Unified Growth Theory

Oded Galor

Published by Princeton University Press, 41 William Street, Princeton,
New Jersey 08540

In the United Kingdom: Princeton University Press, 6 Oxford Street, Woodstock,
Oxfordshire OX20 1TW

press.princeton.edu

Jacket illustration: *Time Goes By,* 2007, GIMP-created image, © Manuel Lao

Library of Congress Cataloging-in-Publication Data

Galor, Oded, date.
Unified growth theory / Oded Galor.
p. cm.
Includes bibliographical references and index.
ISBN 978-0-691-13002-6 (hardback : alk. paper)
1. Economic development. 2. Technological innovations—Economic aspects.
I. Title.
HD75.G348 2011
338.9001—dc22 2010043076

British Library Cataloging-in-Publication Data is available

This book was composed in Times New Roman and Bell Gothic using ZzTEX
by Princeton Editorial Associates, Inc., Scottsdale, Arizona.
Printed on acid-free paper.

Printed in the United States of America
10 9 8 7 6 5 4 3 2 1

CHAPTER 1

Introduction

A complete, consistent, unified theory . . . would be the ultimate triumph of human reason.

—Stephen W. Hawking

The transition from an epoch of stagnation to an era of sustained economic growth has marked the onset of one of the most remarkable transformations in the course of human history. While living standards in the world economy stagnated during the millennia preceding the Industrial Revolution, income per capita has undergone an unprecedented tenfold increase over the past two centuries, profoundly altering the level and distribution of education, health, and wealth across the globe.

The rise in the standard of living has not been universally shared among societies. Variation in the timing of the take-off from stagnation to growth has led to a vast worldwide divergence in income per capita. Inequality, which had been modest until the nineteenth century, has widened considerably, and the ratio of income per capita between the richest and the poorest regions of the world has been magnified from a moderate 3:1 ratio in 1820 to a staggering 18:1 ratio in 2000 (Figure 1.1).

An equally striking development has emerged in the world distribution of population. The decline in population growth in Europe and North America toward the end of the nineteenth century and the long delay in the onset of a corresponding demographic transition in less developed regions, well into the second half of the twentieth century, have generated significant bifurcation in the global distribution of population. The share of world population that resides in the prosperous region of Europe has declined by nearly one-half over the past century, whereas the fraction of the human population that lives in the impoverished regions of Africa and Latin America has doubled.

Throughout most of human existence, the process of development was marked by Malthusian stagnation: resources generated by technological progress and land expansion were channeled primarily toward an increase in the size of the population, providing only a glacial contribution to the level of income per capita in the long run. While cross-country variations in technology and land productivity were reflected in differing population densities, their effect on variation in living standards was merely transitory.

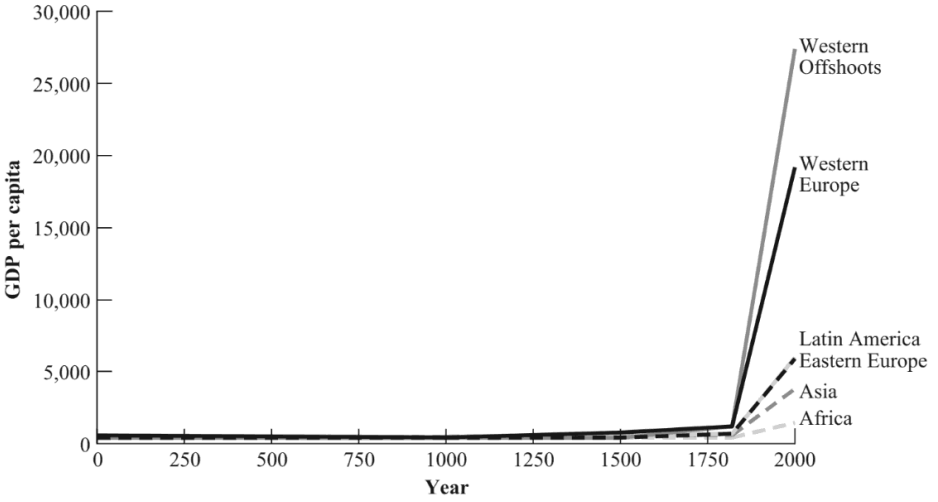

FIGURE 1.1. Evolution of regional income per capita over the past two thousand years.
Data source: Maddison (2001).
Note: The Western Offshoots are Australia, Canada, New Zealand, and the United States.

In contrast, over the past two centuries, various regions of the world have departed from the Malthusian trap and have witnessed a considerable increase in growth rates of income per capita. The decline in population growth over the course of the demographic transition has liberated productivity gains from the counterbalancing effect of population growth and enabled technological progress and human capital formation to pave the way for the emergence of an era of sustained economic growth.

The transition from an epoch of Malthusian stagnation to an era of sustained economic growth and the corresponding divergence in income per capita across the globe have been the center of intensive research during the past decade. The inconsistency of the predominant theories of economic growth with some of the most fundamental characteristics of the growth process and their limited ability to shed light on the origins of the vast global disparity in living standards have led to the development of a unified theory of economic growth that captures the growth process in its entirety.

Unified Growth Theory explores the fundamental factors that have contributed to the remarkable transition from stagnation to growth and examines their significance for the understanding of the contemporary growth process of developed and less developed economies. First, it unveils the factors that have generated the Malthusian trap. What accounts for the epoch of stagnation that

has characterized most of human history? Why did episodes of technological progress in the pre-industrial era fail to generate sustained economic growth? Why has population growth counterbalanced the expansion of resources per capita that could have been generated by technological progress?

Moreover, the theory uncovers the forces that triggered the take-off from stagnation to growth. What is the origin of the sudden spurt in the growth rates of income per capita and population during the course of industrialization? What was the source of the striking reversal in the positive relationship between income per capita and population growth that existed throughout most of human history? Would the transition to the modern state of sustained economic growth have been feasible without the decline in population growth? What are the hurdles faced by less developed economies in their attempts to transition to a sustained-growth regime?

Further, Unified Growth Theory sheds new light on the origins of the perplexing divergence in income per capita across developed and less developed regions in the past two centuries. What accounts for the sudden take-off from stagnation to growth among some countries in the world and the persistent stagnation in others? Why has the positive link between income per capita and population growth reversed its course in some economies but not in others? Has the transition to a state of sustained economic growth in advanced economies adversely affected the process of development in less developed ones? Have variations in prehistoric biogeographical factors had a persistent effect on the composition of human capital and economic development across the world?

1.1 Toward a Unified Theory of Economic Growth

Non-unified theories of economic growth have been instrumental in advancing the understanding of the role that technological progress and the accumulation of factors of production have played in the modern era of economic growth. Nevertheless, they are inconsistent with the qualitative aspects of the growth process over most of human existence, and they fail to identify the forces that triggered the take-off from stagnation to sustained economic growth—insights that are instrumental for understanding the contemporary growth process and the origins of the great divergence in income per capita over the past two centuries.

The preoccupation of non-unified theories of economic growth with the growth process of developed economies in the past century and of less developed economies in the past few decades has become harder to justify in light of the disparity between the main features of the modern growth era and those that have characterized the growth process over most of human existence. It has

become evident that as long as growth theory rests on distinct and disjoint theories to characterize the process of development during the Malthusian Epoch and the Modern Growth Regime, the understanding of the contemporary growth process will be limited and distorted.[1] "It is as though an artist were to gather the hands, feet, head and other members for his images from diverse models, each part perfectly drawn, but not related to a single body, and since they in no way match each other, the result would be monster rather than man" (Copernicus quoted in Kuhn [1957, p. 137]).

The advancement of Unified Growth Theory has been fueled by the conviction that the understanding of global variation in economic development would be fragile and incomplete unless the prevailing theory of economic growth reflects the principal driving forces behind the entire process of development and captures the central role that historical factors have played in bringing about the current disparities in living standards.[2] Moreover, it has been fostered by the realization that a comprehensive understanding of the hurdles faced by less developed economies would remain obscure unless the factors that facilitated the transition of the currently developed economies from stagnation to growth could be identified and modified to account for the differences in the growth structure of less developed economies in an increasingly interdependent world.

Unified Growth Theory provides a fundamental framework of analysis for the evolution of individuals, societies, and economies over the entire course of human history. The theory captures in a single analytical framework the main characteristics of the process of development: (i) the epoch of Malthusian stagnation that has characterized most of human history; (ii) the escape from the Malthusian trap and the associated spike in the growth rates of income per capita and population; (iii) the emergence of human capital formation in the process of development; (iv) the onset of the demographic transition; (v) the

[1] The evolution of theories in older scientific disciplines suggests that theories founded on the basis of a subset of the existing observations may be attractive in the short run but are nonrobust and nondurable in the long run. For instance, classical thermodynamics, which lacked microfoundations, was ultimately superseded by the micro-based statistical mechanics. Moreover, attempts to develop unified theories in physics have been based on the conviction that all physical phenomena should eventually be explainable by some underlying unity. In particular, Unified Field Theory proposes to unify by a set of general laws the four distinct forces that are known to control all observed interactions in matter: electromagnetism, gravitation, the weak force, and the strong force.

[2] Clearly, the understanding of the contemporary world would be limited and incomplete in the absence of a historical perspective. However, the intensity of recent explorations of the interaction between economic development and economic history could be attributed to increasing frustration with the failure of the ahistorical branch of growth theory to capture some of the most fundamental aspects of the growth process.

contemporary era of sustained economic growth; and (vi) the divergence in income per capita across countries.[3]

The theory unveils the principal economic forces that have generated the remarkable transition from stagnation to growth and underlines their significance for understanding the contemporary growth process of both developed and less developed economies. Moreover, it sheds light on the role of historical and prehistorical characteristics in the divergence of income per capita across regions of the world in the past two centuries.

Unified Growth Theory suggests that the transition from stagnation to growth has been an inevitable by-product of the process of development. It argues that the inherent Malthusian interaction between the rate of technological progress and the size and composition of the population accelerated the pace of technological progress and ultimately raised the importance of education in coping with the rapidly changing technological environment.[4] The rise in industrial demand for education brought about significant reductions in fertility rates. It enabled economies to divert a larger share of the fruits of factor accumulation and technological progress to the enhancement of human capital formation and income per capita, paving the way for the emergence of sustained economic growth.

The theory further explores the dynamic interaction between human evolution and the process of economic development and advances the hypothesis that the forces of natural selection played a significant role in the evolution of the world economy from stagnation to growth. The Malthusian pressures have acted as the key determinant of population size and conceivably, via natural selection, have shaped the composition of the population as well. Lineages of individuals whose traits were complementary to the economic environment generated higher levels of income, and thus a larger number of surviving offspring, and the gradual increase in the representation of their traits in the population contributed to the process of development and the take-off from stagnation to growth.

[3] The term "Unified Growth Theory" was coined by Galor (2005) to categorize theories of economic growth that capture the entire growth process in a single framework of analysis. The only unified theory of economic growth that captures the endogenous evolution of population, technology, human capital, and income per capita over the entire course of economic development, while generating both a spontaneous transition from Malthusian stagnation to sustained growth and a great divergence has been developed by Galor (2005, 2010), based on Galor and Weil (1999, 2000), Galor and Moav (2002), and Galor and Mountford (2008). This theory therefore is the central pillar of this book.

[4] The increased demand for human capital has not necessarily resulted in an increase in the rate of return on human capital due to institutional changes (e.g., the provision of public education) that lowered the cost of investment in human capital and facilitated a massive increase in the supply of education.

1.2 Origins of Global Disparity in Living Standards

Unified Growth Theory sheds light on the notable divergence in income per capita across the globe during the past two centuries. The theory advances the understanding of three fundamental aspects of comparative economic development. First, it identifies the factors that have governed the transition from stagnation to growth and have thus contributed to the observed worldwide differences in economic development. Second, it highlights the persistent effects that variations in historical and prehistorical conditions have had on the composition of human capital and economic development across countries. Finally, it uncovers the forces that have sparked the emergence of convergence clubs, and it explores the characteristics that have determined the association of different economies with each club.

1.2.1 Catalysts for the Engine of Transition from Stagnation to Growth

The first layer of Unified Growth Theory explores the underlying forces that have determined the timing and pace of the transition from an epoch of Malthusian stagnation to an era of sustained economic growth and have thus contributed to the disparity in economic development across countries. Country-specific characteristics that have affected the intensity of the pivotal interaction between the rate of technological progress and the size and composition of the population have generated variations in the transition from stagnation to growth and contributed to the gap in income per capita across countries.

Variation in rates of technological progress has reinforced the differential pace of the emergence of demand for human capital, the onset of the demographic transition, and the shift from stagnation to growth, and has thus contributed to the divergence in income per capita in the past two centuries. In particular, worldwide variation in the pace of technological progress has been triggered by cross-country differences in (i) the stock of knowledge and its rate of creation and diffusion among members of society; (ii) the level of protection of intellectual property rights, its positive effect on the incentive to innovate, and its adverse effect on the proliferation of existing knowledge; (iii) financial constraints and the level of competitiveness of the innovation sector; (iv) the composition of cultural and religious attributes and their effects on knowledge creation and diffusion; (v) the composition of interest groups in society and their incentives to block or promote technological innovations; (vi) the level of human diversity and the degree to which it complements the implementation and advancement of new technological paradigms; (vii) the propensity to trade and its effect on technological diffusion; and (viii) the abundance of natural resources essential for an imminent technological paradigm.

CHAPTER 2

From Stagnation to Growth

Every phase of evolution commences by being in a state of unstable force and proceeds through organization to equilibrium.

—Kabbalah

This chapter provides an overview of the three fundamental regimes that have characterized the process of development over the course of human history: the Malthusian Epoch, the Post-Malthusian Regime, and the Modern Growth Regime.

Since the exodus of *Homo sapiens* from Africa approximately 100,000 years ago, human civilization has gradually evolved from nomadic tribes to complex industrial societies. During most of their existence, modern humans were associated with nomadic tribes that were engaged in hunting and gathering. The onset of the Neolithic Revolution about 10,000 years ago triggered the transition of societies to agricultural communities and the subsequent emergence of cities, states, and nations. Lastly, the Industrial Revolution 250 years ago marked the dawn of the recent industrial phase of modern societies (Figure 2.1).

The process of development during most of human existence was marked by Malthusian stagnation. Technological progress was insignificant by modern standards, and resources generated by technological progress and land expansion were channeled primarily into an increase in population. Variations in technology and land quality across countries were reflected in differences in population density, while the standard of living did not echo the degree of technological advancement.

In the past two centuries, in contrast, the pace of technological progress intensified in association with the process of industrialization. Various regions of the world departed from the Malthusian trap and experienced a considerable rise in the growth rate of income per capita and population. Unlike episodes of technological progress in the pre-Industrial Revolution era that failed to generate sustained economic growth, the increasing role of human capital in the production process during the second phase of industrialization, and the onset of a demographic transition, liberated gains in productivity from the counterbalancing effects of population growth. The decline in the growth rate of population and the associated enhancement of technological progress and

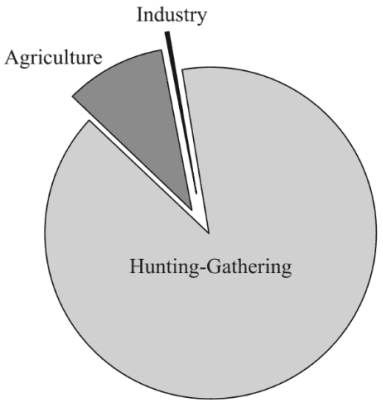

FIGURE 2.1. Modes of production since the exodus of *Homo sapiens* from Africa.

human capital formation paved the way for the emergence of the modern state of sustained economic growth.

The differential timing of the take-off from stagnation to growth across countries and the corresponding variation in the timing of the demographic transition have led to a significant divergence in income and to substantial changes in the distribution of population around the globe. Some regions have excelled in the growth of income per capita, while others have dominated population growth.

2.1 The Malthusian Epoch

During the Malthusian Epoch, humans were subjected to a persistent struggle for existence. Periods marked by an absence of changes in the level of technology or in the availability of land were characterized by a stable population size as well as a constant level of income per capita, whereas those characterized by improvements in the technological environment or in the availability of land generated temporary gains in income per capita, leading ultimately to larger but not richer populations. Technologically superior countries eventually developed denser populations, but their standards of living did not reflect the degree of their technological advancements.[1]

[1] Thus, as reflected in the viewpoint of a prominent observer of the period, "The most decisive mark of the prosperity of any country [was] the increase in the number of its inhabitants" (Smith, 1776, p. 128).

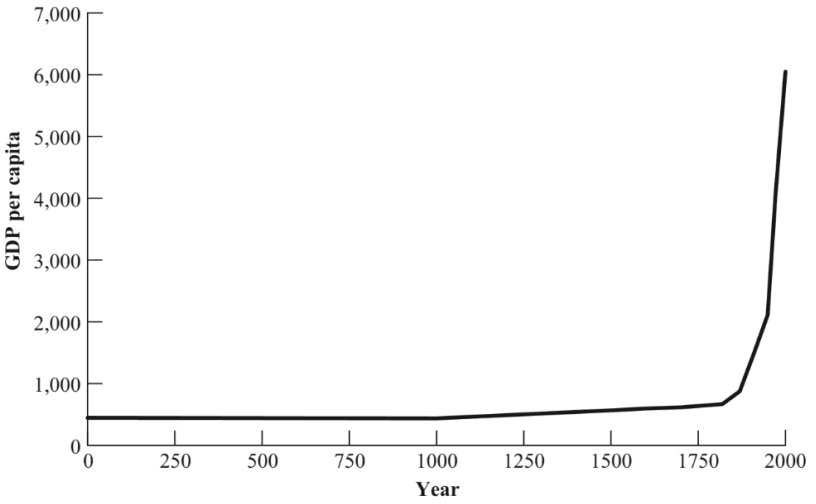

FIGURE 2.2. Evolution of world income per capita, 1–2001.
Data source: Maddison (2003).

2.1.1 Stagnation of Income per Capita in the Long Run

The average long-run growth rate of output per capita was negligible during the Malthusian Epoch, and standards of living did not differ greatly across countries. As depicted in Figure 2.2, the average level of income per capita during the first millennium fluctuated around $450 per year, and the average growth rate of output per capita in the world was nearly 0%. Similarly, in the years 1000–1820, the average level of income per capita in the world economy was below $670 per year, and the average growth rate of world income per capita was minuscule, creeping up at a rate of about 0.05% per year (Maddison, 2001).

This pattern of stagnation was observed across all regions of the world. As depicted in Figure 1.1, the average level of income per capita in Western and Eastern Europe, the Western Offshoots, Asia, Africa, and Latin America was in the range of $400–450 per year in the first millennium, and the average growth rate in each of these regions was nearly zero. This state of stagnation persisted until the end of the eighteenth century across most regions. In particular, the level of income per capita in 1820 ranged from about $420 per year in Africa, $580 in Asia, $690 in Latin America, and $680 in Eastern Europe, to $1,200 in the Western Offshoots and Western Europe. Furthermore, the average annual growth rate of output per capita over this period ranged from 0% in the impoverished region of Africa to 0.14% in the most prosperous region of Western Europe.

FIGURE 2.3. Fluctuations in gross domestic product (GDP) per capita: England, 1260–1760.
Data source: Clark (2005).

Nevertheless, wages and income per capita fluctuated significantly within regions, deviating from their sluggish long-run trend over decades and sometimes over several centuries. For example, as depicted in Figure 2.3, income per capita in England fluctuated considerably over most of the past millennium. In particular, it declined during the thirteenth century and increased sharply during the fourteenth and fifteenth centuries in response to the catastrophic population decline in the aftermath of the Black Death. This two-century rise in income per capita was followed by population growth, which brought about a decline in income per capita in the sixteenth century back to its fourteenth century level. Finally, income per capita increased once again in the seventeenth century and remained stable during most of the eighteenth century.

2.1.2 Population Dynamism

> *Population, when unchecked, increases in geometrical progression of such a nature as to double itself every twenty-five years.*
>
> —Thomas Malthus

Population growth during this time followed the Malthusian pattern as well. As depicted in Figure 2.4, the slow pace of resource expansion during the first

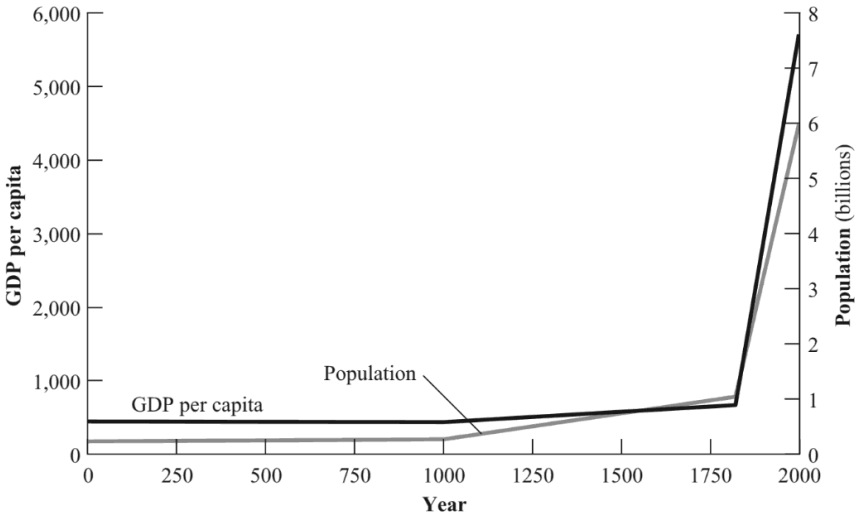

FIGURE 2.4. Evolution of world population and income per capita, 1–2000.
Data source: Maddison (2003).

millennium was reflected in a modest increase in the population of the world from 231 million people in 1 CE to 268 million in 1000 CE, a minuscule average growth rate of 0.02% per year.[2] The more rapid—but still sluggish—expansion of resources during 1000–1500 permitted world population to increase from 268 million in 1000 CE to 438 million in 1500, a slow 0.1% average growth rate per year. Resource expansion during 1500–1820 had a more significant impact on world population, which increased from 438 million in 1500 to 1.04 billion in 1820, an average pace of 0.27% per year. This positive association between income per capita and the size of the population has been maintained in the past two centuries as well, with world population surpassing the remarkable level of six billion people (Maddison, 2001).[3]

Variation in population density across countries during the Malthusian Epoch primarily reflected cross-country differences in technology and land

[2] Since output per capita grew at an average rate of 0% per year during 0–1000, the pace of resource expansion was approximately equal to the pace of population growth, namely, 0.02% per year.

[3] Lee (1997) reports positive income elasticity of fertility and negative income elasticity of mortality from studies examining a wide range of pre-industrial countries. Similarly, Wrigley and Schofield (1981) find a strong positive correlation between real wages and marriage rates in England during 1551–1801, and Clark and Hamilton (2006) find that in England, at the beginning of the seventeenth century, the number of surviving offspring is higher among households with higher levels of income and literacy rates.

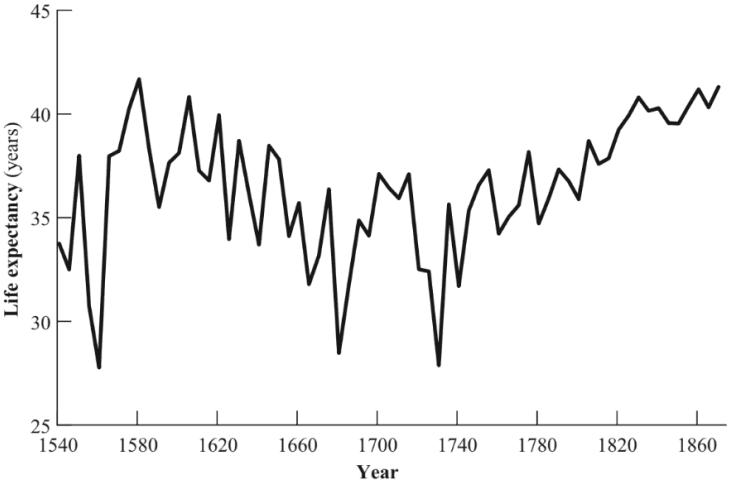

FIGURE 2.6. Life expectancy: England, 1540–1870.
Data source: Wrigley and Schofield (1981).

favorable climatic conditions, and major epidemics (which resulted in a decline of the adult population) brought about temporary increases in real wages and income per capita. In particular, as depicted in Figure 2.7, the catastrophic decline in the population of England during the Black Death (1348–1349) from about 6 million to about 3.5 million people demonstrates the causal effect of population decline in a Malthusian world. The land-labor ratio significantly increased and real wages tripled in the subsequent 150 years.[7] Ultimately, however, it appears that most of this increase in real resources per capita was channeled into an increase in the size of the population, bringing the real wage rate in the 1560s back to its pre-plague level.

2.1.5 Technological Progress

Technological progress during the Malthusian Epoch was positively affected by the size of the population. Population scale increased the supply of innovative ideas and their rate of diffusion. In addition, the size of the population affected the degree of specialization in the production process, the extent of learning by doing, and the scope for inter-regional trade and thus the degree of technological imitation and adoption. Moreover, increased population density contributed to population pressure and thus to the necessity of innovations (Boserup, 1965; Kremer, 1993).

[7] Voigtländer and Voth (2009) suggest that this major shock was instrumental for the rise in European income per capita above subsistence in the early modern period.

FIGURE 2.7. Population and real wages: England, 1250–1750.
Data source: Clark (2005).
Note: Reliable data on the evoluion of population during 1400–1525 is not available.

2.1.6 Main Characteristics of the Epoch

The evidence suggests that the process of development during most of human existence was marked by Malthusian stagnation. Resources generated by technological progress and land expansion were channeled primarily into increases in the size of the population, with only a minute contribution to the level of income per capita in the long run. While cross-country variations in levels of technology and land productivity were reflected by differences in population densities, their differential effect on living standards was merely transitory.

Nevertheless, the epoch of stagnation in income per capita masked a dynamism that may have ultimately brought about the take-off from this regime. In particular, Unified Growth Theory suggests that although growth of income per capita was minuscule during the Malthusian Epoch, the dynamism in population and technology that characterized this period was instrumental for the eventual emergence of economies from this stagnation.

2.2 The Post-Malthusian Regime

Ironically, shortly before the publication of Malthus's influential essay, some regions in the world began to emerge from the trap that he was describing. During the Post-Malthusian Regime, the Malthusian mechanism linking higher income to higher population growth continued to function. However, the effect

that higher population had on diluting resources per capita, and thus on lowering income per capita, was counteracted by an acceleration in technological progress and capital accumulation, allowing income per capita to rise despite the offsetting effects of population growth.

The take-off of developed regions from the Malthusian Regime was associated with the Industrial Revolution and occurred during the first part of the nineteenth century. In contrast, the take-off of less developed regions took place toward the beginning of the twentieth century and was delayed in some countries until well into the twentieth century. The Post-Malthusian Regime ended with the onset of the decline in population growth that took place toward the end of the nineteenth century in Western Europe and the Western Offshoots and in the second half of the twentieth century in less developed regions.

2.2.1 Take-off in Income per Capita

During the Post-Malthusian Regime, the average growth rate of output per capita increased significantly, and living standards started to differ considerably across countries. The average growth rate of output per capita in the world soared from 0.05% per year during 1500–1820 to 0.5% per year in 1820–1870 and 1.3% per year in 1870–1913. The timing of the take-off and its magnitude differed across regions. As depicted in Figure 2.8, the take-off from the Malthusian Epoch and the transition to the Post-Malthusian Regime occurred at the beginning of the nineteenth century in Western Europe and the Western Offshoots; at the end of the nineteenth century in Latin America; and only in the second half of the twentieth century in Asia and Africa.

The differential timing of the take-off from the Malthusian Epoch increased the gap between the richest regions of the West and the impoverished region of Africa from about 3:1 in 1820 to approximately 5:1 in 1870. The level of income per capita across the globe in 1870, as depicted in Figure 1.1, ranged from about $440 in Africa, $540 in Asia, $700 in Latin America, and $870 in Eastern Europe, to $1,970 in Western Europe and $2,430 in the Western Offshoots.

2.2.2 Spike in Population Growth

The rapid increase in income per capita in the Post-Malthusian Regime was partly channeled into an increase in population. The Western European take-off, along with that of the Western Offshoots, brought about a sharp increase in population growth in these regions and consequently a modest rise in population growth in the world as a whole. The subsequent take-off of less developed regions and the associated increase in their population growth brought about an additional significant rise in world population growth. The rate of world population growth increased from an average of 0.27% per year during 1500–1820 to

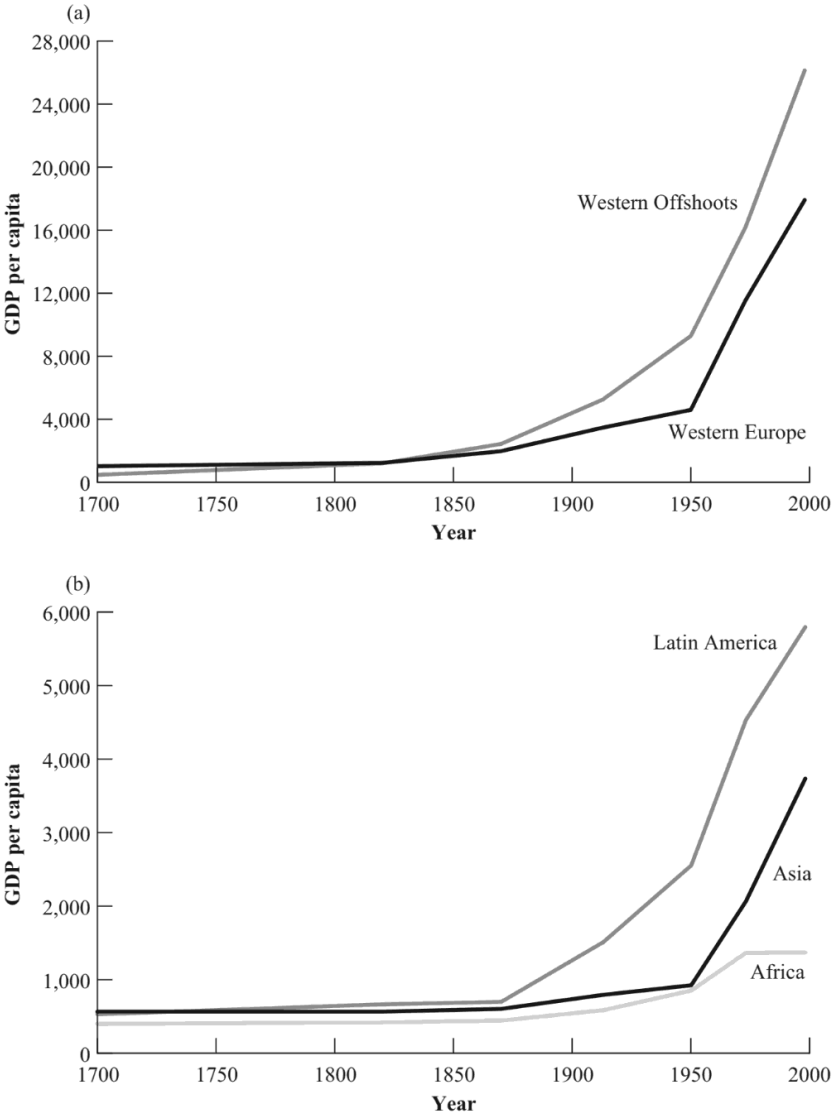

FIGURE 2.8. Differential timing of the take-off across regions: (a) early take-off; (b) late take-off.
Data source: Maddison (2001).

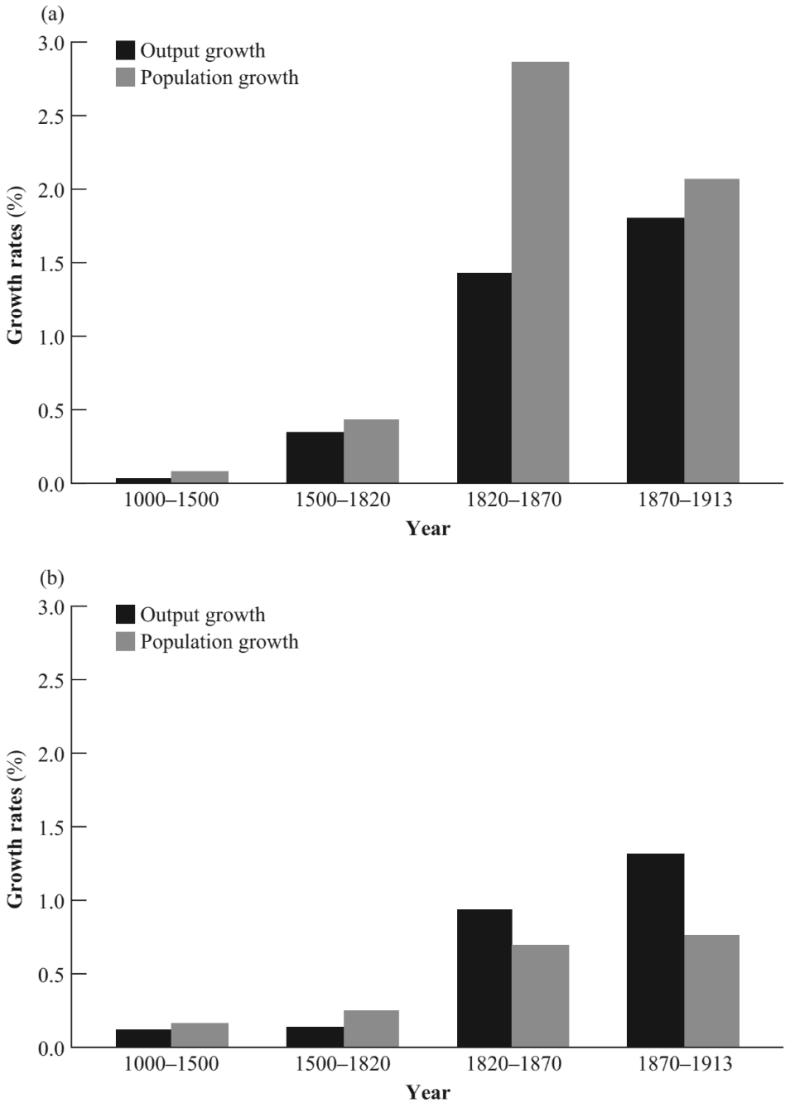

FIGURE 2.9. Regional growth of GDP per capita and population, 1500–2000: (a) Western Offshoots; (b) Western Europe; (c) Africa; (d) Latin America. *Data source:* Maddison (2001).

growth of income per capita was only 0.1% per year in the earlier period and 0.2% in the later one. In the United Kingdom, where growth was the fastest, the same rough division between total output growth and population growth can be observed: total output grew at an annual rate of 1.1% in the 120 years after 1700, while population grew at an annual rate of 0.7%. Population and income per capita continued to grow after 1820, but increasingly, the growth of total output was expressed as growth in income per capita. Population growth was 40% of total output growth during 1820–1870, dropping further after the demographic transition to about 20% of output growth during 1929–1990.

2.2.3 Fertility and Mortality

The rise in real income and relaxation in households' budget constraints during the Post-Malthusian Regime allowed for an increase in fertility rates along with increased investment in human capital. Despite the decline in mortality rates, fertility rates (as well as population growth) increased in most of Western Europe until the second half of the nineteenth century (Dyson and Murphy, 1985; Coale and Treadway, 1986). In particular, as depicted in Figure 2.10, despite a century-long decline in mortality rates, crude birth rates in England increased during the eighteenth century and the beginning of the nineteenth century. Thus, the net reproduction rate (i.e., the number of daughters per woman who reach reproduction age) increased from approximately the replacement level of one surviving daughter per woman in 1740 to about 1.5 on the eve of the demographic transition in 1870.

It appears that the significant rise in income per capita during the Post-Malthusian Regime increased the desired number of surviving offspring and thus, despite the decline in mortality rates, fertility in some regions increased, enabling households to reach this higher rate. In the absence of modern contraceptive methods, fertility was partly controlled during this period via adjustment in the age of marriage.[8] As depicted in Figure 2.11, the pattern of increased crude birth rates during 1700–1820 was associated with an earlier female age of marriage.[9]

[8] The importance of this mechanism of fertility control is implicitly reflected in the assertion by William Cobbett (1763–1835), a leader of the campaign against the changes brought by the Industrial Revolution: "men, who are able and willing to work, cannot support their families, and ought . . . to be compelled to lead a life of celibacy, for fear of having children to be starved." Quoted from "To Parson Malthus," *Political Register* (London, May 8, 1819).

[9] The same pattern is observed in the relationship between crude birth rates and crude marriage rates (per 1,000).

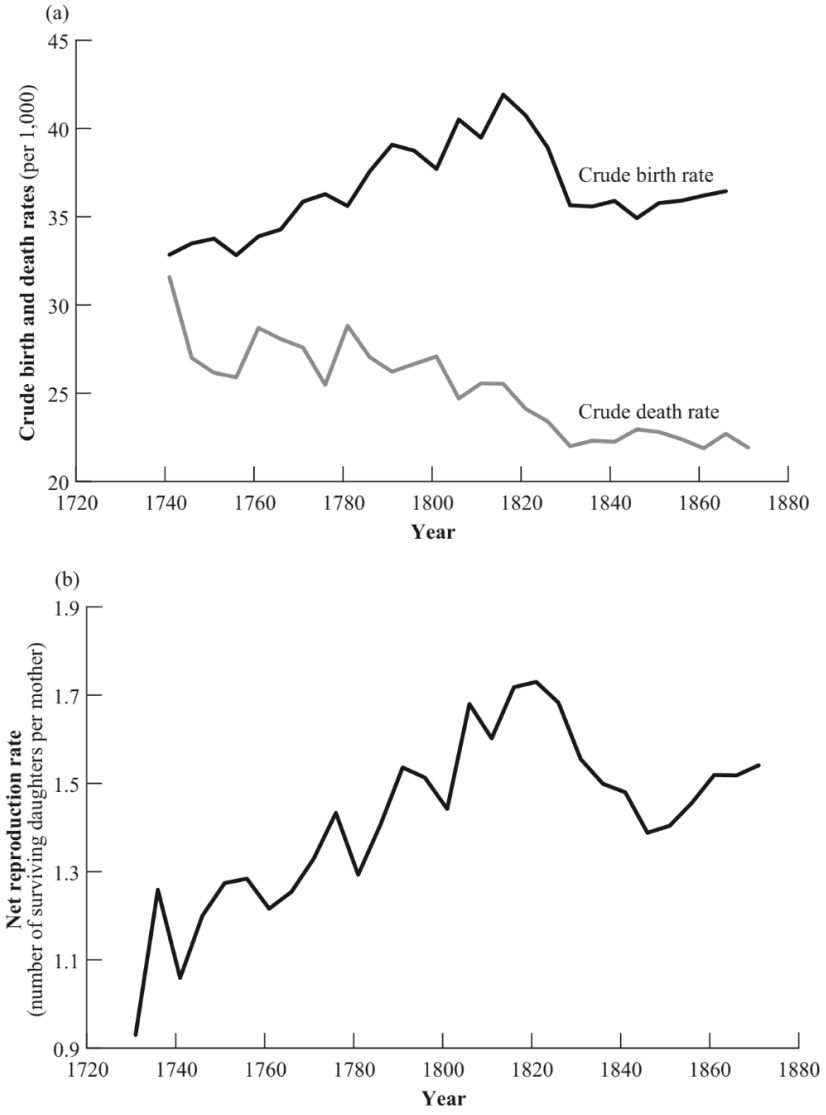

FIGURE 2.10. (a) Fertility and mortality, and (b) net reproduction rate: England, 1730–1871.
Data source: Wrigley and Schofield (1981).