Why are some countries rich and others poor?
The Industrial Revolution and the Rise of the West.

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Since 1500, incomes have risen in most of the world, however:

- Incomes have risen fastest in the countries that were richer in 1500
- Consequently, world inequality is much greater today than in 1500
- In 1500, average income in the UK was only 30% higher than in India
- Today, the average UK income is ten times that in India.
The graph shows when the West got rich.
## GDP per head, 1990US$’s

<table>
<thead>
<tr>
<th></th>
<th>1500</th>
<th>1820</th>
<th>1913</th>
<th>2000</th>
</tr>
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<tbody>
<tr>
<td>UK</td>
<td>714</td>
<td>1707</td>
<td>4921</td>
<td>19818</td>
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<tr>
<td>Italy</td>
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<td>1117</td>
<td>2564</td>
<td>18740</td>
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<td>5301</td>
<td>28129</td>
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<td>4447</td>
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<td>600</td>
<td>600</td>
<td>552</td>
<td>3425</td>
</tr>
<tr>
<td>India</td>
<td>550</td>
<td>533</td>
<td>673</td>
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</tr>
<tr>
<td>Japan</td>
<td>500</td>
<td>669</td>
<td>1387</td>
<td>21069</td>
</tr>
</tbody>
</table>
Distribution of global manufacturing

Source: Crafts and Venables (2003, p. 327)
The Big Question is: Why are some nations rich and others poor?

- Technological change is the fundamental cause of economic growth
- Other changes—urbanization, rising incomes, capital accumulation are results of more efficient production
- The Rise of the West, therefore, comes down to the invention and utilization of labour saving technology.
Why was Arkwright’s water frame applied on a mass scale in Britain?
While this machine was little used and then abandoned in China
and Vaucanson’s automated loom was ignored in eighteenth century France?
Five classic answers explain the Rise of the West

• Geography: did the natural world favour the West?
• Political institutions: Did limited government foster commerce and thereby the rise of the West?
• Demography: Did different patterns of marriage and fertility give the West its lead?
• Culture: Was the West more ‘rational’ than the Rest?
• Science: Did the scientific revolution of the 17th century cause the industrial revolution of the 18th?
1. Geography favoured the winners:

- Coal was a cornerstone of the Industrial Revolution
- Abundant land and resources led the USA to invent labour saving technology
- Do the tropics suffer from malaria and the tsetse fly?
2. Limited Government

• ‘Good’ institutions include
  – Limited government
  – Low taxes
  – Secure property rights
• They create a broad market and a ‘favourable climate for investment.’
• These were secured in England by the Glorious Revolution of 1688 (parliamentary supremacy)
• The rest of the world was cursed with despotism.
The trouble is that parliamentary ascendancy meant that

- Britain had higher taxes than France
- Britain was more successful than France in seizing an empire.
- British property was more vulnerable than French property (witness the sorry story of irrigation in France versus improvement in England).
- “despotic power [which] was only available intermittently before 1688…was always available thereafter” (Hoppit 1996, p. 126)
3. demography

- Western Europeans had late marriages and not everyone married.
- Rest of the world had early and universal marriage
  - The difference arose in the late middle ages when the chance to earn high wages created ‘Girl Power’ and women could say no to undesired husbands.
- The result was persistently higher incomes in West that led to more savings and investment in education.
- In rest of the World population growth always defeated economic development and produced grinding poverty.
4. culture

• Weber thesis: protestant reformation led to rational pursuit of gain and high rate of saving
• Economic growth required replacement of spiritual view by naturalistic view—the ‘disenchantment of the world’
• Weber thought the West exemplified these values but the Rest did not: true or false?
• Did other cultures have other virtues? E.g. did the Japanese have a useful group solidarity?
Culture changed as ‘human capital’ was accumulated.

Proportion of the Adult Population That Could Sign Its Name

<table>
<thead>
<tr>
<th>Country</th>
<th>1500</th>
<th>1800</th>
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<tbody>
<tr>
<td>England</td>
<td>.06</td>
<td>.53</td>
</tr>
<tr>
<td>Netherlands</td>
<td>.10</td>
<td>.68</td>
</tr>
<tr>
<td>Belgium</td>
<td>.10</td>
<td>.49</td>
</tr>
<tr>
<td>Germany</td>
<td>.06</td>
<td>.35</td>
</tr>
<tr>
<td>France</td>
<td>.07</td>
<td>.37</td>
</tr>
<tr>
<td>Austria/Hungary</td>
<td>.06</td>
<td>.21</td>
</tr>
<tr>
<td>Poland</td>
<td>.06</td>
<td>.21</td>
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<tr>
<td>Italy</td>
<td>.09</td>
<td>.22</td>
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<tr>
<td>Spain</td>
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Correlated rise in numeracy and trade skills
5. Scientific revolution

- Scientific Revolution in the 17th century—Galileo, Newton, Boyle, et al.

- Some discoveries led to technological breakthroughs
  - Atmosphere has weight and condensing steam creates a vacuum led to steam engine

- Did culture at large change as science became a model for knowledge and control?

- Needham problem: Why was China overtaken by the West despite early breakthroughs (eg paper, printing, gun powered, compass, etc)? Didn’t China have the same scientific knowledge as the West?
Good institutions, culture, etc. may have been *necessary* for the Industrial Revolution, but they were not *sufficient*.

- Good institutions, etc., increase the *supply* of inventions.
- What drove the western economies forward were developments that increased the *demand* for technology that raised labour productivity.
- This demand for labour saving technology was a result of the creation of a global economy after 1500.
In the rest of the lecture, I consider the supply and demand for technology in three phases with digressions:

• Why did Britain pioneer labour saving technology in the Industrial Revolution (1760-1830)?
  – Why not in East Asia?

• Why did USA further develop labour saving technology and mass production (1850-1920)?
  – How did some countries catch-up?

• How and why did innovation become science based in the 20th century?
  – What is the future of the third world?
Phase I: British Industrial Revolution

• It presupposed favourable institutions and culture, but Britain was not unique.
• What set first the Dutch and then the British apart was their great success in the global economy that developed after 1500.
• Success in the global economy created a high wage, cheap energy economy that made it profitable to adopt and invent revolutionary technology that raised labour productivity.
• Notice that this is a self-reinforcing process that leads to economic divergence.
The success of the Dutch and British was based on international trade and increasingly on their empires.

Dutch Empire
The First British Empire (ca. 1763). The empire was the result of commercial enterprise and Britain’s military successes.
Growth of trade led to:

• Growth of port cities and rural industries
  – London grew from 50,000 in 1500 to 1 million in 1800 mainly due to trade.
  – Witney, small town near Oxford, grew because it was the centre of a workshop industry that made all of the blankets for the Hudson Bay Company

• Growth like this led to tight labour markets and high wages.
Success in the global economy transformed economic structures.

Percentage Distribution of the Population, 1500 – 1800

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<td>agri- urban</td>
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<td>rural nonagri-</td>
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<tr>
<td>culture</td>
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**most successful over the period**
- England: 7% 18% 74% 29% 36% 35%
- Netherlands: 30% 14% 56% 34% 25% 41%
- Belgium: 28% 14% 58% 22% 29% 49%

**moderately successful over the period**
- Germany: 8% 18% 73% 9% 29% 62%
- France: 9% 18% 73% 13% 28% 59%
- Austria/Hungary: 5% 19% 76% 8% 35% 57%
- Poland: 6% 19% 75% 5% 39% 56%

**small advance over the period**
- Italy: 22% 16% 62% 22% 20% 58%
- Spain: 19% 16% 65% 20% 16% 64%

Source: Allen (2000, pp. 8-9).
Economic success had a big impact on wages.

The Rest Falls Behind Northwest Europe
in labourers’ standard of living

1 = bare bones subsistence income

London
Amsterdam
Vienna
Florence
Delhi
Beijing
Eighteenth century Britain was unique for labour that was very expensive relative to capital.
The growth of London led to the English coal industry, which gave northern Britain the cheapest energy in the world.

**Price of Energy**
early 1700s

<table>
<thead>
<tr>
<th>City</th>
<th>Price of Energy in Grams of Silver per Million BTUs</th>
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<tbody>
<tr>
<td>Amsterdam</td>
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<tr>
<td>London</td>
<td></td>
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<td>Paris</td>
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<tr>
<td>Strasbourg</td>
<td></td>
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<tr>
<td>Newcastle</td>
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<tr>
<td>Beijing</td>
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</table>

grams of silver per million BTUs
The Industrial Revolution was the result of the evolution of wages and energy prices.

- High wages and cheap energy prices created a demand for technology that substituted capital and energy for labour.
- High wages increased the supply of technology by acquiring schooling and skills to meet that challenge.
The famous technologies of the Industrial Revolution like the Steam engine,
The cotton spinning machines,
Iron production with coal.
These were only profitable to use in Britain—not in other countries.

• They increased the use of capital and coal.
• These were cheap in Britain but expensive elsewhere.
• Consequently, the new technology was only profitable to use in Britain.
• Even there, it was marginal at the beginning.
Rate of return to buying a spinning jenny for domestic use around 1775.

- England—38%
- France—3%
- India—-5%

Profitability was high in England because labour was expensive compared to capital.

Even if French and Indian institutions had been ‘perfect,’ the Industrial Revolution would not have happened there because it would not have paid to mechanize.
Why was the Industrial Revolution *invented* in Britain?

- ‘Invention is 1% inspiration and 99% perspiration,’ (Thomas Edison)
- In the 18th century, the inspiration was not usually the hard part.
- The key to invention was doing the engineering development to make simple ideas work.
The revolutionary technology was only profitable to *invent* in Britain.

- All of these inventions entailed R&D costs.
  - Arkwright, for instance, spent £13,000 to perfect his cotton inventions.
- There was no point going to such expense if the invention was not going to be used.
- The Industrial Revolution was British because it would not have paid to invent it anywhere else.
- That is why the industrial revolution was British!
The Industrial Revolution did not stay in Britain because British engineers improved the technology to the point where it was profitable everywhere!

• All inputs were saved—even those that were scarce in Britain.
• Coal consumption per horsepower-hour dropped from 45 lbs in 1727 to 2 lbs. in 1870.
• As a result, the revolutionary technology became profitable to use in the countries where it has not paid previously.
• That’s when the industrial revolution spread to Europe and north America.
Steam engines are an example.
First Digression:

Why didn’t the industrial Revolution happen in East Asia?
Japan in Tokugawa period 1603-1868

• Prima facie example of bad institutions causing stagnation
  – Division of society into four castes
  – Country divided into feudal domains
  – Tokugawa shogun acting in name of emperor had supreme power and could confiscate domains
  – Severe limitations on international trade.
  – Internal tariffs between feudal domains.
However, the economy worked well in many ways.

- In 1700, Japan had three of the ten largest cities in the world.
- Much manufacturing in smaller cities and towns.
- Large volume of trade and an internal division of labour to supply cities.
- Legal system was adequate to support the trade and production system.
- High level of literacy
- Feudal counties competed against each other to promote economy
- Demographic system exhibited preventive check and restrained population growth.
The Japanese were also inventive. But their inventions led to stagnation.

• In Japan, labour was cheap and energy was expensive.
• As a result, invention was directed to saving energy and using labour.
• This lowered the productivity of labour.
• That produces a poverty trap—not economic growth.
19th century Japanese silk was powered by humans (labour intensive).
Here’s the man turning the crank!
18th century British silk mill was powered by water (capital-intensive).
Japan is an object lesson in what Europe would have been like if its economy had not been stimulated by the globalisation.
Phase II: The nineteenth century was a re-run of the eighteenth, but the centre of progress shifted to North America.

- The growth of the American economy in the nineteenth century was based on the exploitation and export of agriculture and resource products—cotton, wheat, minerals—and the successful adoption of British industrial technology.
Slaves loading cotton on a steamboat
The cotton’s destination: an English mill
As a result, the USA became the world’s high wage economy.
The American lead increased in the 19th century.

Figure 6.3 Real wage, bricklayers (1896 Manchester pence per day)
Figure 6.5 Average annual earnings, manufacturing workers (1896 Manchester £)
In response to the high wages, the USA invented an increasingly mechanized technology that boosted labour productivity.
Output per man-year in blast furnaces
Second Digression

What was happening in the Rest of the World?
Modern technology shifted from the core to the periphery when:

- There was a suitable political environment (peace and reasonable legal system).
- Technology was cost-effective:
  - Either the technology evolved to become ‘appropriate’.
  - Or there was sufficient engineering capacity to adapt the technology to local conditions.
This was true of rich countries as well as poor countries.

- Canada is an example.
- It’s growth was initially due to the export of primary product staples—not dissimilar to the USA—and drew immigrant labour from northern Europe on similar terms.
- So Canada was a high wage economy.
- American technology was, therefore, broadly ‘appropriate’.
However, the Canadian tariff made the situation more complicated.

• It encouraged manufacturing production in Canada by raising the price of manufactures including the price of capital goods.

• Canadian factories were not simply copies of American factories—they were reengineered to reflect the high price of capital goods relative to labour.
Canadian manufacturing productivity

- In Canada, labour and raw materials are typically cheaper than in the US.
- Capital is relatively more expensive in the US.
- In response, Canadian industry uses more labour and materials relative to capital, so labour and material productivity are low and capital productivity high.
- Over time, Canadian firms invent technologies that accentuate these differences.
Japan was a very different country.

- In 1850, a poor economy with hand technology.
- Most international trade was prohibited.
- In 1853 and 1854, the American Commodore Perry and his naval squadron forced Japan to sign ‘friendship’ treaty giving Americans trading rights and extra-territorial justice for citizens.
- Other European powers gained similar concessions.
- ‘Unequal treaties’ remained long term irritant.
Commodore Perry landing in Yokohama 14 July 1853.
Upshot was Meiji Restoration in 1868 when modernizers took control of state

- **Aim:** ‘rich country, strong army’
- **Method:** import and adapt western institutions and technologies
- **Legal, political, and educational reforms.**
- **Japanese success depended on these national policies but also on people and local institutions that responded to opportunities.**
The Meiji state set up factories with imported technology, but most were failures.

- The factor proportions were wrong, so they were not cost-effective in Japan.
- To be successful technology had to be re-engineered to match Japanese circumstances.
- The Ministry of the Interior imported English spinning mules in 1879 but they were uniformly unprofitable.
Success in cotton spinning was achieved with the rattling spindle (garabo)
This was targeted industrial policy

• Invented by Gaun Tokimune
• An intermediate technology suited to Japanese conditions.
• A local initiative—not a Meiji state policy.
• Financed and promoted by Chikuma prefecture (successor to feudal county industrial promoters)
• Survival of Tokugawa (pre-industrial) state and private organizations was important for industrial success.
Japan was unique:
Why didn’t China or India develop?

- They once had indigenous manufacturing capability that might have been a base for development.
- India was colonized and China almost
- States were either not interested (India) or too weak (China) to follow Japan’s route to ‘rich country, strong army’.
British empire did create vast free trade zone and secure property.

• However, free trade destroyed Indian manufacturing.

• ‘The bones of the cotton weavers are bleaching the plains of India.’ (William Bentinck, Governor General, 1835)

• British policy aimed to develop India’s comparative advantage as an agricultural producer.
  – Tea growing was promoted
  – Punjab irrigated
The Chinese Empire did not respond effectively to western imperialism

• Britain defeated China in the Opium Wars (1839-42, 1856-60) that mandated free trade in opium and other commodities.
• China further weakened by Taiping Rebellion (1850-64) and boxer Rebellion (1899-1901).
• Self Strengthening Movement (c. 1861-95) aimed to strengthen military and economy but were ineffective compared to Japan.
• End of Qing dynasty in 1912
Phase III: Growth in 20\textsuperscript{th} century became more science based.

- Electricity, pharmaceuticals, nuclear, electronics, chemicals, etc., rely on scientific discoveries and are mediated with scientific language.

- Nuclear power requires $E = mc^2$ but the spinning jenny did not require $F = ma$
New institutions become important:

- Industrial research laboratories
- Government and university research
- Is civilian technology derived from military technology paid for by governments?
Science based technologies are biased in favour of skilled (educated) labour.

- Manifestly true for research scientists and engineers
- Public and private organizations also required highly educated workers to operate effectively
- Productivity of production personnel is also increased with education.
Skilled biased technical change initially benefited rich countries.

- New technology increases the demand for skilled (educated) labour.
- Advanced countries have large educational systems.
- New technology is ‘inappropriate’ for poor countries.
Third Digression

Prospects for the Third World
Two responses are possible among poor countries.

- Expand the size of their educational systems to close the gap with the rich countries.
- Re-engineer advanced technology to make it more suitable to their factor proportions.
- The problem remains of creating suitable institutions to promote the assimilation of advanced technology.
### Percentage of the population in school

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan (Percentage)</th>
<th>Indonesia (Percentage)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1870</td>
<td>2.5%</td>
<td>0.1%</td>
</tr>
<tr>
<td>1880</td>
<td>6.7</td>
<td>0.1</td>
</tr>
<tr>
<td>1900</td>
<td>10.8</td>
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</tr>
<tr>
<td>1913</td>
<td>14.1</td>
<td>1.1</td>
</tr>
<tr>
<td>1928</td>
<td>17.5</td>
<td>2.8</td>
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<td>1973</td>
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<tr>
<td>1989</td>
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</table>
Education explains part of the gap:

But not the whole gap!
Education explains part of the gap:

But not the whole gap!
What else is involved:

- Bad geography?
- Bad institutions?
- Rapid population growth?
- Bad culture?