony, with each planet and moon following their own path under one set of natural laws. The church even promoted the study of simplified versions of Newton's laws as the basis for a moral and productive life.

With the support of the church and the prestige of Newton firmly behind it, the Royal Society enjoyed a wave of national support and admiration in the early 1700s. This led to widespread interest in its experimental practices. Sales of scientific instruments took off and became nationwide, even international and, by the mid-1700s, London was established as the world center for the manufacture of such instruments. Public lectures, demonstrations, and provincial scientific societies flourished, and people from all walks of life—gentlemen, ladies, craftspeople, and businesspeople—flocked to them.

As we observed in Chapter 7, craftspeople, businesspeople, instrument makers, and gentlefolk (even clergy) undertook their own programs of experimentation and carefully ordered observations in the hope of making their own discoveries and of advancing useful knowledge. It was precisely this cooperation and many-sided exploration of industrial processes that was crucial to success. Thus, although Denis Papin, assistant to Robert Boyle and curator of instruments of the Royal Society, developed one of the first designs for a piston-based steam engine, Papin never succeeded in building a working model (although he did develop another practical invention—the pressure cooker). Rather, it was a craftsman, Thomas Newcomen, who was able to fabricate the working parts and develop the complex system of steam inlet and outlet valves that made a working steam engine possible.

Newcomen no doubt learned of the possibility of an atmospheric engine and the basic principles of atmospheric pressure and creating a vacuum by condensing steam from the publications of the Royal Society and the public lecturers who spoke throughout the country. But it was his experience in the mining industry and his skills as a craftsman that made it possible for him to develop a working steam engine.

Similarly, several decades later, the instrument maker James Watt took the scientific ideas developed by Joseph Black and others regarding latent heat and ideas about energy efficiency based on Newton's mechanics of work and used them to guide construction of an improved steam engine. Watt himself moved freely from the world of craftspeople and instrument makers and mining engineers (who needed and constructed the full-scale engines based on his designs), to the world of scientists in the University of Glasgow and the Royal Society, and to the world of entrepreneurs and industrialists such as John Roebuck and Matthew Boulton (his partners in the marketing and manufacture of steam engines). It was this fluid mixing of people, bringing together the talents of people of ideas, people of mechanical skills, and people with market savvy—all of whom were eager to follow experimental programs of discovery to create new products and new processes—that made the invention of the steam engine, and later the Industrial Revolution, a reality.

Two factors were crucial for the advance of practical scientific engineering, for its adoption by industrialists and entrepreneurs, and for its spread among thousands of craftspeople and technical workers—factors that were unique to Britain and might never have caught on elsewhere. First was the elevation of instrument-based experimental research programs and the discovery and demonstration of empirical relationships to the status of an independent, even superior, method of establishing knowledge. The second was the adoption of the experimental method, use of scientific instruments, and awareness of current scientific research as proper elements in the education and lives of ordinary people—especially for those seeking work in industry.

Both of these elements were part of the legacy of Francis Bacon, who was both a philosopher and the Lord Chancellor, or chief legal official, for England in the early 1600s. Bacon had insisted on public experiments as the best path to new knowledge. In addition, Bacon argued that experimental knowledge would lead to greater improvements of manufacturing, production, medicine, crafts, and all the useful arts than any knowledge gained by logic or by consulting ancient tradition.

The Royal Society adopted Bacon as one of its heroes. The society not only trumpeted his ideas of experimental and instrumental investigation as the true path to knowledge, they also promoted Bacon's view that experimental programs would lead to *useful* knowledge that would bring greater material wealth and prosperity. It was this view—that experimental knowledge would be useful to businesspeople, craftspeople, manufacturers, merchants, and anyone else involved in useful pursuits—that led the society to publish and publicize its works. It was also this belief that led to the founding of mechanics' libraries and lecture series to spread knowledge of what the society called the New Philosophy or Experimental Philosophy.

Especially in Scotland, where new opportunities opened up after its union with England in 1707, scholars, doctors, lawyers, clergy, and businesspeople set out to improve their backward country by creating a new, modern education for their fellow Scots that focused more on new knowledge and scientific discoveries than on ancient texts. Throughout the eighteenth century, the Scottish universities of Glasgow, Edinburgh, Aberdeen, and St. Andrews developed the most modern and empirical curriculum in the world.

The Scottish universities trained many of the leading physicians, scientists, and political and economic thinkers of both Europe and America in the 1700s (the president of Princeton University during the American Revolution, John Witherspoon, was a Scot who had been educated at Edinburgh). Scotland—which up to 1700 had been one of the most impoverished territories of Europe—became in short order one of the leading intellectual centers of the world and, by 1800, one of its leading centers of industrial innovation, mining, and manufacturing. It did so by embracing the new discoveries, experimental methods, and Newtonian approaches to science and insisting that education in these discoveries and methods be a crucial part of the intellectual equipment of everyone from mechanics to major industrialists. It is perhaps no accident that James Watt was a Scotsman who got his start working with steam engines at the University of Glasgow, or that so many other Scottish engineers, such as John McAdam, William Murdoch, and Thomas Telford, played leading roles in the Industrial Revolution.

Additionally, education in the latest scientific results and experimental methods became widely available in Britain through public lectures, demonstrations, and the broadsheets and manuals that were available in the mechanics' libraries, which sprung up throughout the country. A small industry developed that provided simplified introductions and practical formulas derived from the latest scientific works. Everyone from craftspeople to the upper class could easily acquire a working knowledge of the latest research if they wished, and many did.

Women too joined in the general enthusiasm for learning, and many become major scientists and inventors in their own right. These included the paleontologist Mary Anning, the botanist Anna Atkins, the mathematician Lady Augusta Ada Byron Lovelace, the astronomer Caroline Herschel, and the physicist Mary Sommerville in Britain, the British-influenced Madame de Chatelet in Paris (who translated Newton's work into French), and the astronomer Maria Mitchell in the United States.

The adoption of the experimental method and the availability of the latest scientific findings turned craftspeople and instrument makers into modern engineers. It was the familiarity of businesspeople and industrialists with the benefits of experiment and scientific research—and research's potential to create valuable new innovations—that led businesspeople to hire and finance engineers to improve their operations. For roughly a century after the publication of Newton's major work (in 1687), Britain alone promoted the teaching and use of the experimental method and Newtonian mechanics for craftspeople, engineers, and businesspeople and encouraged all of these groups to mix with leading scientific researchers and even to pursue their own programs of research and discovery. It was Britain that, in this manner, first made scientific engineering a normal and expected part of economic production and manufacturing.

Until the end of the eighteenth century, by contrast, in most of Europe the distinctions between craftwork, business, and scientific work remained very strong. Industrialists and manufacturers continued to focus on knowledge of their products, trade secrets, and markets rather than on scientific knowledge or methods that would lead to new products or processes. Meanwhile, European mathematical scientists pursued their research without much regard for their practical application. The experimenters and theorists at the French Royal Academy remained an elite group engaged in internal debates; their work was not widely dispersed, preached, or taught to the French public in the eighteenth century. The debates in France's leading salons were much more focused on politics and reforming royal institutions than on experimental science.

It is striking that even in the late eighteenth and early nineteenth centuries—after the errors of Descartes' mechanics were well known and the French scientist Antoine Lavoisier had led an experimental revolution in chemistry—the application of scientific discoveries to manufacturing and industrial processes in France still lagged well behind Britain. Many French scientists still treated mechanics mainly as a set of problems in abstract mathematics, rather than as the empirical study of the real world. What if there had been no British successes in engineering and manufacturing to spur the French and other Europeans to develop their own practical and scientific engineering? It is possible that the mathematicians of Europe would indeed have caught up to the accomplishments of earlier generations of Chinese, Indian, and Muslim mathematicians, but like them, their work might have had little or no impact on industrial production.

Conclusion: Trajectories of Science and the Puzzle of Industrialization

Many of the world's great civilizations had great accomplishments in science and technology. The Indians had advanced mathematics at an early date, and by the Middle Ages the Chinese and Muslims had mathematics and astronomy that were well in advance of Europe. Islamic chemistry and optics anticipated European findings by several centuries. At this time, all of these civilizations also had powerful technologies—from windmills, to cotton textile and ceramics production, to shipbuilding and navigation techniques—that Europeans lacked. Thus it is an enormous puzzle why none of these great civilizations made any progress toward steam-powered industry and transportation or any of the thousands of other technical innovations that accelerated the pace of economic change and thus created an Industrial Revolution in the West.

The answer lies in the fact that advanced mathematics alone or a handful of technical breakthroughs do not create an acceleration in the pace of economic advance. In most great civilizations, moreover, scientific advances often were halted or even lost altogether during periods of political crises, as societies usually turned to a revival of tradition or religious orthodoxy to help restore order.

In the West, in the century after 1500, a series of discoveries forced thinkers to seek an escape from ancient and religious traditions of knowledge and to focus instead on mathematical/logical and empirical approaches to understanding nature. However, unless those approaches were closely integrated with a program of experimental research, advanced mathematics and logic alone could still produce errors in thinking about nature and thus fail to provide the basis for a scientific or an industrial revolution. Experimental research had to become widely dispersed throughout society, and scientific engineering had to become a normal part of good business for industry to be transformed. It was in eighteenth-century Britain that these changes first came together to create wave after wave of scientifically inspired technical innovations and thus to create modern industrial growth.

Additional Reading

Henry, John. *The Scientific Revolution and the Origins of Modern Science.* New York: Palgrave, 2002.

Saliba, George. *Islamic Science and the Making of the European Renaissance.* Cambridge, MA: MIT Press, 2007.

CONCLUSION

The Rise of the West: A Temporary Phase?

From the Age of Steam to the Space Age: The Rise of a Modern Military-Industrial Society

The development of modern scientific engineering as a normal part of economic production has permanently transformed the way economic growth occurs. In the late eighteenth century, the pioneering economist Adam Smith observed that historically, economic growth occurs when countries make more efficient use of their traditional resources, including labor, by specializing in certain products and tasks. However, by the early 1800s it was clear that greater gains in economic growth could be achieved by using programs of experiment and discovery to develop new machines, new processes, and new products. Innovation had become the central driving force for modern economic growth.

Two other great economists—Karl Marx and Joseph Schumpeter—were more accurate in their observations about modern economic growth. Marx, writing in the 1840s, was perhaps the first economist to see that perpetual innovations could lead to unbounded economic growth that would transform the world. Previously, economists had focused on the problem of diminishing returns, arguing that once the most efficient use of existing resources had been achieved, growth would stop. This is what gave economics the nickname "the dismal science." Marx's great error was to assume that all the gains from modern economic growth would go to a tiny handful of industrialists, leaving craftspeople and other workers to suffer from increasingly greater inequality. In fact, the very process of invention and innovation prevents this. As long as workers, craftspeople, and entrepreneurs can gain an education and are free to start a business or sell their ideas, their innovations can challenge the dominance of large companies, and they can create their own wealth. Bill Gates did not become one of the world's richest men by controlling the large companies of the 1960s, but by innovating—and hiring engineers to continue innovating—and creating new products that completely overturned the dominant computer companies of the 1960s.

The story is similar across the industrial world. When people are free to start new companies based on new ideas, new people rise to the ranks of the wealthy. Thousands or millions of jobs are created in new industries. Howard Hughes in aviation, Thomas Edison in electricity, Alexander Graham Bell in telephones, Charles Goodyear in rubber, and recently Bill Gates, Michael Dell, and others in computing all created new industries out of product or process innovations. The countries with the greatest inequality and poverty tend to be those countries in which industry is small and innovation is absent—either due to lack of education to train engineers or lack of opportunities to start new businesses—so that power and wealth is controlled by those who own land or other natural resources, and others are shut out of any economic opportunities.

Schumpeter correctly argued that modern economic growth was due to the creative destruction of old and outdated enterprises by new ideas and industries. When cars replaced the horse and carriage, carriage makers were out of business; but those who educated themselves in automotive engineering were able to create a new and larger industry that employed many more people (and paid higher wages) than carriage-making.

Schumpeter's error was to assume that entrepreneurs (people who start new businesses or seize new opportunities) are scarce, but that the ideas for new products or processes are plentiful. In fact, entrepreneurs have been creating wealth in many traditional industries around the world for centuries. Entrepreneurs brought American tobacco and Chinese tea to Britain, Caribbean sugar to Europe, and Arabian horses to China. The great ages of Venice, Holland, and Manchu China were created by entrepreneurs who reshaped patterns of production and trade across continents.

Yet for entrepreneurs to truly innovate, they need the fruits of programs of experimental investigation and discovery and the scientific knowledge that allows engineers to create new sources of power, new materials, and new processes. This was far scarcer in history than the initiative of entrepreneurs! Indeed, the typical pattern throughout history is for societies to venerate and return to their traditional and religious sources of knowledge and authority. Where experimental research programs have developed, they were usually the preserve of small numbers of elites and not closely linked to practical work (Jabir's work in chemistry was one of the outstanding exceptions). For experiment and discovery to become the pursuit of a large number of individuals—across different occupations and social groups, all interested in linking scientific discovery to practical economic benefits—was truly exceptional. When this happened in eighteenth-century Britain, it set off a trajectory of scientific progress and economic growth that spread throughout the world and continues to this day.

For just over a century, from 1710 to 1850, Britain was the dominant site for engineering inventions and the application of those inventions to create new products and processes. Although by the late 1700s and early 1800s, Americans such as Eli Whitney (cotton gin) and Ben Franklin (stove, lightning rod, bifocal glasses), Frenchmen such as Berthollet (chlorine bleaching), and Italians such as Alessandro Volta (chemical batteries) also made important inventions, Britain had an overwhelming lead, especially in such areas as steam power, coal mining, textile machinery, and machine tools for working wood and metal.

The result was that Britain gained a dominant position in the world's production of energy, cotton cloth, steam power, steamships, railroads, metal goods, and machine tools. Even such humble items as the flush toilet, safety pin, and rubber band were invented in Britain during this period. British engineers also pioneered the improvement of everything from roads to raincoats.

One way to gain a sense of how important the rise of modern industry was to Britain's economy is to look at how the energy available to British industry grew compared with that of other countries, particularly China. From 1750 to 1900, the power used in British industry grew from about 75,000 horsepower (over 90 percent of that from water wheels) to almost 10 million horsepower (over 95 percent of that from steam engines). Because Britain's population only increased by about 5½ times during this period, this means the total industrial power *per person* available to Britain increased nearly 25 times.

The energy to fuel the steam engine came mostly from coal. England's total energy use from coal and wood fuels in 1700 has been estimated to be only one-twelfth the amount of energy from those fuels consumed in Qing China at that time. But by 1850, after an increase in coal output of almost twenty-fold, England's 18 million inhabitants were using about half as much fuel energy as the 400 million inhabitants in all of Qing China. In other words, average inhabitants of England had roughly ten times as much energy per year available to them as did the inhabitants of China. Nor was that the end. By 1900, perhaps the peak of England's global power, British coal was providing roughly one-quarter of the entire fuel energy output of the world for a population that constituted less than 3 percent of the world population.[1]

Not surprisingly, Britain's technological advantages, which were followed in the United States and other parts of Europe after 1800, were also put to another major use—superior military weapons. Steam-powered warships and riverboats tilted the balance in the long struggle of Western societies to win concessions from the major Asian states of China and Japan.

The British fleets sent to China in the Opium Wars had many conventional men-of-war, but it was the newly developed iron-hulled steamships that proved decisive. The British ship *Nemesis* was the first steam-driven paddlewheel iron ship sent into combat in China. With a draft of only 5 feet, this ship could operate in shallow coastal waters in virtually any wind or tidal conditions. "The Opium War of 1839-42 marked an important historical moment . . . of innovation in Western military technology and tactics: [t]he emergence of the steam-driven vessel as a considerable force in naval battles. . . . In the Shanghai campaign, the [*Nemesis*] towed the men-of-war with their heavy guns into firing range on the city and served as a transport that could unload the British directly onto the docks. Well before the war's end, new steamers of similar design were being sent to China's waters."[2] Unable to counter the maneuverability and versatility of the iron-hulled steamships, the Chinese were forced to capitulate, losing for the first time in war to Western powers.

A similar fate befell Japan, which was forced to open up its trade by an American naval force led by Commodore William Perry. Until Perry's expedition in 1853, the Japanese had repulsed all foreigners and banned European ships from their shores. But Perry's ships overcame Japanese resistance precisely because they did not sail into Tokyo (then Edo) harbor—they steamed in. Perry commanded a fleet led by three modern steam frigates, whose huge black smokestacks drove paddlewheels that allowed his fleet to defy winds and tides and bring their guns tightly to bear on Japanese defenses. The Japanese, quite literally, had never seen anything like it. It was their amazement at this new technology as much as the presentation of force itself that persuaded the Japanese to open their ports and sign a treaty. New technology was what changed the balance of East and West in the nineteenth century.

From 1850 to today, new inventions have continued to transform economic and military balances around the world. Work by the British scientists Humphrey Davy and Michael Faraday on electrolysis, and by Faraday, the Dane Hans Christian Oersted, and the Frenchman Andre Marie Ampere on electric currents and magnetism in the early 1800s, led to the development of electric motors and to the generation of electricity from waterfalls and steam turbines a few decades later. In the late 1800s, the Germans invested heavily in technical schools and research institutes.

As a result, they took over from Britain the lead in discoveries in chemistry, particularly the organic chemistry that was crucial for the development of chemical dyes, synthetic fertilizers, and new drugs. German engineers were also pioneers in the development of internal combustion engines. By the early 1900s, German chemical and mechanical engineers had founded such firms as Bayer, BASF, Bosch, and Daimler-Benz. Meanwhile, the Swedish chemist Alfred Nobel invented dynamite, the French developed the designs for water and steam turbines, and the Italians made important breakthroughs in electronics and radio. The Americans Wilbur and Orville Wright developed the first workable airplane. Sadly, the latter was soon teamed up with another nineteenth- and early twentieth-century invention—the machine gun.

The twentieth century saw even faster progress, as "R and D" (research and development) became a normal part of company operations, and more and more scientists and engineers were trained and employed in industry. Europeans and Americans designed and improved engines, agricultural machinery, and equipment for construction, earth-moving, and mining; they also built new sources of power such as the diesel and gasoline engines and, later, jet and rocket engines. Automobiles, planes, and trains became the normal modes of transportation; phones, computers, and television became the normal modes of communication and entertainment. Electric lighting and power lit up entire cities. Refrigeration and cheap transport made it possible for the fruits and meats of countries all around the world to be served on the tables of the United States and Europe, while the use of giant trawlers pulled fish out of the oceans faster than they could reproduce.

The scientific study of the forces that bind atoms led to nuclear power, but also to nuclear weapons, first used in World War II and now possessed by eight nations around the world. In the last dozen years, the Internet and inexpensive personal computers and cell phones have allowed people from around the world to communicate instantaneously and to create their own Web sites for endless purposes, ranging from on-line auctions and web-logs (blogs), to downloading music and videos, to recruiting engineers for new jobs and terrorists for new causes.

Where will all this lead?

The main message of this book has been that the rise of the West was *not in any way* based on a general European superiority over other regions or civilizations of the world. Europeans were not wealthier, more advanced technically or scientifically, or better at manufacturing and commerce than the major societies in Asia. Until 1500, Europe was somewhat lagging in wealth, technology, and science. Even as late as 1700, it was just catching up to the more advanced regions of Asia in agricultural productivity and still unable to manufacture cotton, silks, or porcelains as fine as those produced in India and China. In fact, most of Europe was suffering from declining living standards well into the 1800s. There is no indication, prior to 1700, that anything in Europe's religion, technology, trade, or even laws and government would give it a distinctive advantage for the future.

After all, Europe shared in the same mid-seventeenth–century crises, due to rising population and social and political conflicts, as did China and the Ottoman Empire. In the following century, almost all the major European powers except England followed the same trend as China, enforcing state orthodoxy in religion to restore order and strengthening the central ruler at the expense of local elites. Europe's trade expansion after 1500 was not a mark of superiority, but of Europe's joining an already-active network of oceanic trade centered in Asia. Indeed, for the next 300 years, the bulk of Europe's trade expansion was aimed at importing the superior manufactured products of Asia in return for bulk exports of silver shipped from the New World.

What created a different path for Europe was a combination of six unusual factors.

First, a cluster of remarkable new discoveries led Europeans to question and eventually reject the authority of their ancient and religious texts to a degree not found in any other major civilization. These discoveries ranged from the existence of a New World across the Atlantic to supernovae in the skies and moons around Jupiter. While other regions and civilizations also knew of these phenomena, they had not built their civilization on authoritative texts that ruled out such discoveries. Religion and the study of classical texts survived in Europe, but survived as guides to moral and spiritual behavior, not as authorities on the natural world.

Second, Europeans developed an approach to science that combined experimental research and mathematical analysis of the natural world. This combination was most clearly shown in the work of Galileo, Kepler, Huygens, and Newton, who departed from most earlier scientific traditions (including that of Aristotle) and instead built on the work of Islamic science. They went beyond their predecessors, however, by applying the experimental/mathematical approach to the study of motion and forces on moving objects, using telescopes to study the skies, and using barometers and vacuum pumps to study vacuums and gases. This is what led to Galileo's and Kepler's new principles of motion and astronomy, to Newton's laws of mechanics, to Torricelli's and Pascal's discovery of atmospheric pressure, and to Boyle's discovery of the "spring" or pressure of air under changing temperatures and compression.

The third key factor was the infusion of the British Lord Chancellor Francis Bacon's ideas regarding evidence, demonstration, and the purpose of scientific *investigation.* In most scientific traditions the purpose of science was to accumulate information about the real world, then make sense of it using logic and apply it to build on traditional religious and philosophical ideas. Such knowledge was then used mainly by elites to distinguish themselves by their access to privileged knowledge and not widely shared with ordinary craftsmen and manufacturers. Bacon's teachings—that scientists should collect facts and present evidence in public, like lawyers establishing facts before a jury, and build their explanations of nature from those facts, not from traditional philosophy—urged scientists to gather as many facts as possible and to let those facts and observations guide conclusions.

Bacon argued that observation and experimental research—not tradition or logic alone—were always the true tests of knowledge. Bacon's followers thus overturned the dominance of traditional authority and logical argument over observation that had generally prevailed in medieval thought. Bacon also insisted that experiment-driven scientific discovery would lead to people's material benefit and encouraged people to pursue the practical benefits from research whenever possible.

A fourth key factor was the development of an instrument-driven approach to experiment and observation. This approach clearly drew on the work of the Islamic chemist Jabir. But joined to a Baconian program of public demonstration and wide-ranging empirical investigation of nature, it became far more powerful. In this remarkable turnabout, evidence gained from observations with scientific instruments was elevated to being more trustworthy than evidence gained from the unaided senses, *or* from logical or mathematical reasoning alone.

Instrument-driven research was guided especially by Robert Boyle and Robert Hooke in England but also by Evangelista Torricelli in Italy, Anders Celsius in Sweden, Daniel Fahrenheit in Germany, and many others. As new instruments were developed—thermometers and barometers, micrometers, telescopes, microscopes, chronographs, sextants, calorimeters, vacuum pumps, electrostatic generators—the approach grew more powerful still.

Instrument-driven research allowed the proliferation of new discoveries precisely because it revealed things that thousands of years of observation of nature with the unaided senses had left unknown. Once you are convinced that the microscope, for example, is giving you a true and superior knowledge of the world, you can use it to study plants, animals (fleas, insects), snow crystals, skin, bacteria—almost anything! If you also believe that increasing your knowledge of the world with the microscope will lead to economic benefits, then it is worth investing in making more powerful and clearly focused microscopes, which in turn produce more discoveries. The success of instrument-driven research spurred the invention of new and more powerful instruments, which allowed new discoveries, which in turn often led to new instruments, and so on, in an expanding pattern of rapid discoveries.

A fifth key factor was a climate of tolerance and pluralism, rather than of conformity and state-imposed orthodoxy, and of Anglican Church support for the new science. Britain, like other past centers of innovation, became a mixing ground for different groups due to the tolerance that was enshrined in the Toleration Act of 1689. English Anglicans, Irish Protestants, Scottish Presbyterians, French Calvinists (who fled religious persecution in France), and a variety of other groups such as Quakers all played a major part in Britain's scientific and engineering advances of the eighteenth and nineteenth centuries.

In addition, somewhat remarkably, in eighteenth-century Britain the Anglican Church not only tolerated but actively supported and preached the new Newtonian and experimental science, promoting Newton's views as a way to balance religion and toleration. This fortuitous support was not automatic and did not always hold. In the late eighteenth century, mobs of "church and king" supporters destroyed the laboratory of the British chemist and radical theologian Joseph Priestly. However, for most of the eighteenth century, Britain enjoyed a religious climate in which the study of Newton's work was positively encouraged and the participation of people of many different faiths in intellectual and economic life was given official protection.

The sixth key factor was the easy support for entrepreneurship and the close social relations among entrepreneurs, scientists, engineers, and craftspeople. In most societies, the pursuit of science was the hobby of leisured gentlemen or court scientists. Engineers who used mathematical and scientific insights for construction were generally employed only by the state to work on fortifications and military engines or on roads and bridges. The idea that scientists should consort with craftspeople and businesspeople or that engineers should work for industrialists or on their own seeking profitable inventions were exceptions to most societies' notions of proper social behavior.

Yet in Britain, although social class still played a major role in social relations, the public demonstrations and the empirical focus of Bacon's approach encouraged an open mind about accomplishment. Indeed, the Royal Society bestowed memberships on anyone who contributed useful inventions or new scientific instruments, including entrepreneurs such as Matthew Boulton (Watt's partner in developing the Watt steam engine). Unlike the membership in the French Royal Academy of Sciences, many members of the Royal Society were not professional scientists.

The wide circulation of ideas and contacts among scientists and craftspeople, technicians, and engineers in Britain meant that abstract designs, discoveries, or basic principles, often developed by scientists, could be turned into practical machines or large-scale processes by people with mechanical skill and experience in constructing machines. In addition, widely shared interest in scientific progress and shared beliefs in the economic value of discovery among businesspeople meant that inventors and engineers could find support for their efforts. Thus James Watt originally gained support from the Scottish coal industrialist John Roebuck, but when Roebuck had financial reverses and could no longer support him, Watt obtained a partnership with the Birmingham buckle and button manufacturer Matthew Boulton. Coal mine operators financed numerous engineers who improved mining, pumping, and hauling of coal, and provincial manufacturers financed canals to bring their goods to market. Inventors like Watt who wanted patent protection or tariffs to protect their markets while they developed their inventions were able to get it from Parliament—although that too required some backing and connections, only possible because inventors, businesspeople, and scientists joined forces.

In the French Revolution of 1789, one of the rallying cries of the revolutionaries was that they wished to create a society of "careers open to talent," instead of one blocked by noble privileges. Britain had already created a society with careers open to talent in the early eighteenth century—particularly scientific and engineering talent, which became the basis for some substantial fortunes.

THE FOUNDATIONS OF MODERN ECONOMIC GROWTH

Given that so many different conditions had to come together, it should be no surprise that the Industrial Revolution started only in one time and place. Indeed, those conditions might not have come together even in Britain, had political events turned out differently. If Francis Bacon's career in law had not ended early in disgrace, thus giving him time to write on philosophy and science, or if William III had not prevailed over James II and established religious toleration in Britain, the full combination of causes might not have occurred. Thus the development of modern economic growth in Britain must be seen as a *contingent* process—something that was certainly not inevitable and might not have happened at all.

If the Cartesian rationalist approach had prevailed everywhere in Europe and Newton and experimental science not been given a privileged place in Britain, perhaps European science would have become the domain of mathematicians and logicians but remained distinct from practical work and business concerns. If there had been no supernovas in the skies over Europe in 1572 and 1604, clearly visible to everyone, would other discoveries of wonders in the heavens, seen only with a telescope, have been so convincing? Might classical knowledge have remained more secure? Finally, if the classical Greeks had not been so rigidly attached to their geometry and notions of the "perfect" heavens, might the West's classical tradition have been more flexible and thus not required an escape into new logical or empirical systems of knowledge to remedy its defects? In short, a large number of particular events had to come together in a particular order for a new approach to knowledge to arise, spread, and take hold by displacing older systems of ideas.

The development of modern scientific engineering and its application to industry was not only *contingent.* It was also *cumulative*—the outcome of a many steps taken over the centuries in a long and global development. We must constantly remind ourselves that the rise of the West, to the extent that it rests on scientific engineering and the acceleration of technological change, was *not* solely a European process, nor was it a process that occurred everywhere in Europe.

Almost all of what we regard as European science and mathematics of the sixteenth and seventeenth centuries was based on the Islamic development of mathematics, physics, chemistry, and medicine from AD 800 to 1400. The Islamic world then stretched from Spain and the rich African kingdoms of Mali and Morocco in the west, embracing centers of scholarship from Cordoba to Fez and Cairo, across Iraq and Persia to India. The caliph in Baghdad assembled the best scholars and the mathematical and scientific knowledge of the Greeks, Arabs, Persians, and Hindus for debate and discovery. The products of this cosmopolitan civilization, distilled in Arabic texts and later translated into Latin, were what provided the basis first for the Renaissance and then for the development of modern experimental and mathematical science in Europe. The roots of modern science were therefore essentially global, not European.

In addition, almost all of Europe's early technical achievements were inspired by a desire to catch up to superior Asian technology. Whether in the production of steel, cotton cloth, ceramics, ships, or even cast iron, in 1500 Europeans could only dream of producing goods that would approximate Asian quality. Efforts to realize those dreams eventually led to machines and inventions that allowed Europeans to catch and eventually surpass Asian achievements. Still, as late as 1750, it seemed unlikely that Europe would ever match Asian goods in quality and price. Asian inventions and techniques—from use of the compass in navigation, to paper-making, to casting metals—were directly incorporated into European technology and laid the basis for future technological change.

Finally, while almost all European countries by 1800 had begun to contribute important inventions, the development of a culture of innovation that accelerated technical change was not a Europe-wide phenomenon. By 1700, a number of European countries, especially in southern and eastern Europe, had begun a retreat into religion and authoritarian government that could have slowed or halted the surge of industrialization. The unusual characteristics of Britain's social, political, religious, and intellectual life—many of them emerging over many centuries from *Magna Carta* to the Toleration Act of 1689—created an alternative to the dominant tendencies on the continent and created the first society in which innovation and scientific engineering became widespread and firmly integrated into everyday production routines.

Only after the British had demonstrated the importance of pluralism, technical education, experimental science, and business innovations based on scientific engineering to economic advance did the rest of Europe set out to imitate it. Modern economic growth, based on an educated workforce, freedom of ideas, technological innovation, and the application of scientific engineering to industry, began to spread.

During the French Revolution, the revolutionaries sought to catch up with Britain by granting religious tolerance, creating careers open to talent, and modernizing science education. By the late 1800s, the Japanese were sending abroad for Europeans to reform their school system, and the Germans had made technical education the core of their program to strengthen their society.

Because the Industrial Revolution had broad, global roots and was brought about by a combination of specific factors—rather than resulting from general features of European history or European social or cultural characteristics—it should have been straightforward for other, non-European countries to generate modern economic growth if they could combine the same specific factors.

Why then has this been so difficult to do? Why, with only a few exceptions—Japan, South Korea, Chile, Singapore, Taiwan—have countries outside of Europe, North America, and Australia/New Zealand found it so hard to achieve European standards of living?

Obstacles to Modern Economic Growth

The primary reasons why modern economic growth has not spread to more nations are lack of scientific training, lack of entrepreneurial opportunity, or both.

First, a dependence on selling natural resources can trap countries into low levels of development. Many societies have been able to achieve brief bursts of economic growth and middling levels of wealth by selling natural resources to other, more industrialized countries. Argentina sold wool and beef; Cuba sold sugar; Zambia sold copper; Nigeria and Mexico sold oil; Brazil and Malaysia sold rubber. There are many other examples. As long as their commodities can be sold for a high price, all is well for those countries. But when the industrial world hits a slump and demand falls or if another producer enters the market or an artificial substitute is found, the commodity markets can crash. Countries that depend on selling commodities rather than on selling their own manufactured goods to world markets are like Europe trading its American silver in the 1500s: They may do well for a while trading on the bounty of nature, but that alone will never make them leaders in the world economy.

The reason is that commodities do not have a trajectory for further growth. Producing sugar or coffee or copper or diamonds does not require highly skilled labor or great advances in technology. Moreover, the real gains in value and income accrue not to those countries that produce these commodities, but to those processors who turn them into candy or fancy coffee drinks or copper wire or diamond jewelry. The greatest financial gains come in processing and creating valuable products, not in producing raw materials.

Yet in highly unequal societies with privileged elites who benefit from the sale of commodities, it is not easy to create change. Elites who need an unskilled labor force to provide cheap labor do not want to provide widespread technical education. Nor do they need industrialists to create new industries that might become sources of power or patronage that threaten the elites' political and economic control. It is thus the sad story that the very richest areas of Latin America in the eighteenth century—the sugar island of Haiti, the rubber and sugar plantations of northern and central Brazil, the tin mining regions of Bolivia—are among the poorest areas in the world today. High inequality and selfish elites who depend mainly on commodity production for wealth are one reason why regions fail to modernize or industrialize.

A second obstacle to modern economic growth is investment in the wrong kinds of education. Many countries that observed the success of the West did not appreciate how much that success depended on broad education, free thought, the technical training of craftspeople, and the production of scientifically skilled engineers. Instead, they thought that college education of any kind would do. They thus wasted millions of dollars training college graduates in the traditional skills of law, administration, social sciences, arts, humanities, medicine, accounting, even theology—without also nurturing the engineering and entrepreneurial talent that would create a modern economy capable of employing legions of humanists and professionals. The result has been massive unemployment of overeducated men and women, leading more to social unrest than economic progress.

Many developing countries also spent too much on university education—which trained an advantaged elite (and often created a surplus of overeducated but unemployed and restive youth)—and far too little on elementary, secondary, and technical education that would empower many more people to improve their lives. Narrow and misdirected educational spending has probably done as much damage to prospects for growth as lack of educational spending.

A third obstacle to modern economic growth is a lack of opportunities for people with training, ideas, and talent to create new industries. Socialist countries—whether communist (like Cuba) or non-communist (like India)—did develop modern education systems and trained thousands of outstanding scientists and talented engineers. However, they were assigned to work in state factories to meet production quotas, not given the opportunity to create new industries or profit from their ideas. Such competent scientists and engineers were often capable of meeting production targets and creating industrialization by importing and copying models developed elsewhere. But without giving their own engineers and industrialists the opportunity to start their own firms and industries based on creating new products and processes, socialist societies could only follow the global economic leaders, never join them.

A fourth path to poverty is creating closed economies. Many successful countries, including the United States, Britain, and Japan, have used market restrictions or tariffs to shelter specific industries or to help certain firms and industries to improve their competitiveness in the world economy. Yet the aim of such policies has always been to increase gains from trade and to compete more effectively, not to close off trade altogether. By contrast, a number of developing countries reacted to the gap between the West and the rest by seeking to close their countries to Western manufactured goods and instead to manufacture their own industrial products. Initially, this may have been a good idea. However, by keeping their economies closed, these countries also removed the opportunities and incentives for their own engineers to innovate and compete. Like socialist countries, they became stuck with outdated technologies for production. Only when their economies were thrown open to competition did they start to grow.

Finally, one more path to poverty, much rarer in the world today but fairly common in most of history, was for religious orthodoxy to stifle innovation or for religious education to dominate and displace scientific and technical education. Where new ideas are treated as sinful rather than as achievements to be admired, or where study of traditional beliefs is elevated far above the study of modern science in prestige and rewards, innovation can hardly become the basis for everyday economic life!

Even economists must bear some of the blame for harmful orthodoxies. For many years, European economists failed to understand their own history and did not appreciate the need for tolerant government, quality technical education, and innovative entrepreneurship to generate modern economic growth. Instead, they believed that the more efficient use of a country's resources, or the accumulation of capital, or the availability of credit, were sufficient for growth, and that investment and education would follow and produce technical improvement. These inaccurate views led to policies that encouraged the exploitation of a country's natural resources or promoted excessive capital spending and debt in developing countries but which did not produce growth. Countries that followed their own path, such as Japan and South Korea, often did better than countries that were persuaded to follow the economic advice of international development organizations.

Today, economists increasingly agree that any country with a tolerant and effective government, solid technical education, and an economy that is open and supportive of entrepreneurship and trade can build a modern economy and catch up with the West.

The Coming Rise of the Rest

Although these obstacles have caused much poverty in the world, there is hope that they will not persist. More and more countries around the world, from China and India to Poland and Botswana, have come to appreciate that the path to modern economic growth simply requires making a modern technical education widely available and making it easy for entrepreneurs and engineers to combine their talents to start new businesses. Initially, these new businesses may gain from taking advantage of domestic supplies of natural resources or low-cost skilled labor. However, to drive modern growth they must allow workers and firms to climb up the ladder of using increasingly skilled labor and become increasingly competitive in international markets. Eventually, to draw even with the leaders of the industrial world, they must develop new products and processes in which they are the innovation leaders.

As this happens, the rest will rise, and the West—in its share of world income and output—will inevitably decline. It is already happening. In 1980, the United States' gross domestic production (GDP) was more than *5 times* the combined gross domestic production of China and India. In 2000, U.S. total GDP was only twice that of India and China.[3] This was not because U.S. consumption had fallen. It did not; in fact it nearly doubled. Rather, production in India and China grew much faster, tripling in India and growing six-fold in China, thus reducing the global share of the United States. By 2030, if current growth rates in these countries are sustained, the United States' GDP will be only one-half the combined total of China and India, creating new economic balances in the world.[4]

The growth of major economies outside of the United States and Europe will cause some adjustments and no doubt will spur anxieties and rivalries, especially among those who still see economic growth as a matter of different societies competing for a fixed "pot of growth" that only a few can share. This delusion needs to be set aside. If growth comes from innovation and better engineering, then gains can spread to all. The invention of gas lighting in Britain, of chemical fertilizers in Germany, of the telephone in the United States, and of the transistor radio in Japan did not impoverish other countries; on the contrary, they eventually made everyone in the world better off by making new products available. It is only countries that stop innovating (or that have never begun) that risk becoming impoverished.

In the coming decades, the rise of the rest should accelerate as other nations learn to remove their obstacles to growth and join the ranks of countries enjoying rapid growth based on the diffusion of technical knowledge and the freedom to innovate. As modern economic growth spreads, the rise of the West—an event that lasted only a brief two centuries, from 1800 to 2000—will be seen to have been a temporary, but transformative, stage in world history.

NOTES

INTRODUCTION

1. These data are for 2004. Electricity generation data are from the United States Energy Information Administration Web site, Table 6.3 (Time Series) World Total Net Electricity Generation, July 7, 2006, http://www.eia.doe.gov/iea/elec.html. Population totals are from the United Nations Population Fund, *State of World Population 2004* (New York: United Nations, 2004), 106–109.

CHAPTER ONE

1. During the medieval warm period 500 years earlier, Viking sailors had traveled across the northern Atlantic, established colonies in Greenland, and visited the coast of Canada. Yet these settlements remained small, and when global temperatures dropped in the fourteenth century the colonies failed. By 1500, the Vikings had abandoned Greenland, travel to North America had ceased, and tales of contact with lands to the west passed into legend.

CHAPTER TWO

1. The history of world population is a fascinating topic, although it often is wracked by long debates based on slim evidence. The figures given here for England come from Michael E. Jones, *The End of Roman Britain* (Ithaca, NY: Cornell University Press, 1996); John Hatcher, *Plague, Population, and the English Economy 1348–1530* (London: Macmillan, 1977); and E. A. Wrigley and Roger Schofield, *The Population History of England, 1541–1871: A Reconstruction* (Cambridge: Cambridge University Press, 1989).
2. Karl Marx and Friedrich Engels, *The Communist Manifesto* (originally published 1848), ed. David McLellan (Oxford, UK: Oxford University Press, 1998).
3. David Levine, *At the Dawn of Modernity: Biology, Culture, and Material Life in Europe after the Year 1000* (Berkeley: University of California Press, 2001); Alfred Crosby, *The Measure of Reality: Quantification in Western Europe 1250–1600* (Cambridge: Cambridge University Press, 1997); Jan de Vries and Ad van der Woude, *The First Modern Economy: Success, Failure, and Perseverance of the Dutch Economy 1500–1815* (Cambridge: Cambridge University Press, 1997).
4. John Hajnal, "Two Kinds of Pre-industrial Household Formation Systems," *Population and Development Review* 8 (1992): 449–494; Wrigley and Schofield, *Population History of England.*
5. James Lee and Wang Feng, *One Quarter of Humanity: Malthusian Mythology and Chinese Realities* (Cambridge, MA: Harvard University Press, 1999).
6. David Hackett Fischer, *The Great Wave: Price Revolutions and the Rhythm of History* (New York: Oxford University Press, 1996).
7. Wrigley and Schofield, *Population History of England,* 528.

8. Chris Galley, *The Demography of Early Modern Towns* (Liverpool: Liverpool University Press, 1998), 5.
9. Robert Allen, "Agricultural Productivity and Rural Incomes in England and the Yangtze Delta, c. 1620–c. 1820," *Economic History Review* (forthcoming, 2008); Jack A. Goldstone, "Feeding the People, Starving the State: China's Agricultural Revolution of the 17th/18th Centuries," (paper presented to the Global Economic History Network, Irvine, California, 2003); Kenneth Pomeranz, *The Great Divergence* (Princeton, NJ: Princeton University Press, 2000).
10. For more about Zheng He, see Louise Levathes, *When China Ruled the Seas* (New York Oxford University Press, 1994).
11. It is confusing, but necessary, to speak of both "England" and "Britain." When describing events or trends that occurred mainly in England (and the smaller territory of Wales), I refer to "English" conditions (see Figure 1.1). However, when describing events or trends that involved not only England and Wales, but also Scotland and Ireland—such as the civil wars of the seventeenth century, the growth of the overseas empire, or the spread of industrialization—I refer to "British" events. In 1707 Scotland joined with England and Wales to form the Kingdom of Great Britain, so we shall usually say "Britain" or "British" to refer to events and trends in the eighteenth century and later.
12. Mark Overton, *Agricultural Revolution in England: The Transformation of the Agrarian Economy 1500–1850* (Cambridge: Cambridge University Press, 1996), 82.
13. Mark Elvin, *The Pattern of the Chinese Past* (Stanford, CA: Stanford University Press, 1973).

CHAPTER THREE

1. S. N. Eisenstadt, *The Origins and Diversity of Axial Age Civilizations* (Albany, NY: SUNY Press, 1986).
2. In Chinese the name is Kong Fu Zi, meaning "Master Kong." The name Confucius was a Latin version coined by the Jesuit missionary Matteo Ricci in the seventeenth century, when he wrote to Europeans about Chinese beliefs.
3. Weber did many comparative studies of world religions, but his most famous is *The Protestant Ethic and Spirit of Capitalism*, first published in 1904.
4. Randall Collins, "An Asian Route to Capitalism: Religious Economy and the Origins of Self-Transforming Growth in Japan," *American Sociological Review* 62, no. 6 (1997): 843–865.

CHAPTER FOUR

1. This is from *Book of Useful Information on the Principles and Rules of Navigation*, written in 1490: http://www.saudiaramcoworld.com/issue/200504/the.navigator.ahmad.ibn.majid.htm (accessed March 8, 2008).
2. John M. Hobson, *The Eastern Origins of Western Civilization* (Cambridge: Cambridge University Press, 2004), 149; Sushil Chaudhury, "The Inflow of Silver to Bengal in Global Perspective, c. 1650–1757," in *Global Connections and Monetary History, 1470–1800*, ed. Dennis O. Flynn, Arturo Giraldez, and Richard von Glahn (Aldershot, UK: Ashgate Publishing, 2003), 167.

CHAPTER FIVE

1. Massimo Livi-Bacci, *A Concise History of World Population* (Oxford, UK: Blackwell, 1992), 31.
2. For England (including Wales): E. A. Wrigley and Roger Schofield, *Population History of England, 1541–1871: A Reconstruction* (Cambridge: Cambridge University Press, 1989),

529. For Russia: Livi-Bacci, ibid. For China: James Lee and Wang Feng, *One Quarter of Humanity: Malthusian Mythology and Chinese Realities* (Cambridge, MA: Harvard University Press, 1999), 28.

3. Nikola Koepke and Joerg Baten, "The Biological Standard of Living in Europe during the Last Two Millennia," *European Review of Economic History* 9 (2005): 61–95.
4. Gregory Clark, "Farm Wages and Living Standards in the Industrial Revolution: England, 1670–1869," *The Economic History Review* 54 (2001): 496.

CHAPTER SIX

1. Peter Lorge, *War Politics and Society in Early Modern China, 900–1795* (London: Routledge, 2005), p. 103. In comparison, the Spanish Armada sent to attack England in 1588, which was the largest fleet seen in Europe to that date, comprised 150 ships and 30,000 men. This would have been just a small skirmishing party on the scale of Asian warfare.

CHAPTER SEVEN

1. Nathan Rosenberg, *Inside the Black Box: Technology and Economics* (Cambridge, UK: Cambridge University Press, 1982), 59–60.
2. Abbott Payson Usher, "The Industrialization of Modern Britain," *Technology and Culture* 1 (1960): 110.
3. William N. Parker, *Europe, America, and the Wider World, Essays on the Economic History of Western Capitalism* (Cambridge, UK: Cambridge University Press, 1984), 33.
4. Ian Inkster, "Technology as the Cause of the Industrial Revolution, Some Comments," *Journal of European Economic History* 12 (1983): 656.
5. E. A. Wrigley, *Continuity, Chance, and Change* (Cambridge, UK: Cambridge University Press, 1988).
6. Joel Mokyr, *The Gifts of Athena: Historical Origins of the Knowledge Economy* (Princeton, NJ: Princeton University Press, 2002), 29.

CHAPTER EIGHT

1. John J. O'Conner and Edmund F. Robertson, "Arab Mathematics: Forgotten Brilliance?" *The MacTutor History of Mathematics Archive* (School of Mathematics and Statistics, University of St. Andrews, Scotland: 1999), http://www-history.mcs.st-andrews.ac.uk/HistTopics/Arabic_mathematics.html (accessed April 3, 2008).
2. Ibid.
3. Figure 6.1 also shows a Muslim region (19) labeled "Khazaks, Uzbeks." This was not an empire, or even a single state, but a region populated by tribal groups under diverse and shifting leadership. By 1700, this area was coming under the control of Russia from the north and the Safavids from the south.
4. One group of Greek scholars—the Alexandrians, of whom the most famous was Archimedes—did apply mathematics to study such things as the working of simple machines (levers and pulleys) and the properties of curved mirrors and bodies submerged in fluids. However, they could not easily study motion: Greek efforts to apply mathematics to motion led to paradoxes, such as Zeno's paradox that an arrow could never reach its target because it would first have to cover half the distance, then half the remaining distance, then half of that remaining distance, and so on ad infinitum. These problems could not be resolved until the invention of calculus many centuries later. More importantly, even the Alexandrians' mathematical studies did not lead most of them or their followers to turn away from Aristotle's philosophy, which remained the most widely followed guide to the basic physical principles of the

universe. Even the great astronomer Ptolemy, who wrote several books on the solar system, continued to promote Aristotle's vision of concentric spheres of heavenly material, called aether, that moved in endless uniform circles. When Ptolemy's own mathematics required him to posit relationships that violated Aristotle's physics, he accepted the physics and treated his own mathematics simply as a system of accounting for the motions of heavenly bodies by means of various combinations of circular motions. Later Arab astronomers noted the impossibility of Aristotle's physics being compatible with Ptolemy's mathematics description of planetary movements—but they responded by working to correct and replace Ptolemy's mathematics, not by correcting or replacing Aristotle's physics!

CONCLUSION

1. Vaclav Smil, *Energy in World History* (Boulder, CO: Westview, 1994), 186–187.
2. Jonathan Spence, *The Search for Modern China* (New York: W.W. Norton, 1990), 158.
3. World Bank Development Indicators on-line, http://mutex.gmu.edu:3965/ext/DDPQQ/member.do?method=getMembers&userid=1&queryId=6 (consulted April 4, 2008). This is GDP adjusted for purchasing power parity (PPP), at constant 2005 prices.
4. This projection starts from the 2005 PPP-adjusted GDP figures presented in the *World Bank International Comparison Program, Tables of Final Results* (Washington, DC: International Bank for Reconstruction and Development, 2008) and projects to 2030 using 3 percent annual growth for the United States and 8 percent annual growth for India and China.

INDEX

"One of the biggest, most difficult, and practically important questions of world history is often summed up in the words 'Why Europe?' That is, among Eurasia's interconnected centers of power—China, India, the Near East, and Europe—why was it Europe that eventually came to outstrip, dominate, or conquer those other centers and the rest of the world?

Historians' explanations often invoke postulated European advantages in religion, government, trade, exploiting slaves, or looting the New World, and in general making steady progress for many centuries. In this clearly written and wide-ranging textbook, the distinguished historian Jack Goldstone synthesizes many bodies of recent research bearing on this question. He finds that Europe's rise was not the culmination of long progressive trends, but rather a recent phenomenon barely two centuries old. Until relatively recently, China and the Near East were in fact technologically more advanced and better fed than Europe. Instead, Goldstone argues, 'What created a different path for Europe was the combination of six unusual factors. . . . ' Rather than give away the solution to this historical murder mystery, I encourage readers to enjoy Goldstone's own persuasive account."

—JARED DIAMOND, Professor of Geography, UCLA, and author of the Pulitzer-prize-winning *Guns, Germs, and Steel*

"This is a wonderful book, just what the world history teaching field needs."

—ROSS DUNN, San Diego State University

The McGraw·Hill Companies

McGraw Hill Higher Education

ISBN 978-0-07-284801-4
MHID 0-07-284801-4

EAN 9 780072 848014 90000

www.mhhe.com