Chapter 1
The great divergence

Economic history is the queen of the social sciences. Her subject is *The Nature and Causes of the Wealth of Nations*, the title of Adam Smith's great book. Economists seek the 'causes' in a timeless theory of economic development, while economic historians find them in a dynamic process of historical change. Economic history has become particularly exciting in recent years since the scope of the fundamental question – 'why are some countries rich and others poor?' – has gone global. Fifty years ago, the question was 'why did the Industrial Revolution happen in England rather than France?' Research on China, India, and the Middle East has emphasized the inherent dynamism of the world's great civilizations, so today we must ask why economic growth took off in Europe rather than Asia or Africa.

Data on incomes in the distant past are not robust, but it looks as though the differences in prosperity between countries in 1500 were small. The present division between rich and poor largely emerged since Vasco da Gama sailed to India and Columbus discovered the Americas.

We can divide the last 500 years into three periods. The first, which lasted from 1500 to about 1800, was the *mercantilist era*. It began with the voyages of Columbus and da Gama, which led to an integrated global economy, and ended with the Industrial Revolution. The Americas were settled and exported silver, sugar, and tobacco; Africans were shipped as slaves to the Americas to produce these goods; and Asia sent spices, textiles, and porcelain to Europe. The leading European countries sought to increase their trade by acquiring colonies and using tariffs and war to prevent other countries from trading with them. European manufacturing was promoted at the expense of the colonies, but economic development, as such, was not the objective.

This changed in the second period of *catch-up* in the 19th century. By the time Napoleon was defeated at Waterloo in 1815, Britain had established a lead in industry and was out-competing other countries. Western Europe and the USA made economic development a priority and tried to achieve it with a standard set of four policies: creation of a unified national market by eliminating internal tariffs and building transportation infrastructure; the erection of an external tariff to protect their industries from British competition; the chartering of banks to stabilize the currency and finance industrial investment; and the establishment of mass education to upgrade the labour force. These policies were successful in Western Europe and North America, and the countries in these regions joined Britain to form today's club of rich nations. Some Latin American countries adopted these policies incompletely and without great success. British competition de-industrialized most of Asia, and Africa exported palm oil, cocoa, and minerals once the British slave trade was ended in 1807.

In the 20th century, the policies that had worked in Western Europe, especially in Germany, and the USA proved less effective in countries that had not yet developed. Most technology is invented in rich countries, and they develop technologies that use more and more capital to increase the productivity of their ever more expensive labour. Much of this new technology is not cost-effective in low-wage countries, but it is what they need in order to catch up to the West. Most countries have adopted modern technology to some degree, but not rapidly enough to overtake the rich countries. The countries that have closed the gap with the West in the 20th century have done so with a *Big Push* that has used planning and investment coordination to jump ahead.

Before we can learn *how* some countries became rich, we must establish *when* they became rich. Between 1500 and 1800, today's rich countries forged a small lead that can be measured in terms of GDP (gross domestic product) per person (Table 1). In 1820, Europe was already the richest continent. GDP per head was twice that of much of the world. The most prosperous country was the Netherlands, with an average income (GDP) of $1,838 per person. The Low Countries had boomed in the 17th century, and the main question of economic policy elsewhere was how to catch up with the Dutch. The British were doing that. The Industrial Revolution had been under way for two generations, and Great Britain was the second richest economy, with an income of $1,706 in 1820. Western Europe and Britain's offshoots (Canada, Australia, New Zealand, and the USA) had incomes of between $1,100 and $1,200. The rest of the world lagged behind, with per capita incomes between $500 and $700. Africa was the poorest continent at $415.

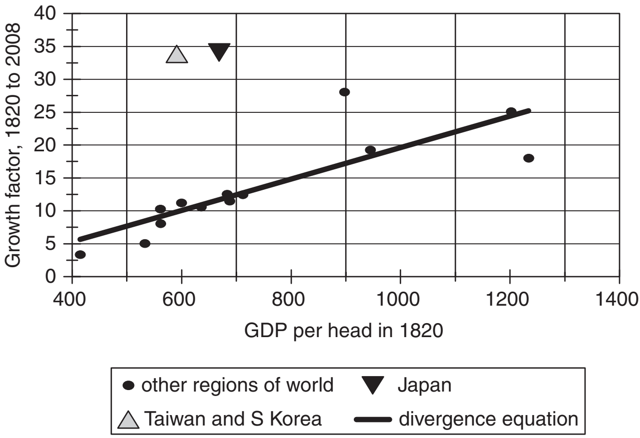
Between 1820 and the present, the income gaps have expanded with only a few exceptions. The countries that were richest in 1820 have grown the most. Today's rich countries have average incomes of $25,000–$30,000, much of Asia and Latin America average $5,000–$10,000, while sub-Saharan Africa has reached only $1,387. The phenomenon of divergence is highlighted in Figure 1, in which the regions plotted towards the right with higher incomes in 1820 had the greatest income growth factors, and the regions on the left with lower initial incomes had smaller growth factors. Europe and the British offshoots realized income gains of 17- to 25-fold. Eastern Europe and much of Asia started

Table 1. GDP per person around the world, 1820–2008

	1820	**1913**	**1940**	**1989**	**2008**
Great Britain	1706	4921	6856	16414	23742
Netherlands	1838	4049	4832	16695	24695
Other Western Europe	1101	3608	4837	16880	21190
Mediterranean Europe	945	1824	2018	11129	18218
Northern Europe	898	2935	4534	17750	25221
USA, Canada, NZ, Australia	1202	5233	6838	21255	30152
Eastern Europe	683	1695	1969	5905	8569
USSR	688	1488	2144	7112	7904
Argentina, Uruguay, Chile	712	3524	3894	6453	8885

	1820	1913	1940	1989	2008
Other Latin American countries	636	1132	1551	4965	6751
Japan	669	1387	2874	17943	22816
Taiwan & S Korea	591	835	1473	8510	20036
China	600	552	562	1834	6725
Indian Sub-continent	533	673	686	1232	2698
Other east Asia	562	830	840	2419	4521
Middle East & North Africa	561	994	1600	3879	5779
Sub-Saharan Africa	415	568	754	1166	1387
World	666	1524	1958	5130	7614

GDP measures the total output of goods and services in an economy as well as the total income generated by it. In this table, GDP is valued in 1990 US dollars so the volume of production (real income) can be compared over time and across space.
Note: Great Britain includes Northern Ireland from 1940

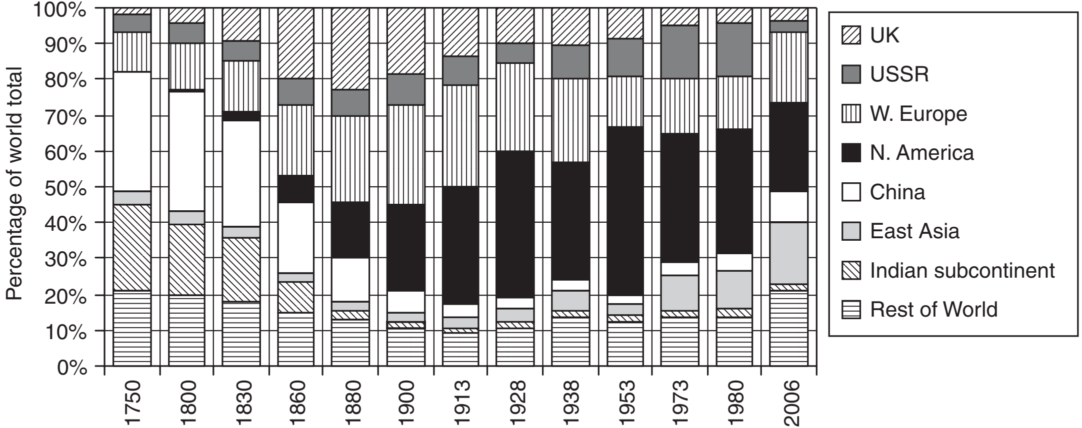


1. The great divergence

with lower incomes and realized increases of 10-fold. South Asia, the Middle East, and much of sub-Saharan Africa were less fortunate, being both poorer in 1820 and achieving income gains of only 3- to 6-fold. They have fallen even further behind the West. The 'divergence equation' summarizes this pattern.

There are exceptions to income divergence. East Asia is the most important, for it is the one region that bucked the trend and improved its position. Japan was the greatest success of the 20th century, for it was indubitably a poor country in 1820 and yet managed to close the income gap with the West. Equally dramatic has been the growth of South Korea and Taiwan. The Soviet Union was another, although less complete, success. China may be repeating the trick today.

Industrialization and de-industrialization have been major causes of the divergence in world incomes (Figure 2). In 1750, most of the world's manufacturing took place in China (33% of the world total) and the Indian subcontinent (25%). Production per person was



2. Distribution of world manufacturing

lower in Asia than in the richer countries of Western Europe, but the differentials were comparatively small. By 1913, the world had been transformed. The Chinese and Indian shares of world manufacturing had dropped to 4% and 1% respectively. The UK, the USA, and Europe accounted for three-quarters of the total. Manufacturing output per head in the UK was 38 times that in China and 58 times that in India. Not only had British output grown enormously, but manufacturing had declined absolutely in China and India as their textile and metallurgical industries were driven out of business by mechanized producers in the West. In the 19th century, Asia was transformed from the world's manufacturing centre into classic underdeveloped countries specialized in the production and export of agricultural commodities.

Figure 2 highlights some key turning points in the history of the world. From 1750 to 1880, the British Industrial Revolution was the major event. In this period, Britain's share of world manufacturing increased from 2% to 23%, and it was British competition that destroyed traditional manufacturing in Asia. The period from 1880 to the Second World War was marked by the industrialization of the USA and continental Europe including Germany, in particular. Their shares reached 33% and 24%, respectively, in 1938. Britain lost ground to these competitors, and its share dropped to 13%. Since the Second World War, the USSR's share of world manufacturing output rose sharply until the 1980s and then crashed precipitously as the post-Soviet countries went into economic decline. The East Asian miracle saw a rise in the share of world manufacturing in Japan, Taiwan, and South Korea to 17%. China has also been industrializing since 1980, and produced 9% of world manufactures in 2006. If China catches up to the West, the world will have come full circle.

Real wages

GDP is not an adequate measure of wellbeing. It leaves out many factors such as health, life expectancy, and educational attainment. In addition, absence of data often makes GDP hard to compute, and, in any event, it may be misleading because it averages the incomes of the rich with the poor. These problems can be finessed by calculating 'real wages', that is, the standard of living that can be bought with one's earnings. Real wages tell us much about the standard of living of the average person and help explain the origins and spread of modern industry, for the incentive to increase the amount of machinery used by each worker is greatest where labour is dearest.

I focus on labourers. To measure their standard of living, their wages must be compared to the prices of consumer goods, and those prices must be averaged to calculate a consumer price index. My index is the cost of maintaining a man at 'bare-bones subsistence' (the least-cost way of staying alive). The diet is quasi-vegetarian. Boiled grain or unleavened bread provide most of the calories, legumes are a protein-rich complement, and butter or vegetable oil provides a little fat. This was typical fare around the world in 1500. Francisco Pelsaert, a Dutch merchant who visited India in the early 17th century, observed that the people near Delhi 'have nothing but a little kitchery [kedgeree] made of green pulse mixed with rice … eaten with butter in the evening, in the day time they munch a little parched pulse or other grain'. The workmen 'know little of the taste of meat'. Indeed, most meats were taboo.

Table 2 shows the consumption pattern defining bare-bones subsistence for an adult male. The diet is based on the cheapest grain available in each part of the world – oats in northwestern Europe, maize in Mexico, millet in northern India, rice in coastal China, and so on. The quantity of the grain is chosen, so that the diet yields 1,940 calories per day. Non-food spending is restricted to scraps of cloth, a bit of fuel, and the odd candle. Most spending is on food, and, indeed, on the carbohydrate at the core of the diet.

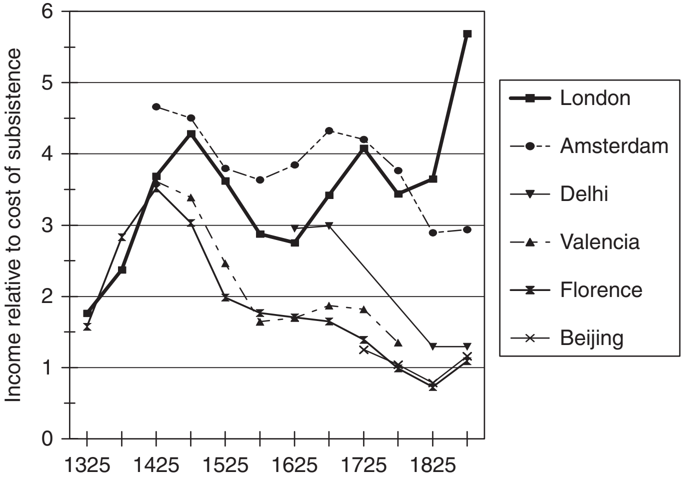
The fundamental standard of living question is whether a fully employed labourer earned enough to support a family at bare-

Table 2. Bare-bones subsistence basket of goods

	quantity per man per year	calories per day	protein (grams) per day
food			
grain	167 kg	1657	72
beans	20 kg	187	14
meat	5 kg	34	3
butter	3 kg	60	0
total		1938	89
non-food			
soap	1.3 kg		
linen/cotton	3 metres		
candles	1.3 kg		
lamp oil	1.3 litres		
fuel	2.0 Million British Thermal Units		

Note: The table is based on quantities and nutritional values for the oatmeal diet of north/western Europe. For other parts of the world, the diet uses the cheapest available grain, and the exact quantities consequently vary.

bones subsistence. Figure 3 shows the ratio of full-time earnings to the family's cost of subsistence. Today, living standards are similar across Europe. The 15th century was the last time that was true. Living standards then were also high: labourers earned about four times bare-bones subsistence. By the 18th century, however, a great divergence had occurred in Europe. The standard of living on the continent collapsed, and labourers earned only enough to purchase the items in Table 2 or equivalent. In the Middle Ages, Florentine workers ate bread, but by the 18th

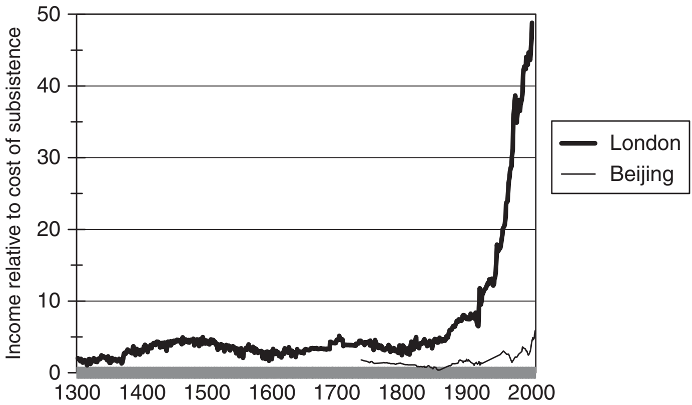


3. Subsistence ratio for labourers

century they could afford only polenta made from maize, newly introduced from the Americas.

In contrast, labourers in Amsterdam and London still earned four times bare-bones subsistence. Workers in London in 1750 did not, however, eat four times the oatmeal specified in Table 2. Instead, they upgraded their diet to white bread, beef, and beer. It was only on the Celtic fringe that the British ate oats. As Doctor Johnson remarked, oats are 'a grain which in England is generally given to horses but in Scotland supports the people'. The workers of southern England also had the income to purchase the luxuries of the 18th century such as the odd book, a mirror, sugar, or tea.

Real wages have diverged as dramatically as GDP per head. Figure 4 shows the real wage of labourers in London from 1300 to the present and in Beijing from 1738. In 1820, the London real wage was already four times subsistence, and the ratio has grown to fifty – mainly since 1870.



4. Subsistence ratio, London and Beijing

In the poor countries of the world, however, real wages are still at bare-bones subsistence. In 1990, the World Bank defined a world poverty line at $1 per day (since raised to $1.25 due to inflation). This figure, which is based on the poverty lines of present-day poor countries, corresponds to bare-bones subsistence as defined in Table 2. Those baskets averaged $1.30 per person per day when priced in 2010. More than one billion people (15% of the world's population) live below that line today, and the proportion was far higher in 1500. Labourers in Beijing were this poor in the 19th century. China's remarkable growth in recent decades has boosted the labourer's standard of living to only six times subsistence – a level that British workers realized 150 years ago.

We can now appreciate the low incomes shown in Table 1 for 1820. They are expressed in 1990 dollars, and, at that time, bare-bones subsistence cost $1 per day or $365 per year. Average income in sub-Saharan Africa in 1820 was $415 – only 15% more than bare-bones subsistence, which was the standard of living of the vast majority. In most of Asia and Eastern Europe, which had more capital-intensive farming systems and hierarchical societies, the average incomes were only $500–$700. Most people lived at subsistence, and the surplus was extracted by the state, the aristocracy, and the rich merchants. Northwestern Europe and the USA had incomes four to six times subsistence. Only in these societies did workers live above bare-bones subsistence, as Figure 3 shows. These economies were sufficiently productive to also support aristocracies and merchants.

Bare-bones subsistence has further implications for social wellbeing and economic progress. First, people living on the bare-bones diet are short. The average height of Italians who enlisted in the Habsburg army fell from 167 cm to 162 cm as their diet shifted from bread to polenta. In contrast, English soldiers in the 18th century averaged 172 cm due to their better nutrition. (Today, the average man is 176–8 cm tall in the USA, UK, and Italy, while the Dutch are 184 cm tall.) When people's heights are stunted for lack of food, their life expectation is also cut, and their health in general declines. Second, people living at subsistence are less well educated. Sir Frederick Eden, who surveyed labourers' incomes and spending patterns in England in the 1790s, described a London gardener who spent 6 pence per week sending two of his children to school. The family bought wheat bread, meat, beer, sugar, and tea, and his earnings (£37.75 per year) were about four times subsistence (just under £10). If their income were suddenly cut to subsistence, vast economies would have had to be made, and who can doubt that the children would have been removed from school? High wages contributed to economic growth by sustaining good health and supporting widespread education. Finally, and most paradoxically, bare-bones subsistence removes the economic motivation for a country to develop economically. The need for more output from a day's work is great, but labour is so cheap that businesses have no incentive to invent or adopt machinery to raise productivity. Bare-bones subsistence is a poverty trap. The Industrial Revolution was the result of high wages – and not just their cause.

Chapter 2
The rise of the West

Why has the world become increasingly unequal? Both 'fundamentals' like geography, institutions, or culture and 'accidents of history' played a role.

Geography is important. Malaria holds back the tropics, and Britain's coal deposits underpinned the Industrial Revolution. Geography is rarely the whole explanation, however, for its significance depends on technology and economic opportunities; indeed, one of the aims of technology is to reduce the burden of bad geography. In the 18th century, for instance, the location of coal and iron deposits determined the location of blast furnaces. Today, ocean transportation is so cheap that Japan and Korea obtain their coal and iron ore from Australia and Brazil.

Culture has been a popular explanation for economic success. Max Weber, for instance, contended that Protestantism made northern Europeans more rational and hard-working than anyone else. Weber's theory looked plausible in 1905 when Protestant Britain was richer than Catholic Italy. Today, however, the reverse is true, and Weber's theory is no longer tenable. Another cultural argument claims that peasant farmers in the Third World are poor because they cling to traditional methods and fail to respond to economic incentives. The contrary, however, is true: farmers in poor countries experiment with new crops and methods, employ labour to the degree that it pays, adopt modern fertilizers and seeds when they are cost-effective, and shift their cropping in response to price changes like farmers in the rich countries. Peasants are poor because they receive low prices for their crops and because they lack appropriate technology – not because they refuse to use it.

While cultural explanations that invoke irrationality and laziness are suspect, there are aspects of culture that affect economic performance. In particular, widespread literacy and numeracy have been necessary (if not sufficient) conditions for economic success since the 17th century. These mental skills help trade to flourish and science and technology to develop. Literacy and numeracy are spread by mass education, which has become a universal strategy for economic development.

The importance of political and legal institutions is hotly debated. Many economists argue that economic success is the result of secure property rights, low taxes, and minimal government. Arbitrary government is bad for growth because it leads to high taxes, regulations, corruption, and rent-seeking – all of which reduce the incentive to produce. These views are applied historically by arguing that absolutist monarchies such as Spain and France or empires like those of China, Rome, or the Aztecs stifled economic activity by prohibiting international trade, threatening property or, indeed, life itself. These views, of course, echo those of Adam Smith and other 18th-century liberals. Successful economic development was due to the replacement of absolutism with representative government. The Netherlands revolted against Spanish rule in 1568 and organized itself as a republic. The country grew rapidly afterwards. The English economy suffered in the early 17th century under the rules of James I and Charles I, who imposed taxes of disputed legality and levied forced loans. Charles's attempts to rule without Parliament failed, civil war broke out, and, in 1649, the

King was convicted of treason and executed. After the Restoration, disputes between Crown and Parliament continued, however, finally culminating in the Glorious Revolution of 1688 when James II fled the country and Parliament gave the Crown to William and Mary. With Parliament supreme, absolutism was checked, and the economy boomed. So goes the economists' history.

However, as economists have been celebrating the superiority of English institutions, historians have been investigating how absolutist monarchy and Oriental despotism actually worked. The usual finding is that they promoted peace, order, and good government. Trade flourished as a result, regional specialization increased, and cities expanded. As regions became more specialized, the national income rose in a process that has come to be called 'Smithian growth'. The greatest threat to prosperity was invasion by barbarians attracted to the civilization's wealth – not expropriation or intervention by the emperor.

The first globalization

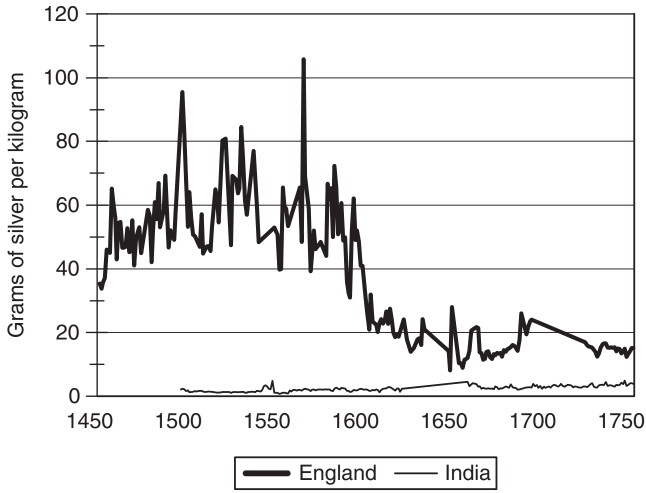
While institutions, culture, and geography always lurk in the background, technological change, globalization, and economic policy turn out to have been the immediate causes of unequal development. The Industrial Revolution itself, moreover, was the result of the first phase of globalization that began in the late 15th century with the voyages of Columbus, Magellan, and the other great explorers. The great divergence, therefore, begins with the first globalization.

Globalization required ships that could sail the high seas. Europeans did not have them until the 15th century. These newly invented 'full-rigged' ships had three masts – the front and middle were square-rigged and the aft was lateen-rigged. Sturdier hulls and the use of rudders instead of steering oars made ships that could navigate the globe.

Initially, the commercial impact of the full-rigged ship was felt in Europe. In the 15th century, the Dutch began shipping Polish grain from Danzig to the Netherlands and, by the late 16th century, to Spain, Portugal, and the Mediterranean. Textiles quickly followed. Italian cities had dominated the cloth industry in the Middle Ages, but English and Dutch producers contrived to make lightweight worsted cloth in imitation of Italian fabrics. By the early 17th century, the Mediterranean was flooded with these 'new draperies', and the English and Dutch drove the Italians out of business. This was a momentous change and began the relocation of Europe's manufacturing industry to northwestern Europe.

The most dramatic impact of the full-rigged ship, however, was in the Voyages of Discovery. Networks of Indian, Arab, and Venetian merchants shipped pepper and spices from Asia, across the Middle East, to Europe, and the Portuguese hoped to out-compete them with an all-water route. In the 15th century, the Portuguese sailed south along the African coast in search of a sea route to the East.

In 1498, Vasco da Gama reached Cochin in India, and filled his ship with pepper. The price in Cochin was about 4% of the price in Europe (Figure 5). The other 96% of the price difference was transport costs. By 1760, the gap between the Indian and English prices in Figure 5 had dropped by 85%, and that reduction is a measure of the efficiency gain from the all-sea route. In the 16th century, however, only Portugal benefited from the cut in transport costs since its state trading company kept the price at the medieval level and pocketed the savings as profits. It was the arrival of the English and Dutch East Indies companies in the early 17th century that broke Portugal's maritime monopoly and cut the European price by two-thirds. The real price received by Indian sellers increased by only a small amount: most of the efficiency gains from the Asian trade were reaped by European consumers.



5. Price of pepper, adjusted to price level of 1600

The Genoese sailor Christopher Columbus, of course, proposed the alternative of sailing west from Europe directly to Asia. He talked King Ferdinand and Queen Isabella of Spain into financing his expedition and landed in the Bahamas on 12 October 1492, convinced that he had reached the East Indies. But it was the Americas he had 'discovered', and that changed the history of the world.

Columbus's and da Gama's voyages set off a scramble for empire, and the Portuguese and Spanish were the early winners. In the two battles of Diu (1509 and 1538), the Portuguese defeated Venetian, Ottoman, and Asian forces and established their hegemony in the Indian Ocean. Then they pushed east towards Indonesia, establishing a string of colonies along the way. Eventually, the Portuguese reached the fabled Spice Islands (that is, the Moluccas in Indonesia), where nutmeg, cloves, and mace were indigenous. The Portuguese also accidentally discovered Brazil in 1500, which became their biggest colony.

Spain's empire was even richer. The greatest successes were the conquests of the Aztec Empire in 1521 by Hernán Cortés and the Inca Empire 11 years later by Francisco Pizarro. In both cases, small Spanish forces defeated large native armies through a combination of firearms, horses, guile, and smallpox. Looting the Aztecs and the Incas brought immediate wealth to Spain. Conquest was followed by the discovery of large silver deposits in Bolivia and Mexico. The silver flooding into Spain paid for the Habsburg armies fighting the Protestants across Europe, provided Europeans with the cash to buy up Asian goods, and unleashed decades of inflation known as the Price Revolution.

The imperial exploits of northern Europeans were modest in the 16th century. The English sent Giovanni Caboto (John Cabot) west in 1497, and he made it to Cape Breton, or Newfoundland. This counted as discovery, although Basque sailors had been fishing the Grand Banks for centuries. The French sent Jacques Cartier to Canada on three voyages in the 1530s and 1540s. Fur trading with the natives counted for little compared to Mexico or the Moluccas.

It was not until the 17th century that the northern Europeans became important imperialists. Their favourite organization was an East Indies company that combined imperialism with private enterprise. Typically, these firms were highly capitalized joint stock companies that traded in Asia or the Americas, maintained military and naval forces, and established fortified trading posts abroad. All of the northern powers had them. The English East India Company was chartered in 1600 and its Dutch counterpart two years later.

The Dutch East Indies Company created a Dutch Empire in Asia at the expense of the Portuguese. The Dutch seized the Moluccas in 1605, Malacca in 1641, Ceylon in 1658, and Cochin in 1662. They made Jakarta the capital of their Indonesian possessions in 1619. The Dutch also seized Brazil in the 1630s and 1640s. They colonized sugar islands in the Caribbean, and founded New York in 1624 and the Cape Colony in South Africa in 1652.

The English also created an empire in the 17th century. In Asia, the English East India Company defeated the Portuguese in the naval battle of Swally off Surat in 1612. Subsequently, fortified trading posts were established at Surat (1612), Madras (1639), Bombay (1668), and Calcutta (1690). By 1647, the East India Company had 23 establishments in India. In the Americas, a variety of individuals and groups established colonies. Jamestown, Virginia, was the first success, in 1607. The legendary Plymouth colony followed in 1620, and the much more important Massachusetts Bay colony ten years later. The Bahamas and a string of islands were taken in the Caribbean in the 1620s and 1630s. Jamaica was added in 1655.

The English state actively expanded its empire – particularly at the expense of the Dutch. The first steps were taken by Oliver Cromwell, during the Commonwealth (1640–60), and continued after the Restoration. Expenditure on the navy was greatly increased. The first Navigation Act was passed in 1651. This mercantilist measure was intended to exclude the Dutch from trading with the English empire. The first Anglo-Dutch War (1652–4) was fought for commercial advantage, but was far from successful. After the Restoration of Charles II in 1660, the Navigation Acts were reinstated and extended, the (now Royal) Navy was expanded, and more wars were fought against the Dutch in 1665–7 and 1672–4. New York was seized in 1664. English colonies were established along the American coast from Georgia to Maine. Their economies grew rapidly by exporting tobacco, rice, wheat, and meat to England and the Caribbean. By 1770, the population of British America had reached 2.8 million, or almost half of England's.

English and Dutch trade with their colonies drove their economies forward. Cities and export-oriented manufacturing grew. The

Table 3. Percentage distribution of the population by sector, 1500–1750

	1500 urban	1500 rural nonagri-culture	1500 agri-culture	1750 urban	1750 rural nonagri-culture	1750 agri-culture
greatest transformation						
England	7%	18%	74%	23%	32%	45%
significant modernization						
Netherlands	30	14	56	36	22	42
Belgium	28	14	58	22	27	51
slight evolution						
Germany	8	18	73	9	27	64
France	9	18	73	13	26	61

(continued)

	1500 urban	1500 rural nonagri-culture	1500 agri-culture	1750 urban	1750 rural nonagri-culture	1750 agri-culture
Austria/Hungary	5	19	76	78	32	61
Poland	6	19	75	4	36	60
little change						
Italy	22	16	62	22	19	59
Spain	19	16	65	21	17	62

occupational structure changed accordingly. Table 3 divides the populations of the main European countries into three groups: agricultural, urban, and rural non-agricultural. In the Middle Ages, about three-quarters of the population was engaged in farming, most manufacturing was carried out in cities, and the 'rural non-agricultural population' consisted of village craftsmen, priests, carters, and the servants of country houses. In 1500, Italy and Spain were the most advanced economies, with the largest cities that produced the best manufactures. The Low Countries (principally modern-day Belgium) were an extension of this economy. The Dutch population was very small, and England was little more than a sheep walk.

By the eve of the Industrial Revolution, there had been far-reaching changes. England was the most transformed country. The fraction of the population in agriculture had dropped to 45%. England was the most rapidly urbanizing country in Europe. London grew from 50,000 in 1500 to 200,000 in 1600 to 500,000 in 1700 and, finally, to one million in 1800. The 'rural non-agricultural share' of the population was 32% in 1750. Most of these people were engaged in manufacturing industries, and their products were shipped across Europe and, sometimes, around the world. Artisans in Witney, Oxfordshire, for instance, sold blankets to the Hudson Bay Company, which swapped them for fur with the natives of Canada. The economy of the Low Countries developed along similar lines. The Netherlands were even more urbanized than England and also had large, export-oriented rural industries.

The rest of Europe was much less transformed. The great continental countries saw a small reduction in the share of their populations in agriculture and a corresponding increase in rural industry with little extra urbanization. Spain and Italy look stationary, with no change in the distribution of their populations.

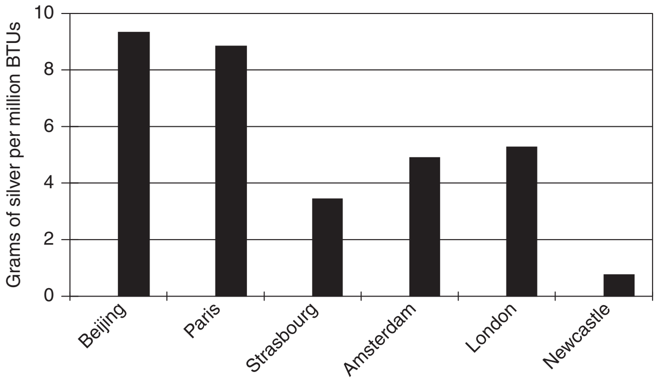
Spain was particularly unlucky. In the 16th century, it looked like the most successful imperialist, for Latin America yielded so much silver. Silver imports, however, led to much greater inflation in Spain than elsewhere. As a result, Spanish agriculture and manufacturing became uncompetitive. The constancy in the share of the urban population in Spain masks great changes – the populations of old industrial cities collapsed while Madrid expanded on the basis of American loot. Globalization spurred northwestern Europe forward but held southern Europe back.

Success in the global economy had major implications for economic development, including:

First, the growth in urbanization and rural manufacturing increased the demand for labour and led to tight labour markets and high wages. Living standards were high in London and Amsterdam (Figure 3).

Second, growing cities and a high-wage economy put great demands on agriculture for food and labour. The result was agricultural revolutions in both England and the Netherlands. Output per farm worker increased by about 50% in both countries and reached the highest levels in Europe.

Third, growing urban demand also led to energy revolutions in both England and the Netherlands. In the Middle Ages, charcoal and firewood were the principal fuels burned in cities. As the cities grew, wood prices skyrocketed, and substitute fuels were developed. In the Netherlands, the alternative was peat; in England, it was coal. Coal was mined in Durham and Northumberland and shipped down the coast to London. England was the only country in the world with a large coal-mining industry in the 18th century, and that also gave it access to the cheapest energy in the world, as Figure 6 indicates.



6. Price of energy

Table 4. Adult literacy, 1500 and 1800. Percentage of the adult population that could sign its name

	1500	1800
England	6	53
Netherlands	10	68
Belgium	10	49
Germany	6	35
France	7	37
Austria/Hungary	6	21
Poland	6	21
Italy	9	22
Spain	9	20

Fourth, the high-wage economy generated a high level of literacy, numeracy, and skill formation in general. Table 4 shows estimates of literacy (measured by the ability to sign one's name rather than make a mark) in 1500 and 1800. Literacy rose everywhere in Europe, but the growth was greatest in northwestern Europe. The Reformation does not explain the rise, as is often assumed, for literacy was as high in northeastern France, Belgium, and the Rhine Valley – all Catholic areas – as in the Netherlands or England. The rise in literacy was due to the high-wage, commercial economy. The expansion of commerce and manufacturing increased the demand for education by making it economically valuable; at the same time, the high-wage economy provided parents with the money to pay for schooling their children.

Chapter 3
The Industrial Revolution

The Industrial Revolution (roughly 1760 to 1850) was a turning point in world history, for it inaugurated the era of sustained economic growth. The Revolution was not the abrupt discontinuity that its name suggests but was the result of the transformations of the early modern economy discussed in the last chapter. The rate of economic growth achieved in the century after 1760 (1.5% per year) was very low by the standards of recent growth miracles in which GDP has grown by as much as 8–10% per year. However, Britain was continuously extending the world's technology frontier, and that is always slower going than catching up to the leader by importing its technology, which is how countries have grown very rapidly. Moreover, the great achievement of the British Industrial Revolution was that it led to continuous growth, so that income compounded to the mass prosperity of today.

Technological change was the motor of the Industrial Revolution. There were famous inventions like the steam engine, the machines to spin and weave cotton, and the new processes to smelt and refine iron and steel using coal instead of wood fuels. In addition, there were a host of simpler machines that raised labour productivity in unglamorous industries like hats, pins, and nails. There was also a range of new English products, many of which, like Wedgwood porcelain, were inspired by Asian manufactures.

In the 19th century, engineers extended the 18th-century mechanical inventions across the board. The steam engine was applied to transportation with the invention of the railway and the steamship. Power-driven machinery, whose use was initially restricted to textile mills, was applied to industry generally.

The question is: why was the revolutionary technology invented in England rather than the Netherlands or France or, for that matter, China or India?

Cultural and political context

The Industrial Revolution took place in a particular political and cultural context that was favourable to innovation, and that may help to explain it.

The English constitution has been a model for European liberals and modern economists alike. It was far from democratic: only 3–5% of the English could vote and even fewer of the Scots. Much power remained with the Crown – in particular, the power to make war and peace. While Parliament had a constitutional right to refuse funds for war, it never did.

The English constitution had many features that promoted economic growth, although they were not the ones stressed by modern economists, who emphasize restrictions on taxation and the security of property. Parliamentary supremacy actually resulted in the reverse. While French monarchs claimed to be absolute, they could not increase taxes without consent, and it was a crisis in public finances that precipitated the Revolution by forcing Louis XVI to convene the États généraux in 1789. The nobility in France were exempt from taxation, but the English Parliament introduced a land tax in 1693 that was imposed on peers as well as commoners. Most tax revenue, however, was raised from excise duties on consumer goods like beer and imports like sugar and tobacco. These taxes were borne primarily by workers, who were not represented in Parliament. Parliament may have checked the Crown, but, in the absence of democracy, who checked Parliament?

In the event, the English state collected about twice as much per person as the French state and spent a larger fraction of the national income. It is arguable that these expenditures promoted economic growth. Most of the money was spent on the army and the navy. The former was occasionally directed abroad but was always available to maintain domestic order by suppressing assemblies opposed to machinery or in favour of democracy. The navy was directed to expand Britain's empire and promote the country's commerce. Even the workers gained from this since imperialism was the basis of the high-wage economy, which in turn led to growth by inducing labour-saving technical change. Had Louis XIV had the power to levy taxes, he might have advanced French prosperity by maintaining the French navy in a permanent state of readiness rather than enlarging or contracting it in response to the swing between war and peace.

Growth was also promoted by Parliament's power to take people's property against their wishes. This was not possible in France. Indeed, one could argue that France suffered because property was too secure: profitable irrigation projects were not undertaken in Provence because France had no counterpart to the private acts of the British Parliament that overrode property owners opposed to the enclosure of their land or the construction of canals or turnpikes across it. What the Glorious Revolution meant in practice was that the 'despotic power' of the state that 'was only available intermittently before 1688…was always available thereafter'.

In addition to a favourable political system, the Industrial Revolution was sustained by the emerging scientific culture. The Scientific Revolution of the 17th century led to a handful of discoveries about the natural world that were applied by inventors in the 18th. In addition, the success of natural philosophy lent credibility to the scientific method, that is, the view that the world is governed by laws that can be discovered by observation and applied to the improvement of human life. Newton's model of the Solar System was the greatest achievement, and it inspired a reorientation of upper-class ideas about religion and nature.

How much popular culture shared in this reorientation is an open question. There are important examples of working-class inventors adopting the Newtonian model. John Harrison, for instance, was lent a copy of Saunderson's lectures on natural philosophy, a Newtonian tract, by a clergyman, and made a copy of it. Did this early interest in Newton dispose Harrison to invent the chronometer? On the other hand, there was continued popular enthusiasm for witchcraft, which was the medieval alternative to science. It is likely that more people believed in witchcraft than in Newton's laws of motion. John Wesley's preaching was attracting millions of followers, and he was of the view that the 'giving up of witchcraft is, in effect, giving up the Bible'.

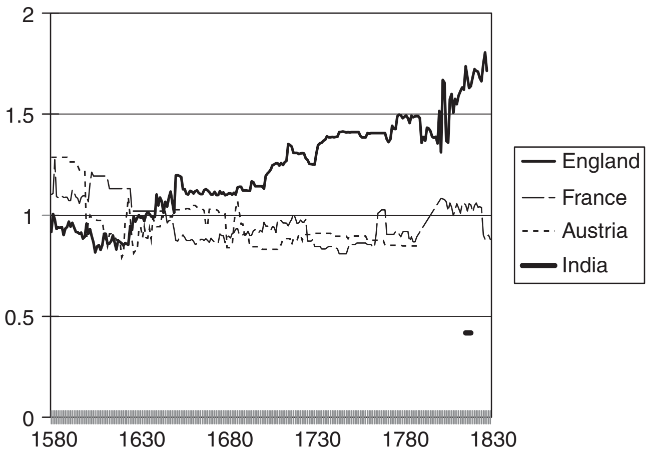
Popular culture was more directly transformed by social changes than by Newton's *Principia Mathematica*. The most powerful changes were urbanization and the growth of commerce. They encouraged the spread of literacy and numeracy by increasing their value. By the 18th century, most sons of craftsmen, artisans, shop keepers, and farmers, and a smaller share of the sons of labourers, received several years of primary education. Many girls were also schooled. The result was a public that read newspapers and followed politics to an unprecedented degree. It was a new world when a radical like Tom Paine could achieve celebrity by selling hundreds of thousands of copies of *The Rights of Man*.

Explaining the Industrial Revolution

Scientific discoveries were known across Europe, and upper-class enthusiasm for natural philosophy was universal. These cultural developments, therefore, cannot explain why the Industrial

Revolution was British. Instead, the explanation lies in Britain's unique structure of wages and prices. Britain's high-wage, cheap-energy economy made it profitable for British firms to invent and use the breakthrough technologies of the Industrial Revolution.

In Chapters 1 and 2, we saw that wages in Britain were sufficiently high for most people to eat bread, beef, and beer, instead of subsisting on oatmeal. More to the point, so far as technology is concerned, British wages were high relative to the price of capital (Figure 7). In the late 1500s, the wage rate relative to the price of capital services was similar in southern England, France, and Austria, which are representative of continental Europe. By the middle of the 18th century, however, labour relative to capital was 60% more expensive in England than on the continent. In the early 19th century, which is the first time a comparison can be made with Asia, labour was even cheaper relative to capital in India than it was in France or Austria. The incentive to mechanize production was correspondingly less in India.



7. Wage relative to price of capital services

It was the same story with energy. Britain, especially on the coal fields in the north and in the midlands, had the cheapest energy in the world. Consequently, energy was much cheaper compared to labour in Britain than it was anywhere else.

As a result of these differences in wages and prices, businesses in England found it profitable to use technology that saved on expensive labour by increasing the use of cheap energy and capital. With more capital and energy at their disposal, British workers became more productive – the secret of economic growth. In Asia and Africa, the cheapness of labour led to the opposite result.

The cotton industry

Eric Hobsbawm famously wrote: 'Whoever says Industrial Revolution says Cotton.' From tiny beginnings in the mid-18th century, the industry grew to be Britain's largest, accounting for 8% of GDP in 1830 and 16% of British manufacturing jobs. Cotton was the first industry to be transformed by factory production. The growth of cotton led to the explosive growth of Manchester and many smaller cities in the north of England and Scotland. Britain's expansion came at the expense of India, China, and the Middle East. When these countries eventually began to re-industrialize, cotton was one of the first industries they turned to.

In the 17th century, China and India had the world's largest cotton industries. Bengal, Madras, and Surat shipped cotton cloth across the Indian Ocean and as far as West Africa. Cotton was also produced in small centres across Asia and Africa. The various East Indies companies began to ship cotton calicoes and muslins to Europe in the late 17th century where they successfully competed against linen and wool, the principal European textiles. Cotton was so successful that France prohibited its import in 1686, and the English restricted its domestic consumption. However, there was a large export market in West Africa, where cotton cloth was bartered for slaves. In this market, English cloth competed against Indian cloth.

International competition was the spur that led to the mechanization of cotton spinning. The finer the cotton, the more time it took to spin. Wages were so high in England that competition with India was only possible in the coarsest fabrics. There was a large market in finer fabrics, but England could only compete if machines were invented to reduce labour. The stakes were considerable: in 1750, Bengal spun about 85 million pounds of cotton per year, while Britain managed only 3 million. There were numerous attempts to mechanize production. James Hargreaves' spinning jenny, developed in the mid-1760s, was the first commercially successful machine, followed closely by Richard Arkwright's water frame. Samuel Crompton's mule, invented in the 1770s, married the jenny and the water frame (hence its name) and became the basis of mechanical spinning for a century.

These machines owed nothing to scientific discoveries. None involved great conceptual leaps; instead, they required years of experimental engineering to come up with designs that worked reliably. Thomas Edison's remark that 'invention is 1% inspiration and 99% perspiration' is on the mark for the cotton industry.

The crux in explaining why the Industrial Revolution was invented in Britain is, therefore, explaining why British inventors spent so much time and money doing R&D (Research and Development, that is, Edison's 'perspiration') to operationalize what were often banal ideas. The key is that the machines they invented increased the use of capital to save labour. Consequently, they were profitable to use where labour was expensive and capital was cheap, that is, in England. Nowhere else were the machines profitable. That is why the Industrial Revolution was British.

Cotton yarn was manufactured in three stages. First, the bales of raw cotton were broken open and the dirt and debris removed.

Second, the cotton was carded, that is, the strands of cotton were aligned into a loose strand called a roving by dragging the cotton between cards studded with pins. Third, the roving was spun into yarn. Before machines, the whorl and drop spindle was used to make fine yarn, while the spinning wheel made coarse yarn. In each case, the roving was stretched to thin it, then twisted to strengthen it, and, finally, the yarn was wound on a spindle to send to weavers.

All of these stages were mechanized, and, indeed, Richard Arkwright's greatest achievement was to design a mill (Cromford Mill No.2) in which machines were laid out in a logical sequence, and which became the model for the early cotton mills in Britain, the USA, and the continent. Spinning was the crux of the problem, and inventors had worked on it since at least the 1730s. Lewis Paul and John Wyatt were on the right track in the 1740s and 1750s with their system of roller spinning, but their mill in Birmingham always lost money. James Hargreaves' spinning jenny, invented in the 1760s, was the first commercially successful spinning machine. It elaborated the spinning wheel by running many spindles off one wheel and using draw bars and linkages to mimic the movements of the spinner's hands. Arkwright employed clockmakers for five years in order to perfect his water frame that used rollers. With roller spinning, the roving was stretched by pulling it through successive pairs of rollers, which, like mangles, dragged the cotton forward. Each pair of rollers moved faster than the previous, so they lengthened and thinned the yarn by pulling against each other.

Crompton's mule was the last great spinning machine. It combined the draw bars of Hargreaves' jenny with the rollers of Arkwright's water frame to make a machine that could spin yarn far finer than any of the other machines. The jenny and the water frame made England competitive with Indian producers in coarse yarn; the mule made England the low-cost producer in fine yarn as well.

The economics of these machines were similar. All of them reduced the hours of labour needed to produce one pound of yarn. At the same time, they increased the capital required per pound. As a result, the cost saving from mechanical spinning was higher where labour was more expensive. In the 1780s, the rate of return to building an Arkwright mill was 40% in England, 9% in France, and less than 1% in India. With investors expecting a 15% return on fixed capital, it is no surprise that about 150 Arkwright mills were erected in Britain in the 1780s, 4 in France, and none in India. Relative profitability was similar with the spinning jenny, as was the result – 20,000 jennies were installed in England on the eve of the French Revolution, 900 in France, and none in India. There was no point in spending much time or money to invent mechanical spinning in France or India since it was not profitable to use it there.

The situation did not remain like this, which is why the Industrial Revolution spread to other countries. Arkwright's mills created an integrated series of machines that cut costs by more than Hargreaves' jenny. Crompton's mule cut the cost of spinning fine yarn. A long list of inventors improved the mule over the next half century. They economized on capital as well as on labour. By the 1820s, improved cotton machinery could be profitably installed on the continent, and by the 1850s, it proved profitable to install even more improved machinery in low-wage economies such as Mexico and India. By the 1870s, factory cotton production began to shift into the Third World.

The steam engine

The steam engine was the most transformative technology of the Industrial Revolution since it allowed mechanical power to be used in a wide range of industries as well as in railways and ocean ships.

Steam power was a spin-off of the Scientific Revolution. Atmospheric pressure was one of the hot topics of 17th-century physics. It was investigated by famous scientists across Europe, including Galileo, Torricelli, von Guericke, Huygens, and Boyle. By the middle of the century, Huygens and von Guericke had shown that, if a vacuum was created in a cylinder, then the pressure of the atmosphere would force a piston into it. In 1675, the Frenchman Denis Papin used this idea to make a crude, proto steam engine. A practical engine was completed by Thomas Newcomen in 1712 in Dudley, after 12 years of experimentation. Newcomen's engine involved boiling water to make steam, filling a cylinder with it, and then injecting cold water into the cylinder to condense the steam so that the pressure of the atmosphere depressed a piston into the cylinder. The piston was connected to a rocker beam that raised a pump as the piston was depressed.

The steam engine emphasizes the importance of economic incentives in inducing invention. The science of the engine was pan-European, but the R&D was conducted in England because that was where it paid to use the steam engine. The purpose of the Newcomen engine was to drain mines, and Britain had many more mines than any other country due to the large coal industry. In addition, the early steam engines burned vast quantities of coal, so they were cost-effective only where energy was cheap. John Theophilus Desaguliers wrote in the 1730s that the Newcomen engines were 'now of general use … in the Coal-Works, where the Power of the Fire is made from the Refuse of the Coals, which would not otherwise be sold'. They were scarcely used anywhere else. Despite the scientific breakthroughs, the steam engine would not have been developed had the British coal industry not existed.

Steam power became a technology that could be applied to many purposes and used around the world, but only after the engine was improved. This was not accomplished before the 1840s. Engineers like John Smeaton, James Watt, Richard Trevithick, and Arthur Woolf studied and modified the engine, reducing its energy requirements and smoothing its delivery of power. Coal consumption per horse power-hour of power was cut from 44 pounds in the Newcomen engines of the 1730s to one pound in the triple expansion marine engines of the late 19th century. The genius of British engineering undid the country's competitive advantage by improving its technology to the point that it could be profitably used around the globe. This allowed the Industrial Revolution to spread abroad and the whole world to industrialize.

Continuing invention

The greatest achievement of the Industrial Revolution was that the 18th-century inventions were not one-offs like the achievements of earlier centuries. Instead, the 18th-century inventions kicked off a continuing stream of innovations.

Cotton continued to be a focus of effort. While the 18th-century inventions had turned spinning into a factory system, weaving was still done on hand looms in cottages. This was changed by the Reverend Edmund Cartwright, who spent decades and wasted his fortune perfecting a power loom. He was inspired by automatons like Jacques de Vaucanson's mechanical duck that wowed the court in Versailles by flapping, eating, and defecating! (Voltaire quipped: 'Without Vaucanson's duck, you have nothing to remind you of the glory of France.') If a mechanism could poop like that, couldn't it also do useful work? Cartwright thought so and patented his first loom in 1785 and an improved version in 1792. It was not commercially viable, however. Many inventors improved it piecemeal. By the 1820s, the power loom was displacing hand looms in England, but they continued in use until the 1850s. The power loom greatly increased capital costs while reducing labour costs, so its adoption was sensitive to factor prices as well as the relative efficiency of the two methods. It is singularly important that the power loom was taken up more rapidly in the USA than it was in Britain. By the 1820s, wages were already higher in the USA, and the pattern of technological innovation reflected that difference.

Cotton also led the way in the application of steam power to factories. Experiments had been made earlier, of course. In 1784, Boulton and Watt invested in the Albion Flour Mill, the first large-scale steam-powered factory, to promote their engines. The next year, steam was applied to a cotton mill for the first time. However, most factories were driven by water power until the 1840s. It was only then that the fuel consumption of steam engines had dropped sufficiently to make them a cheaper source of power. After that, the use of steam to power industry expanded continuously.

Steam power also revolutionized transportation in the 19th century. Everyone who invented a high-pressure steam engine (Cugnot, Trevithick, Evans) used it to power a land vehicle, but they were all unsuccessful since they could not negotiate the unpaved roads. One solution was to put the engine on rails. Coal and ore had long been hauled in carts rolling on primitive wooden rails laid in mines. In the 18th century, iron rails replaced wood, and the lines were extended. In 1804, Richard Trevithick built the first steam locomotive for a railway at the Penydarren Ironworks in Wales. From then on, colliery railways became the testing ground for steam locomotives. The 26-mile Stockton and Darlington Railway (1825) was planned as a coal railway but showed there was money to be made in carrying general freight and passengers. The first general-purpose railway was the 35-mile Liverpool and Manchester Line, opened in 1830. It was a great success and set off a frenzy of railway promotion in Britain. Almost 10,000 kilometres of track were open by 1850, and 30 years later, the network reached 25,000 kilometres.

Steam power was also applied to water travel – another way of avoiding bad roads! Invention was international from the start. The first working vessels were French – the *Palmipède* (1774) and *Pyroscaphe* (1783) – and the first commercially successful ship was Robert Fulton's *Clermont*, which plied the Hudson River from

1807. Two years later, John Molson, the Canadian brewer, sailed steamships on the St Lawrence River using engines built in Trois-Rivière, Québec.

By the middle of the 19th century, steam was displacing sail in ocean transportation. Britain became the centre of world shipbuilding in view of its pre-eminence in iron and engineering. Brunel's *Great Western* (1838) marked a breakthrough, for it established that a ship could carry enough coal to cross the Atlantic, and his *Great Britain* (1843) was the first ship to be built of iron and to use a propeller instead of paddle wheels. It took another half century, however, for steam to vanquish sail. The reason was that ships still had to carry their own coal, so they lost much of their cargo space on long voyages. The first routes to shift to steam were consequently short. As the coal requirements of steam engines were reduced, ships could sail longer distances with the same amount of coal, and the distance for which steam could undercut sail lengthened. The last routes to fall were those from China to Britain where clipper ships survived until the end of the 19th century.

Steam power is an example of a general-purpose technology (GPT), that is a technology that can be applied to a variety of uses. Other GPTs include electricity and computers. It takes decades to develop the potential of GPTs, so their contribution to economic growth takes place long after their invention. That was certainly true for steam. As late as 1800, almost a century after Newcomen's invention, steam power made only a minute contribution to the British economy. By the middle of the 19th century, however, the potential of steam was finally being realized as it was applied widely to transportation and industry. Half of the growth of labour productivity in Britain in the mid-19th century was due to steam. This long-run pay-off is an important reason that economic growth continued through the century. Another reason was the growing application of science to industry, which we will consider in the next chapter.

Chapter 8
The standard model and late industrialization

By 1850, Europe and North America had pulled ahead of the rest of the world. How the poor countries could catch up was the new problem. Colonies could do little, since their options were restricted by the imperial power. Independent states, however, could apply the standard model – railways, tariffs, banks, and schools – that had worked for the USA and Western Europe. This strategy, however, proved less and less fruitful as time went by.

Imperial Russia

Russia was for a long time the most backward part of Europe. Peter the Great (1672–1725) tried to turn it into a modern Western power. He built the new port of St Petersburg and founded many factories mainly devoted to the military. There was no catch-up with the West, however. The extent of Russia's backwardness was made clear by the country's defeat by England and France in the Crimean War (1853–6). Modernization was so pressing that Tsar Alexander II abolished serfdom. Reformers hoped this would kick-start economic growth by creating free labour and private property, but there was no quick response.

The post-emancipation government adopted the standard development model with some modification. First, a national market was created through a vast programme of railway construction. By 1913, 71,000 kilometres of track were open and linked Russia to the global economy.

> When the peasants marketed their grain in Nikolayev [in 1903], they asked, 'What is the price in America according to the latest telegram?' And what is still more surprising they know how to convert cents per bushel into kopecks per pood.

Second, tariffs were used to build up industry. By 1910, Russia smelted 4 million tons of pig iron per year. It was not in the first division with the USA, Germany, and the UK, but it was a leader in the second. Russia also developed an important engineering industry. In addition, the state promoted light industry with high tariffs on cotton textiles and moderate tariffs on raw cotton. As a result, the cultivation of cotton expanded in what became Uzbekistan. In the early 20th century, Russian mills processed almost as much cotton as Germany's. Third, the biggest innovation in economic policy lay in finance. Private banks were too weak to play the role they had in Belgium or Germany. Instead, Russia relied on foreign capital. Railways were financed by selling securities abroad, and foreign direct investment became the principal means of bringing advanced technology to the country. Plants were built to West European specifications, however, without any adaptation to Russia's different economic circumstances, with the result that production costs were higher than in Western Europe. Fourth, education was expanded from the 1860s onwards. By the First World War, almost half of the adult population was literate. Even amongst manual workers, the earnings of the literate were higher than those of the illiterate, so schooling was attractive to many people.

The standard model (as amended) boosted the share of heavy industry in Russia from 2% of GDP in 1885 to 8% in 1913, but agriculture remained the biggest sector (its share slipped from 59% to 51%). Agricultural output doubled over this period as the world price of wheat rose, and farming accounted for most of the growth in GDP. Tsarist economic growth was mainly an agricultural boom, souped up with some tariff-induced industrialization. Growth would probably have petered out when the world price of wheat collapsed after the First World War. Another economic model was needed to catch up to the West.

An indicator of the limited impact of the standard model in Russia was the state of the labour market. Despite the growth in GDP, labour demand did not grow enough to fully employ the population, so wages remained at subsistence, and the extra income created by growth accrued as profits to the owners of industry and as rent to the owners of land. These became the flash-points of social conflict. Unequal development led to a revolt in 1905 and, more explosively, in 1917. The failure of the standard model to transform Russia led to its own undoing.

Japan

Japan is a particularly interesting case, for it was the first Asian country to catch up with the West. Japanese history is divided into four periods: Tokugawa (1603–1868), when the country was governed by Tokugawa shoguns; Meiji (1868–1905), when power was returned to the Emperor Meiji and economic modernization began; Imperial (1905–40), when heavy industries were founded; and, finally, the Era of High Speed Growth (1950–90), when Japan caught up with the rich countries of the West.

The roots of Japan's success lie in the Tokugawa period, although the country had many institutions that were inimical to economic growth. Society was divided into castes – samurai, peasants, artisans, and merchants – and the polity into several hundred domains ruled by lords called daimyo. Domains could be confiscated, and this created insecurity of property at the highest social level – rather like Elizabethan England. Draconian restrictions were imposed on international trade and contacts.

Inbound ships were only allowed from China, Korea, and the Netherlands, and the Dutch were restricted to a tiny settlement in Nagasaki.

Technology advanced in the Tokugawa period, but the character of the improvements was the reverse of Britain's. Since wages were low in East Asia, the Japanese invented technology that increased the employment of labour in order to raise the productivity of land, capital, and materials. Labour, for instance, was deployed constructing irrigation systems to raise crop yields. New varieties of rice such as *akamai* were planted, and water control allowed a second crop such as wheat, cotton, sugar cane, mulberry, or rapeseed to be grown. Farmers worked more hours per hectare and used less capital, as hoes were substituted for ploughs and draft animals.

Productivity in manufacturing processes was also improved. Domains tried to attract industries and supported research to raise their productivity since more production led to more tax revenue. In the case of silk, early experiments to use machinery along English lines (for example, employing gear and belt systems inspired by clocks and automatons) were abandoned since they were not economic. Instead, experiments were directed at improving the productivity of silk worms. Selective breeding and temperature control cut maturation time and boosted silk per cocoon by one-quarter. In mining, mechanical systems of drainage were known but not used; instead, armies of workers did the work. Likewise, much labour was expended to extract the maximum amount of metal from ores. The exception that proves the rule was sake. Capital-intensive, water-powered factories were installed but only because the government restricted production by limiting the time during which breweries could operate. That restriction led to high-volume plant design.

Tokugawa development produced uneven prosperity. The population and rice crop both grew in the 17th century, but the wages of labourers stayed at 'bare-bones' subsistence. The average person consumed about 1,800 calories per day in the late Tokugawa and early Meiji periods. Most calories and protein came from rice, potatoes, and beans rather than meat or fish. The correlate was that people were short: men averaged 157 cm and women 146 cm.

Many people, nonetheless, enjoyed a more affluent lifestyle. About 15% of the population lived in cities; Edo (modern-day Tokyo), with a population of one million, Osaka, and Kyoto (each 400,000) were amongst the largest cities in the world. Life expectancy was increasing. Leisure grew as peasants took 'recreation days' and travelled around the country. School attendance was very high for an agrarian society. In 1868, 43% of boys and 10% of girls attended school, where they learned reading and arithmetic. More than half of adult men were literate. Reading for instruction and pleasure was widespread. Books were too expensive for most people to buy, but they could be rented from shops. In 1808, there were 656 rental bookshops in Edo, supplying about 100,000 households (roughly half the population) with books. The high level of education was probably due to the commercialization of the Japanese economy, and it underlay later growth.

Tokugawa Japan achieved an impressive level of engineering and administrative competence that was apparent in the establishment of the first iron foundry in Nagasaki. Military necessity was the impetus. In 1808, *HMS Phaeton* entered the city's port to attack Dutch shipping. *Phaeton* threatened to bombard the harbour unless provisions were provided. The Japanese had no iron cannon to defend themselves since they had no furnaces to cast them. Nabeshima Naomasa, who became the lord ruling Nagasaki and who was an enthusiast for Western science, established a team to create a cannon foundry. The group included savants and craftsmen skilled in iron. They translated a Dutch book describing a foundry in Leyden and replicated it. In 1850, they succeeded in building a reverberatory furnace, and three years later were casting cannon. In 1854, the Nagasaki group imported state-of-the-art, breech-loading Armstrong guns from Britain and manufactured copies. By 1868, Japan had eleven furnaces casting iron.

The Meiji Restoration

In 1839, the British attacked China to force the country to allow the importation of opium, which was one of the East India Company's most lucrative products. Narco-imperialism triumphed with China's defeat in 1842. Would Japan be next? The answer seemed to be 'yes' when the US Commodore Perry arrived with four warships in 1853 and demanded that Japan end its restrictions on foreign trade. Without a modern navy, Japan felt it had to agree and signed treaties with the USA, Britain, France, and Russia. An adequate military was urgent. The Tokugawa shogun took some steps to improve Japanese security, but many regarded this as too little, too late.

In 1867, the Emperor Meiji ascended the thrown. Modernizers effected a virtual *coup d'état*, and the last Tokugawa shogun relinquished his powers. The slogan of the modernizers was 'rich country, strong army'.

The new regime undertook sweeping reforms. All of the feudal domains were 'surrendered' to the Emperor, and the 1.9 million samurai were paid off with government bonds. The four orders of society were abolished, so anyone could take any job. The peasants were confirmed in the ownership of their land and modern property rights were created. Feudal payments were replaced by a land tax to the national government. This provided most state income in the 1870s. In 1873, universal conscription was introduced and a Western-style army created. This further eroded the privileges of the samurai, who had previously been the only people allowed to bear arms. In 1890, a written constitution that created a constitutional monarch on the Prussian model was adopted.

The radical spirit of Meiji Japan is shown by a simple problem – the measurement of time. The traditional Japanese clock divided the interval from sunrise to sunset into six hours and from sunset to sunrise into another six hours. The day hour and the night hour, therefore, differed in duration, and, moreover, the length of each varied over the course of the year. Tokugawa clockmakers experimented with ingenious modifications of Western mechanical clocks to reproduce these hours. In 1873, the first Japanese railway was completed, and the Meiji government faced the problem of publishing a timetable. Rather than a complicated schedule with departure and arrival times varying over the year, the state instead abolished traditional Japanese time and replaced it with the Western 24-hour clock. Modern transportation required modern time.

Meiji economic development

The Meiji government would have liked to develop the country with the standard model that had been successful in Western Europe and North America, but they could easily introduce only two of its four components. The first was the creation of a national market by abolishing the tariffs between domains and building a railway network. The second was universal education. In 1872, elementary schooling was made compulsory, and, by 1900, 90% of the school-age children were enrolled. Secondary schools and universities were founded but were limited and highly competitive. Thousands of Japanese were sent abroad to study. As a result, education progressed much earlier in Japan than in other poor countries. Table 6 contrasts Japan with Indonesia, a country whose experience is representative of most of Asia and Africa. In Japan, a high proportion of the population (10.8%) was in school by the late 19th century, and modern levels of participation (19.7%) were reached by the Second World War. Indonesia, by contrast, lagged several generations behind Japan. Mass education was an important reason for Japan's success in adopting modern technology.

Table 6. Percentage of the population in school

	Japan	Indonesia
1870	2.5	0.1
1880	6.7	0.1
1900	10.8	0.4
1913	14.1	1.1
1928	17.5	2.8
1940	19.7	3.4
1950	22.3	7.0
1973	17.2	13.6
1989	18.8	23.9

The other components of the development model – investment banks and a protective tariff – were harder to implement. Tokugawa Japan had nothing like modern banks. The Meiji state chartered banks from the outset, but the system was chaotic. It took 50 years for Japan to develop a banking system along German lines. Early in the Meiji period, the state filled the gap by acting as the venture capitalist.

It was impossible for Japan to use tariffs to promote industrial development because the maximum tariff rate was capped at 5% by a treaty forced on Japan by the Western powers in 1866. Instead, the state intervened directly in the economy through 'targeted industrial policy'. The most important actors were the Ministries of the Interior and Industry, which were charged with importing modern technology. The Ministry of Industry established Japan's railway and telegraph systems in the 1870s and

1880s. Foreign technicians initially guided the project, but a school to train Japanese engineers was established in Osaka, and the foreigners were dispensed with as quickly as possible. One reason the Japanese managed the projects was to ensure that procurement policy promoted Japanese industry. Japanese potters, for instance, received contracts to make insulators for telegraph lines, and, in that way, an industrial ceramics industry was created.

In the 1870s and 1880s, both ministries operated on the assumption that Japanese business would not introduce modern technology at the required pace, so that the state had to be the entrepreneur. State-owned mines and factories were established using advanced imported machinery, but most were commercial failures. The Tomioka silk-reeling factory, for instance, was built in 1872 with French machinery and steam power but always lost money. In the 1880s, the Japanese government sold most of its industrial establishments and relied on business to make management decisions within the framework established by the state. Japanese business solved the problem of importing technology by re-engineering it to make it appropriate for Japanese conditions.

Japan faced a problem that has only become worse with time: modern technology was embodied in machinery and plant specifications that were designed for Western firms facing Western conditions. By the late 19th century, wages were much higher in the West than they were in Japan, so Western designs used much capital and raw materials to economize on labour. This configuration was inappropriate for Japan and resulted in high costs. Some countries limped along with inappropriate technology, but the Japanese response was far more creative: they redesigned Western technology to make it cost-effective in their low-wage economy.

Silk-reeling was an early example. At the same time that the Tomioka mill was losing money, the Ono merchant family in Tsukiji established a mill that also used European-inspired machinery. In this case, however, the machines were made of wood rather than metal and the power came from men turning cranks rather than a steam engine. The modification of Western technology along these lines became common in Japan as the 'Suwa method'. This was an appropriate technology for Japan in that it used less expensive capital and more cheap labour.

It was the same story with cotton. The early attempts to spin with mules were not successful. Much more successful was the *garabô* (rattling spindle) invented by Gaun Tokimune. The *garabô* could be produced cheaply by local carpenters (so it saved capital) and produced yarn similar to that produced by hand wheels with which it was competing. The *garabô* was not a high-level Meiji project, but it was supported by the Association for Developing Production run by Gaun's local prefecture.

The contrast with India is telling. The cotton-spinning industry that grew rapidly in Bombay in the 1870s used English mules, and the mills were operated in the same manner as in Britain. No systematic attempts were made to reduce capital in the Indian industry. Such efforts were made in Japan, however. An elementary step was to operate the mills with two eleven-hour shifts per day rather than one, which was normal in Britain and India. This cut capital per hour worked in half. From the 1890s onwards, high-speed ring spindles were installed instead of mules. These changes in technique all increased employment relative to capital and cut costs. By the 20th century, Japan was the world's low-cost spinner of cotton and was out-competing the Indians and Chinese as well as the British.

Development of appropriate technology extended to agriculture. The Japanese experimented with US farm machinery in the 1870s, but it was unsuccessful because it used too much capital. More successful were efforts to increase the productivity of land, even if that required the use of more labour. In 1877, *shinriki* rice was developed near Osaka. It gave high yields if it was fertilized and if the paddy was thoroughly tilled. Veteran farmers' organizations were enlisted by the Ministry of Agriculture to spread this culture to the rest of the country. Agricultural output grew steadily in Meiji Japan and made an important contribution to the growth of the economy – once invention focused on increasing the productivity of land, the scarce and expensive factor of production.

The Imperial period, 1905–40

While Japanese society was overhauled in the Meiji period, change in the economic structure was slow. The leading industries were traditional – tea, silk, and cotton. Exports of these products paid for imported machinery and raw materials.

Industrial growth accelerated between 1905 and 1940, and its character changed. The share of manufacturing leapt from 20% of GDP in 1910 to 35% in 1938. The metallurgical, engineering, and chemical industries that dominated post-war Japanese growth were founded in this period, as were the famous firms that produce these products.

These advances coincided with the full implementation of the standard development model. Japan recovered control over its tariffs in 1894 and 1911, and they were immediately raised to protect industry. By the 1920s, the banking system had matured to the point that it could finance industrial development. In addition, Japan retained its system of targeted industrial policy. The combination of policy instruments proved particularly potent for promoting heavy industry.

The first step was taken in 1905 when the Yawata Steel Works were established for strategic reasons. The plant was state-owned and required subsidies for years before becoming profitable. The First World War gave a boost to Japanese business since European imports were cut off. After the war, the military undertook research in conjunction with private companies, and promoted key industries like automobiles, trucks, and aircraft with procurement contracts. Large-scale firms, along with banks that financed them, were owned by holding companies. These *zaibatsu* coordinated production and channelled investment to industry.

While the *zaibatsu* aimed to deal with the shortage of capital in Japan by increasing the rates of savings and investment, management also responded to the factor prices it faced by inventing appropriate technology. American firms operating in a high-wage environment invented highly mechanized, assembly-line production systems that economized on labour. Japanese firms, in contrast, economized on raw materials and capital. One of Japan's most famous products was the Mitsubishi Zero fighter. Its maximum speed of 500 kilometres per hour at 4,000 metres was not achieved by increasing the power of its engine but instead by reducing its weight. One expedient developed in the 1930s was 'just in time' production. Rather than producing components for inventories that required capital to finance, Japanese businesses produced components only as they were needed. 'Just in time' production is a technique that has proved to be so productive that it is now used in settings where capital is cheap as well as where it is dear.

Unlike Tsarist Russia or Mexico, foreign investment was a comparatively unimportant channel for importing Western technology. Instead, Japanese firms established their own R&D departments to copy it and re-engineer it to suit Japanese conditions. Business was supported by the state. When it proved impossible to import electrical turbines from Germany in 1914, Hitachi was awarded a contract for a 10,000-horsepower turbine for a hydro-electric project. Since the largest turbine Hitachi had previously built was 100-horsepower, there was much to learn, and the experience strengthened the firm's engineering capabilities.

Japan's application of the standard development model was a mixed success. On the one hand, an urban society with advanced industries was created. Per capita GDP increased from $737 in 1870 to $2,874 in 1940. Given the stagnation that gripped most of the Third World, these achievements were impressive. On the other hand, the rate of growth in per capita income (2.0% per year) was modest and not much above the US rate of 1.5%. If these rates had continued after 1950, it would have taken Japan 327 years to catch up to the USA. That was not fast enough.

The slow growth of the economy was reflected in weaknesses in the labour market, as in Russia and Mexico. The large-scale firms paid high wages, but wages remained very low in agriculture and small-scale industry because labour demand was weak. These sectors continued to use hand technology or only simple machines. There was a symbiosis between the modern and traditional sectors: if a stage in a modern production process could be performed least expensively by small-scale, handicraft methods, then it was subcontracted to a small firm.

Latin America

Latin America has undertaken the most recent experiments with the standard model. These began at the same time as the southern part of the continent was integrated into the world economy.

Mexico, the Andes, Brazil, and the Caribbean had been part of the world economy since the 16th century, but southern Latin America was too far from Europe for trade to be viable. After 1860, efficient steamships made it profitable to export wheat from Argentina and Uruguay, and guano and copper from the Pacific coast of the continent. Meat exports were added to the list in 1877, when the first refrigerated ship, *Le Frigorifique*, carried frozen mutton from Buenos Aires to Rouen. Exports boomed, and the region attracted settlers and capital from Europe. By

1900, the southern cone was one of the richest regions in the world, and Argentina joined Mexico in developing manufacturing.

Many Latin American countries were too small to become industrial nations and continued to export primary products and import manufactures – and continued to be poor. The larger economies, on the other hand, experimented with the standard development model in the late 19th century and persevered with it until the 1980s, when it was dubbed 'import substitution industrialization' (ISI). First, 90,000 kilometres of railways were laid in Argentina, Brazil, Mexico, and Chile by 1913. Second, tariffs protected industries like textiles and iron. Third, the Russian model was followed with investment financed abroad. Fourth, a notable lapse, however, was the failure to provide universal education. Argentina was the great exception, for it mandated compulsory, free schooling in 1884. As a result, Argentina (followed closely by Chile) led the continent, with over half its adult population literate in 1900 – compared to one-quarter in Mexico, Venezuela, and Brazil.

Manufacturing development gathered pace behind tariffs in the 1920s and 1930s, and the low prices of the continent's agricultural exports lent weight to arguments for industrial development. This sentiment was turned into doctrine by the UN Economic Commission on Latin America, under the direction of the Argentine economist Raul Prebish. *The Economic Development of Latin America and its Principal Problems* (1950) contended that the prices of the primary products exported by Latin America were falling with respect to the prices of the manufactured imports and recommended state promotion of industry to counter the trend. This so-called 'dependency theory' has been politically influential, although its claims are debatable. Consider examples in this book. The history of palm oil and cocoa are in accord with the theory since their prices have fallen with respect to the price of cotton cloth since the mid-19th century (Figures 17 and 18).

However, the price of raw cotton *rose* with respect to the price of cloth in India in the 19th century, leading to de-industrialization (Figures 12 and 13).

Dependency theory led to a comprehensive application of the standard model. Education was finally made universal. Development banks were created to fund development, while foreign investment became the vehicle for financing industry and introducing advanced technology. Tariffs and government controls were used to promote a range of modern industries. Manufacturing output and urbanization soared. Per capita income more than doubled between 1950 and 1980. Foreign debt grew as well, however, and could no longer be serviced when interest rates rose in the early 1980s. Mexico defaulted in 1982, Western banks called in loans, and Latin America went into recession. The standard model had reached its limits.

The failure of tariff-induced industrialization also reflected deeper factors like the evolution of technology. The difference in wages between rich and poor countries had grown, so that the new highly capital intensive technology of the 1950s was even less suitable to poor countries than was the technology of 1850. In addition, a new problem appeared. The new technology of the mid-20th century involved not only high capital to labour ratios but also large plant sizes. These were often too big for the markets of poor countries.

Automobiles are an important example. Most Latin American countries promoted their production, but markets were too small for efficient operation. The MES (minimum efficient size) for vehicle assembly plants in the 1960s was 200,000 autos per year. The MES for engines and transmissions was closer to one million per year, while sheet metal presses could produce four million units in their lifetime. Only seven companies (GM, Ford, Chrysler, Renault, VW, Fiat, and Toyota) produced at least one million autos per year and had engine, transmission, and assembly plants of MES. (Efficiency in metal stamping was realized by changing body design only every few years.) Smaller firms were burdened with higher costs.

Latin American car markets were smaller. In the 1950s, about 50,000 new cars were sold each year in Argentina. The Automotive Decree of 1959 required that 90% of the content of vehicles sold in the country be manufactured there. Production grew at 24% per year until 1965, when 195,000 vehicles were produced, and automobiles accounted for 10% of the economy. ISI looked a great success in terms of the growth in output, but the industry was far too small to realize the economies of large-scale production. The small size of the national market was exacerbated by its division amongst 13 firms, the largest of which produced only 57,000 vehicles. The upshot was that the cost of producing an automobile in Argentina was 2.5 times the cost in the USA. Argentina could never compete internationally with this industrial structure, and the overall efficiency of the economy was dragged down by this sector. Since the same story was repeated in steel, petrochemicals, and other industries, ISI played a big role in depressing GDP per worker and, hence, the standard of living.

The contrast with the 19th century is stark. Scale was not an issue then. Around 1850, a typical cotton mill had 2,000 spindles and processed 50 tons of yarn per year. The USA consumed about 100,000 tons of yarn annually, so it could accommodate 2,000 cotton mills of the MES. It was the same story in other modern industries: a blast furnace produced 5,000 tons per year and total consumption in the USA was about 800,000 tons, or 160 times MES; a rail mill rolled 15,000 tons of rails per year, while the USA laid 400,000 tons (only 27 times more!). The high USA and European tariffs raised the prices paid by consumers in the 19th century, but they did not burden their economies with an inefficient industrial structure. That is a fundamental reason why the standard model worked in North America but not in South America.

The end of the standard model

In Tsarist Russia, Japan, and Latin America, the standard model generated modest economic growth, but not enough to close the gap with the West. With per capita GDP growing at about 2% per year in the advanced countries, poor countries had to generate at least that much growth just to stay even and very much more to catch up in a short time-frame. Tsarist Russia, Japan, and Latin America could not do that with the standard model. A corollary was the slow growth of labour demand that fell short of the growth in population. As a result, Tsarist Russia and Latin America suffered from high inequality and political instability. Many groups in pre-Second World War Japan – workers in agriculture and small-scale industry and women generally – likewise failed to share in the growth. These problems have worsened with time as the scale of efficient production has increased and capital to labour ratios have become even greater in rich countries. Even without the financial crisis of the early 1980s, the standard model had reached the end of its useful life. What would replace it?

Chapter 9
Big Push industrialization

The West pulled further ahead of most of the rest of the world in the 20th century, but some countries bucked the trend and caught up, notably, Japan, Taiwan, South Korea, and (less completely) the Soviet Union. China looks on course to do the same. Growth in these countries was very rapid, and the gap was closed in half a century. They began their growth spurts with an income per head equal to only 20–25% of that in the advanced countries. With the latter growing at 2% per year, the poor country could catch up in two generations (60 years) only if its per capita GDP grew at 4.3% per year. This requires total GDP to grow at 6% or more per year depending on population growth. That is a high hurdle. The only way large countries have been able to grow so fast is by constructing all of the elements of an advanced economy – steel mills, power plants, vehicle factories, cities, and so on – simultaneously. This is *Big Push* industrialization. It raises difficult problems since everything is built ahead of supply and demand. The steel mills are built before the auto factories that will use their rolled sheets. The auto plants are built before the steel they will fabricate is available and, indeed, before there is effective demand for their products. Every investment depends on faith that the complementary investments will materialize. The success of the grand design requires a planning authority to coordinate the activities and ensure that they are carried out. The large economies that have broken out of poverty in the 20th century have managed to do this, although they varied considerably in their planning apparatus.

Soviet economic development

The Soviet Union is the classic example of a Big Push. The 1917 Revolution was followed by four years of civil war, which was won by the Bolsheviks, who conceded the peasants' demands for ownership of the land and its equal division among the farming population. By 1928, the New Economic Policy had revived the economy, Lenin was dead, and Stalin was in power.

The USSR faced the same problem as other poor countries: most of the population was in the countryside engaged in handicraft production and small-scale agriculture. The country needed to build a modern, urban economy. That, in turn, required massive investment in modern technology. The Soviet solution was central planning, and the Five Year Plan became its symbol. Since Soviet businesses were state-owned, they could be directed with instructions from the top (the plan) instead of following the incentives of the market. For a long time, the Soviet model looked like a great success and inspired planned development in many poor countries.

The Soviet Big Push began with the first Five Year Plan in 1928. The growth strategy rested on four legs. The first was channelling investment into heavy industry and machinery production. This accelerated the capacity to build capital equipment and thereby pushed up the rate of investment. The USSR was large enough to absorb the output of large-scale factories, which became the norm. The second was the use of demanding output targets to direct business operations. Since maximizing output might lead to losses, bank credit was liberally given to businesses so that they could cover their costs. The 'hard budget constraints' of capitalism were replaced by 'soft budget constraints'. Third, agriculture was collectivized. Politically, this was the most controversial policy since it was anathema to the peasants, who preferred small family farms and periodic redistributions of land by the village to ensure equality. In the event, collectivization resulted in a huge fall in farm output and led to famine in 1933. The fourth was mass education. Schooling was quickly made universal and compulsory. Adult education was pursued vigorously to cut the time for the whole labour force to be trained.

These measures caused the economy to grow rapidly. By the time the Germans invaded in 1940, thousands of factories, dams, and power plants had been built. The plans tilted investment to heavy industry, which boomed. By 1940, pig iron production had increased from a pre-war maximum of 4 million tons per year to 15 million tons. This was twice as much as Britain produced, but still only half as much as the USA. Electric power generation went from 5 to 42 billion kilowatt-hours. (Lenin once quipped that Communism meant 'Soviet power plus the electrification of the whole country'. By that definition, the Revolution was a success.) The investment rate rose from about 8% of GDP in 1928 to 19% in 1939.

The production of consumer products also increased but by a smaller amount. Partly, this reflected priorities; partly, it was due to the disastrous collectivization of agriculture. Production rebounded by the end of the decade, however. In 1939, the USSR processed about 900,000 tons of ginned cotton. This was double the 1913 level, 50% more than Great Britain (whose output had fallen considerably due to Japanese competition), but only 52% of the USA's. While per capita consumption fell sharply in 1932 and 1933, there was a 20% rise in average living standards between 1928 and 1939. In addition, educational and health services were enormously extended.

The Second World War was a huge blow to the USSR: 15% of the Soviet citizens lost their lives (mortality among men aged 20–49 reached 40%), and housing and factories were destroyed. However, the capital stock was restored by 1950, and rapid economic growth resumed. Investment was kept at about 38% of GDP. By 1975, the USSR produced more than 100 million tons of pig iron and had surpassed the USA. Consumer goods output also increased rapidly. It looked like the Soviet model might really be the best way for a poor country to develop.

And then it all went wrong. The growth rate gradually declined in the 1970s and 1980s. By the end of the decade, it was nil. President Gorbachev called for 'restructuring' (*perestroika*). Central planning gave way to the market, but it was too late to save the USSR, and it was dissolved.

In the case of the Soviet Union, there are really two questions. First, what went right? Why did the GDP per head grow so rapidly from 1928 to the 1970s? Part of the answer relates to 'GDP' and part to 'heads'. GDP grew rapidly since Soviet institutions were effective in building large-scale, modern factories. Channelling investment into heavy industry increased the capacity to build structures and equipment, and soft budget constraints created jobs for people who would otherwise have been unemployed in a surplus labour economy. Even the collectivization of agriculture made a contribution (although a small one) by accelerating the migration of people to the cities where the new jobs lay. At the outset, planning did not require much vision since the object was to fit Western technology to Russian geography.

The second reason that GDP per head grew rapidly was because population growth was slow. The number of people rose from 155 million in 1920 to 290 million in 1990. In part, slow growth was due to excess mortality from collectivization and, especially, the Second World War, but their importance was dwarfed by the decline in the fertility rate. In the 1920s, the average Soviet woman had seven children. By the 1960s, this had dropped to 2.5. The growth in urbanization made a contribution, but the most important cause in the USSR (as in poor countries generally) was the education of women and their paid employment outside the home.

Second, what went wrong? Why did growth slow in the 1970s and 1980s? The possible answers range from the transient to the fundamental and include the end of the surplus labour economy, the squandering of investment on Siberian development, the arms race with the USA which drained R&D resources from civilian industry, the increased difficulty of planning once technological catch-up was completed and the task was to design the future, the impossibility of central control (what would happen to the US economy if the president had to manage it?), and the cynicism and conformity bred by dictatorship. The collapse of the Soviet Union led many observers to reject state planning and celebrate the virtues of the free market. However, other countries did better with alternative forms of planning.

Japan

The aims of Japanese policy before the Second World War were summarized in the slogan 'rich country, strong army'. Defeat in the war led Japan to reject the 'strong army', but it pursued 'rich country' with even greater commitment. Japan needed a Big Push to close the income gap with the West. The project was remarkably successful. Per capita income grew at 5.9% per year between 1950 and 1990, with a peak rate of 8% between 1953 and 1973. By 1990, West European living standards had been achieved.

Japan accomplished this advance by reversing the technology policy that it had pursued in the Meiji and Imperial periods. Instead of adjusting modern technology to its factor prices, Japan adopted the most modern, capital-intensive technology on a vast scale. The investment rate reached about one-third of national income in the 1970s. The capital stock grew so rapidly that a high-wage economy was created within a generation. Factor prices adjusted to the new technological environment, rather than the other way around.

Japanese industrialization in the post-war period required planning, and the key agency was the Ministry of International Trade and Industry (MITI). The policy tools that Japan had perfected in the 1920s and 1930s were used to accelerate the growth rate.

MITI concerned itself with two kinds of problems. One related to the scale of production – the issue that defeated ISI in Latin America. Steel was one of Japan's great successes. Production had increased from 2.4 million tons in 1932 to a peak of 7.7 million tons in 1943, then dropped to 0.5 million in 1945, and had returned to 4.8 million in 1950. A key feature of steel production is that costs are minimized with large-scale, capital-intensive mills. In 1950, minimum efficient size was 1–2.5 million tons. Most US mills were bigger than that, but only one Japanese mill (Yawata, with a capacity of 1.8 million tons) was in the range. The rest of Japan's mills produced half a million tons or less. As a result, Japanese steel was at least 50% more expensive than US or European steel, despite Japan's low wages. MITI's objective in the 1950s was to restructure Japan's industry so that all steel was produced in mills of efficient size. MITI's power came from its control of the banking system and its authority to allocate foreign exchange, which was needed to import coking coal and iron ore. By 1960, capacity had grown to 22 million tons in modernized, large-scale mills. After 1960, MITI's guidance was less direct. Expansion continued through the construction of new facilities on 'green field' sites. These were all of minimum efficient size, which had by then increased to about 7 million tons; in contrast, most capacity in the USA was in old mills of less than efficient size. Japanese mills were also technically more advanced. 83% of Japan's steel in the mid-1970s was smelted in basic oxygen furnaces against 62% in the USA, and 35% was continuously cast compared to 11% in the USA. Despite a large increase in wages, Japan was the world's low-cost steel producer due to its commitment to modern capital-intensive technology. Over 100 million tons were produced in 1975.

Who was going to buy all that steel? Shipbuilding, automobiles, machinery, and construction were major domestic purchasers. Those industries had to expand in step with the steel industry. Ensuring that result was a second planning problem. Their technologies also had to be decided, and a large-scale, capital-intensive approach was taken with these as with steel. In the case of automobiles, for instance, Japanese firms had more capital per worker than their US counterparts, and the Japanese capital was more effective since 'just in time' delivery meant that much less of it consisted of unfinished components. Also, the scale of production was larger in Japan. In the 1950s, the minimum efficient size of assembly plants was close to 200,000 vehicles per year. Ford, Chrysler, and General Motors annually produced 150,000–200,000 vehicles per plant. In the 1960s, new Japanese auto plants incorporated on site stamping and multiple assembly lines to push the minimum efficient size above 400,000 units per year. All Japanese manufacturers produced at this level, and the most efficient, like Honda and Toyota, could reach 800,000 vehicles per plant per year. Japan's move to highly capital-intensive methods created the most efficient industry in the world, and one which could price its products competitively and still pay high wages.

A third planning problem was to ensure an expansion of consumer demand in Japan to purchase these consumer durables. Japan's distinctive industrial relations institutions made a contribution: among large firms, company unions, seniority wages, and lifetime employment meant that some of the surplus of successful firms was shared with their employees. Small firms, however, provided many jobs in Japan, and in the 1950s (as in the interwar period), they paid low wages. During the 1960s and

1970s, the vast expansion of industry ended the labour surplus, and the dual economy disappeared, as wages in the small firm sector rose rapidly. Rising incomes from the expansion of employment led to a revolution in lifestyle as Japanese bought refrigerators and automobiles made with the enlarged supply of steel. Not only did the Japanese have more gadgets, but they ate better and grew taller. In 1891, the average conscript was 157 cm tall, while his counterpart in 1976 was 168 cm. Japanese consumer spending validated the decisions to expand capacity and raise wages, so that the capital-intensive technology was appropriate – after the fact, if not before.

A final planning problem related to the international market. This problem had ramifications far beyond MITI. In the mid-1970s, the Japanese steel industry was exporting almost one-third of its output, mainly to the USA. Similar percentages of automobiles and consumer durables were also shipped there. The US production of steel and autos collapsed under the impact of Japanese competition; indeed, the decline of the American Rust Belt was the counterpart to Japan's Economic Miracle. The USA could easily have prevented these imports by continuing the high tariff policy it had followed since 1816. So-called 'voluntary export restraints' were negotiated, but they were only temporary expedients. Instead, the USA elected to cut tariffs but only if other countries did likewise (multilateral trade liberalization). One reason was that the USA emerged from the Second World War as the world's most competitive economy, so expanding its export opportunities seemed more rewarding than unnecessarily protecting its home market. Japan's export success called this assumption into question. Japan, however, had established itself as the USA's bulwark against Communism in East Asia, and its geopolitical importance maintained its trade options.

The era of high-speed growth could not last forever. The end of the boom is conventionally dated to the collapse of the real estate and share bubbles in 1991, which ushered in an era of deflation.

The cause, however, was more fundamental, for it was the elimination of the conditions that allowed rapid growth in the first place. Japan grew rapidly by closing three gaps with the West – in capital per worker, education per worker, and productivity. This was done by 1990, and Japan was then like any other advanced country: it could grow only as fast as the world's technology frontier expanded – a per cent or two each year. The post-1990 growth slowdown was inevitable.

China

South Korea and Taiwan have followed close on Japan's heels in catching up to the West. Both were Japanese colonies, which gave them an ambiguous start. Modern educational systems were created, but the emphasis was on teaching Japanese rather than Korean or Taiwanese. Infrastructure and agricultural development aimed to make the colonies food suppliers for Japan. Per capita income reached $1,548 in 1940. Following the Second World War, the Japanese were expelled, their property seized, and their land holdings redistributed among the rural population, creating egalitarian peasant societies. Beginning in the 1950s, both countries vigorously pursued industrialization. South Korea, in particular, followed the Japanese Big Push model closely. Advanced technology was imported and mastered by Korean firms since foreign firms were excluded from the country. The state planned investment and restricted imports to protect the Korean manufacturers it promoted. As in Japan, high quality and performance were advanced by requiring these firms to export large fractions of their production. Korea established the heavy industries like steel, shipbuilding, and autos that were Japan's successes, and, a decade or two later, they became Korea's successes as well.

The rise of South Korea and Taiwan is impressive but will be dwarfed in significance if China continues to industrialize as rapidly as it has in recent decades. When the Communists seized power in 1949, GDP per capita was at rock bottom ($448). By 2006, income reached $6,048 per head, placing China among the middle-income countries. This was far better performance than most of Asia, Africa, or Latin America (Table 1).

How did China do it? The usual answer is 'free-market reforms', but this is incomplete. The economic history of China since 1949 divides into two periods – the planning period (1950–78) and the reform period (1978 to present). In the first, China adopted a Communist system with collective farms, state-owned industry, and central planning along Soviet lines. The development strategy favoured the expansion of heavy industry to create the machinery and structures of an urban, industrial society. The investment rate was pushed to about one-third of GDP, and industrial output grew rapidly. Technology policy, dubbed 'walking on two legs', combined capital-intensive, advanced technology with labour-intensive manufacturing where feasible. Steel production, always an objective of Big Push industrializers, jumped from about 1 million tons per year in 1950 to 32 million in 1978. Despite gyrations in policy, including the Great Leap Forward (1958–60), the subsequent famine, and the Cultural Revolution (1967–9), per capita income more than doubled from $448 in 1950 to $978 in 1978 (2.8% per year). This was no mean achievement but did not distinguish China from many other poor countries.

Following Mao's death in 1976, Deng Xiaoping began 'reforms' in 1978. Planning has been dismantled and a market economy created in its stead. Unlike Eastern Europe's 'shock therapy', China has reformed by gradually modifying and supplementing its institutions. Since 1978, growth has also surged.

The first reforms were in agriculture and illustrate the complexity of the issues. Two reforms were particularly important: First, in 1979 and 1981, state procurement agencies increased their purchase prices by a total of 40–50% for production beyond the obligatory deliveries specified in the plan. Second, collective cultivation was replaced by the Household Responsibility System. Under the HRS, the land of the collectives was divided into small farms leased to families, who were obliged to deliver their share of the commune's plan obligations but who were allowed to keep the income from sales at the high prices for production that exceeded quotas.

Farm output surged as these policies were put in place, and that is the main case for their importance. Between 1970 and 1978, GDP originating in agriculture grew at 4.9% per year, which is even more than the 3.9% realized between 1985 and 2000. However, between 1978 and 1984, output leapt up at 8.8% per year. Grain production also grew faster in 1978–84 than it did before or after. Since the rise in prices and the HRS increased the financial incentive for peasants to increase output, the usual conclusion is that the policy changes caused the output growth.

Reform, however, has to share the credit with other developments that were consequences of earlier planning decisions. The reason that Chinese farmers could increase output was because they could use advanced technology that was also coming together at the same time as rural institutions were reformed. Increasing grain yields requires three improvements under Chinese conditions – better water control, high-yielding seed, and fertilizer. There was a large increase in irrigated acreage in China between the 1950s and 1970s, and millions of tube wells were drilled in north China to supply water there. The increase in the supply of water contributed to the growth in grain output during the planning period, and was a prerequisite for the rapid output growth around 1980.

Dramatic yield increases required seed that responded to fertilizer. The biological problem is a general one in the tropics: if fertilizer is applied to the traditional varieties of rice, they produce more leaves and longer stalks. The plant eventually topples over (lodges), preventing the formation of grain. The solution lies in dwarf rice with fibrous stalks that do not lodge, so that the extra growth from fertilizing goes into seed rather than foliage. Japanese rice was naturally of this character, which was the biological basis for the growth in farm output in the Meiji period. Japanese rice could not be cultivated further south, however, due to differences in the length of the day, so it was necessary to breed dwarf varieties suitable to tropical latitudes. The most famous is IR-8, which was developed at the International Rice Research Institute in the Philippines and released in 1966. IR-8 and its successors have been the basis of the Green Revolution in much of Asia. What is less well appreciated is that China got there first. The Chinese Academy of Sciences' breeding programme produced a high-yield dwarf rice two years before IR-8. It was the diffusion of the new dwarf rice that caused Chinese farm output to explode.

High-yielding rice gives high yields only if it is heavily fertilized. In the 1970s, Chinese farmers were already using traditional fertilizers to the maximum. Heavier application required the industrial production of nitrate. Efforts to increase fertilizer production in the 1960s had not been particularly successful, so in 1973–4 the state purchased 13 ammonia factories from foreign suppliers. These came on stream in the late 1970s and provided the fertilizer that caused yields to shoot up. There is no way to know whether the rise in farm output between 1978 and 1984 required the reforms or whether it would have occurred anyway.

The character of technological change in Chinese agriculture resembles that of Japan and reflects the development of technology tailored to the country's factor proportions. As in Japan, labour was abundant and land scarce, so technological advance has until recently concentrated on augmenting the productivity of land. Comparatively little investment has been directed towards saving labour. The history of the Green Revolution in China differs in this respect from its history in India, where mechanization accompanied the adoption of high-yielding crops. Access to cheaper credit gave large-scale farmers the advantage in India, and they increased the size of their holdings at the expense of small farmers, who often lost their land. Farm machinery allowed fewer people to cultivate the soil. China avoided these conflicts. The communal ownership of land equalized holdings in China and preserved small farms, which was a more rational response to the abundance of labour and scarcity of capital, as well as being more equitable.

Reforms have also transformed the industrial sector. The first steps were also taken in the countryside. Manufacturing by-employments had always been a feature of rural China and were taken up by collective farms. After 1978, 'township and village enterprises' (TVEs) were promoted by local party officials. Consumer goods production had lagged, and the TVEs filled the gap, selling their goods in the free market. The consumer goods industries had low capital to labour ratios (unlike the heavy industries that were the focus of planning), so the TVEs used appropriate technology for China, which is why they succeeded in market competition. Between 1978 and 1996, TVE employment grew from 28 million to 135 million, and TVEs increased their share of GDP from 6% to 26%. Marketization was extended throughout the state sector from the mid-1980s when the state froze its plan targets and allowed enterprises to sell production beyond plan requirements on the free market. Since then, the economy has 'outgrown the plan' and become increasingly market-driven, as it has expanded.

In 1992, the 14th Party Congress endorsed the 'socialist market economy' as the goal of reform, and material balance planning, the centrepiece of central planning, was abolished. Subsequent reforms created a financial system to take the place of state allocation of investment and converted state-owned enterprises from government departments into publicly owned corporations. The reform of state-owned industry has involved deep cuts in employment and closing down unproductive capacity. This is a result that the USSR never accomplished and which may have contributed to its growth slowdown by locking a large share of the work force in unproductive jobs rather than redeploying them to new, high-productivity facilities. As investment has become more market-driven, the investment rate has remained high. The state remains active, if less formally involved, in guiding investment in energy and heavy industry. Perhaps for this reason, the steel industry has continued to grow explosively. It now produces 500 million tons per year. The USA, the USSR, and Japan never produced more than 150 million tons, so China has broken all world records. China's population is, of course, much larger, but production per head, now 377 kg (up from 2 kg per head in 1950 and 102 kg as recently as 2001), has reached the consumption level of rich countries. Between 1978 and 2006, per capita income grew at 6.7% per year.

The reforms are the usual explanation for the high growth rate. As with agriculture, the explanation is incomplete. China's 'reformed institutions' may have improved the country's performance compared to Mao's system, but they have not produced superior institutions to those found in most poor countries of the world; indeed, were China growing slowly, its slow growth would be blamed on the property rights, legal system, and Communist dictatorship that it now has. The crucial comparative question about China is not 'why have China's mediocre market institutions performed better than central planning?', but rather 'why have its mediocre market institutions worked as well as they have?' The answer may come down to legacies from the planning period or other features of China's society or its policies that distinguish it from poor countries generally.

Legacies from the planning period have certainly played a role. These include a highly educated population, a large industrial sector, low mortality and fertility rates, and, despite the Cultural Revolution, a scientific establishment with significant R&D capabilities. Primary education was expanded throughout the planning period, with the result that two-thirds of the population were literate according to the 1982 census, and vocational skills were also widespread. Life expectancy had increased from less than 30 years in the 1930s to 41 in the 1950s, to 60 in the 1970s. (It reached 70 in 2000.) The average number of children born to the average woman (the total fertility rate) dropped from over 6 in the 1950s to 2.7 in the late 1970s – even before the one child policy in 1980. As in the USSR, low fertility was probably the result of educating women and giving them the chance to earn money in paid employment.

However historians ultimately factor out the importance of the planning legacy, reformed institutions, sensible policy, and supportive culture, China is completing a historical cycle. If the country grows as rapidly in the next three decades as it has since 1978, it will close the gap with the West. China will become the world's biggest manufacturing nation just as it was before the voyages of Christopher Columbus and Vasco da Gama. The world will have come full circle.