

# The Industrial Revolution



# A Framework for Describing Technological Change

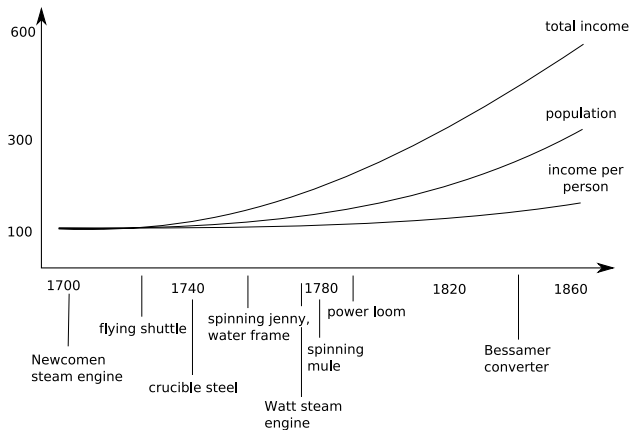
- We can think about technological change falling into to broad categories: microinventions and macroinventions
- *Microinventions* - small, incremental improvements to known technologies
- *Macroinventions* - shifts to entirely new ways of thinking about carrying out production
- The productivity gains of microinventions will be positive but small and potentially diminishing with each successive invention
- After a new macroinvention, microinventive activity takes place to refine the new methods of production
- One possible way to think of the Industrial Revolution is a cluster of macroinventions that led to an acceleration of microinventions

# Major Innovations of the Industrial Revolution

Several innovations during the Industrial Revolution fundamentally changed the way production took place:

- The mechanization of tasks
- The switch from organic to inorganic/mineral energy
- The coupling of thermal and kinetic energy
- The organization of work
- Advances in metallurgy

# Major Innovations of the Industrial Revolution



# Two Views of the Industrial Revolution

- Traditional view: Industrial Revolution was a broad change across many industries, innovation all over the place. 'Britain as workshop of the world'  
*A wave of gadgets swept over England. – T.S. Ashton*
- Crafts and Harley view: Industrial Revolution was actually confined to a couple industries (specifically, cotton and iron). Nothing special was going on elsewhere. 'Britain as cotton factory of the world'
- Enter Peter Temin

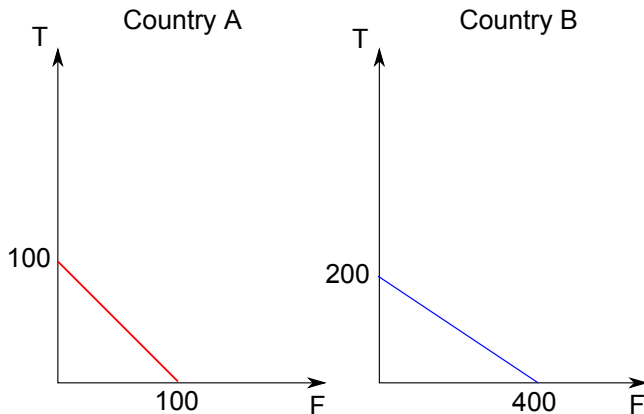
# Two Views of the Industrial Revolution

- Temin decides to test the two views by focusing on international trade
- He argues that if technological change was focused on just iron and textiles, we would observe different trade patterns than if technological change was more widespread
- It is basically a story about how comparative advantage works when you have many goods and technological change that may affect some or all of those goods
- Let's walk through the argument by first doing a quick review of how comparative advantage works

# Two Views of the Industrial Revolution

- Suppose we have two countries  $A$  and  $B$  that can each produce two goods, food ( $F$ ) and textiles ( $T$ )
- Because of differences in resources, wages, worker quality, etc. the countries production capabilities may differ
- Let's say country  $A$  has 100 workers and each worker can produce either one unit of food or one unit of textiles
- Country  $B$  also has 100 workers but they are better, each worker can produce either four units of food or two units of textiles
- Let's look at this graphically

# Two Views of the Industrial Revolution





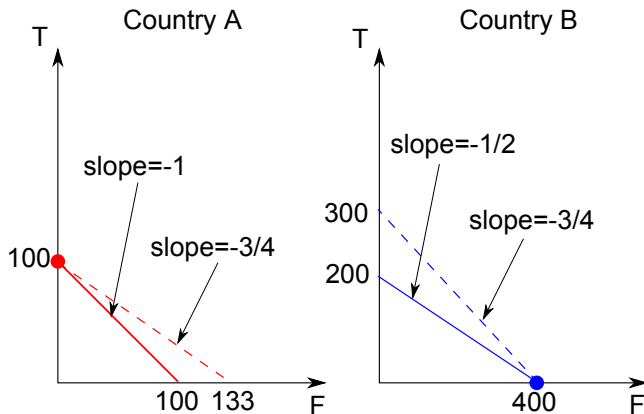
# Two Views of the Industrial Revolution

- Both of these countries can benefit from trade
- Notice that for every extra unit of food country *A* wants, it has to give up one unit of textiles
- For every extra unit of food country *B* wants, it has to give up half of a unit of textiles
- What if country *B* offers to give country *A* one unit of food in exchange for 0.75 units of textiles?

# Two Views of the Industrial Revolution

- The proposed trade:  $A$  gives  $B$  one unit of food in exchange for 0.75 units of textiles
- It's a good deal for country  $A$  (that unit of food would cost them one unit of textiles to produce themselves)
- It's a good deal for country  $B$  (they gave up 0.5 units of textiles to produce the food but got back 0.75 units of textiles)
- It allows both countries to consume more than they could without trade, so they will start specializing and trading

# Two Views of the Industrial Revolution



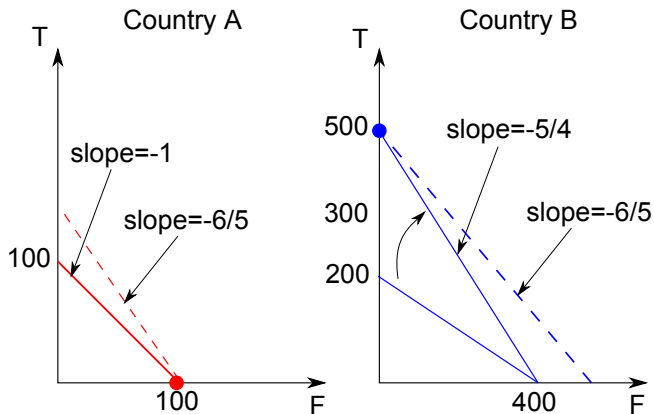
# Two Views of the Industrial Revolution

- So it makes sense for the countries to specialize
- Country *A* has a comparative advantage in producing textiles, they will use all of their workers to produce textiles and trade with country *B* for whatever food they need
- Country *B* has a comparative advantage in producing food, they will produce food to trade for country *A*'s textiles (and maybe produce some textiles themselves if *A* can't produce enough)
- Notice that even though country *B* can produce more textiles with a worker than country *A* can, it still makes sense for *B* to trade for textiles
- Now what happens if country *B* invents new textile technology?

# Two Views of the Industrial Revolution

- Let's say that country  $B$  invents new weaving and spinning technology that let's them make five units of textiles with each worker
- This flips the comparative advantages
- Now country  $B$  has the comparative advantage in textiles ( $\frac{5}{4}$  units of textiles for each unit of food compared to country  $A$ 's one unit of textiles for each unit of food)
- So country  $B$  specializes in textiles and  $A$  switches to specializing in food (and they'll settle on a new price that's advantageous to both, say  $1 F: \frac{6}{5} T$ )
- If we were to look at trade data, we would see country  $B$  switch from being an importer of textiles to being an exporter of textiles

# Two Views of the Industrial Revolution



# Two Views of the Industrial Revolution

- Back to Temin's argument
- If technological change was confined to iron and textiles, England would exploit its new comparative advantage in those industries by producing lots of iron and cloth to export in exchange for everything else
- We would therefore see a rise in exports of iron and textiles and a drop in exports (or rise in imports) of other manufactured goods

# Two Views of the Industrial Revolution

- However, if other manufacturing sectors also experienced technological change, Britain would also expand those industries and export those goods
- So looking at the range of what is exported versus the range of what was imported tells us about the range of industries in which Britain experienced significant technological change
- To the data...



TABLE 2  
SHARES OF TOTAL AND MANUFACTURING EXPORTS  
(percentage)

Sector	1794–1796	1814–1816	1834–1836	1854–1856
Manufacturing/total	86	82	91	81
Cotton/manufacturing	18	49	53	42
Woolens/manufacturing	27	21	17	15
Iron/manufacturing	11	2	2	7
Other/manufacturing	44	28	28	36

Source: Davis, *Industrial Revolution*, pp. 95–101.

# A Final Word on Growth During the Industrial Revolution

## Accounting for Britain's Economic Growth

	Output growth	Contributions from Capital stock growth	Labor force growth	TFP
<b>Crafts</b>				
1760-80	0.6	0.25	0.35	0.00
1780-1831	1.7	0.60	0.80	0.30
1831-73	2.4	0.90	0.75	0.75
<b>Feinstein</b>				
1761-1800	1.1	0.50	0.40	0.20
1801-1830	2.7	0.70	0.70	1.30
1831-1860	2.5	1.00	0.70	0.80

# A Final Word on Growth During the Industrial Revolution

## Accounting for Britain's Economic Growth

	Output growth	Capital stock growth	Human capital stock growth	TFP
<b>Greasley &amp; Oxley</b>				
1760-80	0.6	0.30	0.20	0.10
1780-1831	1.7	0.60	1.10	0.00
1831-73	2.4	0.90	1.70	-0.20

# The Industrious Revolution

- The Industrial Revolution wasn't all just changes in technology
- There were fundamental changes in the way people worked
- There were changes to the nature of paid work, unpaid work, the division of time and relationships within the household
- Not only did what workers produced change, what they bought also changed
- First, let's think about how much people worked

# Work Hours Across Societies

<b>Annual Work Hours Over 800 Years</b>		
Period	Type of worker	Annual hours
13th century	Adult male peasant, UK	1620 hours
14th century	Casual laborer, UK	1440 hours
Middle Ages	English worker	2309 hours
1400-1600	Farmer-miner, adult male, UK	1980 hours
1840	Average worker, UK	3105-3588 hours
1850	Average worker, U.S.	3150-3650 hours
1987	Average worker, U.S.	1949 hours
1988	Manufacturing workers, UK	1855 hours
2000	Average worker, Germany	1362 hours

*The Middle Ages observation corresponds England in the 1400s.*

# Changing the Way We Work

- Before industrialization there were irregular work hours and significant household production
- By 1700, mills started imposing stricter regulation of work hours, machines added even more structure to the work day as the Industrial Revolution progressed
- Forces creating time-discipline: division of labor, supervision of labor, fines, bells, clocks, money incentives, preaching, schooling, suppression of fairs and sports
- There is a general retraining of workers to adhere to a rigid work day

*The weavers, 't is common with them to be drunk on Monday, have their head-ache on Tuesday, and their tools out of order on Wednesday. As for the shoemakers, they'll rather be hanged than not remember St. Crispin on Monday...and it commonly holds as long as they have a penny of money or pennyworth of credit.*

*–John Houghton, Collection of letters, 1681*

*Every one but an idiot knows that the lower classes must be kept poor or they will never be industrious; I do not mean, that the poor of England are to be kept like the poor of France, but, the state of the country considered, they must (like all mankind) be in poverty or they will not work.*

*–Bernard Mandeville, Fable of the Bees, 1714*



William Temple, an advocate of workhouses for poor children, 1770:

*There is considerable use in their being, somehow or other, constantly employed at least twelve hours a day, whether they earn their living or not; for by these means, we hope that the rising generation will be so habituated to constant employment that it would at length prove agreeable and entertaining to them...*

*The poor know little of the motives which stimulate the higher ranks to action - pride, honor and ambition. In general, it is only hunger which can spur and goad them onto labor.*

– Joseph Townsend, 1786

*Instead of being as before, idle, careless, indolent, envious, dissatisfied and disaffected, the fruits of their former depraved, helpless and wretched condition, they become careful and thrifty both of their money and time, and soon begin to imbibe fresh notions respecting themselves and others and are happily found to be better fathers, better husbands and more respected members of the community...*

*-1802 description of Cornish miners*

Richard Wakefield, on the irrationality of parents, 1802:

*Parents in general from whom to take for time the idle, mischievous, least useful and most burdensome part of their family to bring them up without any care or expense to themselves in habits of industry and decency is a very great relief; are very much adverse to sending their children to the houses of industry; from what cause, it is difficult to tell.*

# How Do We Learn About Time Use?

Modern time use data:

- Electronic pagers - write down what you're doing when your paged
- Time use diaries - keep a journal of everything you did
- Random hour recall - asked to recall everything you did in one randomly chosen hour of a previous day

What's available in the 1700's?

- No 18th century pagers
- No sociologists to gather time use diaries
- We do have some diaries (for an extreme case, see Samuel Pepys)
- We also have the Old Bailey

*Two Legerdemain Ladies of profound experience in the mysteries of Shoplifting; one of them having been whipt at the Carts tail but the very last Sessions, were convicted for stealing two pieces of Callicoe, under pretence of buying o kerum . The Goods were taken before they got out of sight in one of their aprons, who alleadged a very civil excuse, assuring the Court that she was drunk with Brandy, and knew not what she did; but that Plea was overrul'd, and both of them found guilty.*

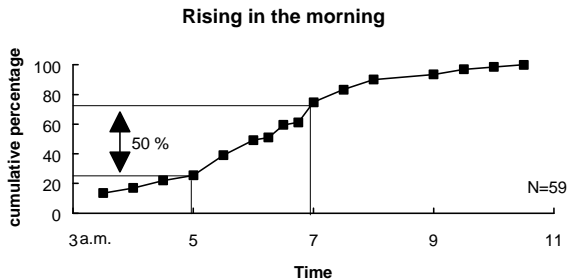
<http://www.oldbaileyonline.org>

*Thomas Wale. I am a Carpenter: I was at work at a building in Queen Anne's-street, near Marybone; I locked up my tools in my chest, on the 20th of January at night, being a Saturday night in that house, and on Monday the 22d when I went to work in the morning, I found my chest had be brook open...*

*Q. What time did you go there in the morning?*

*Wale. About six o'clock.*

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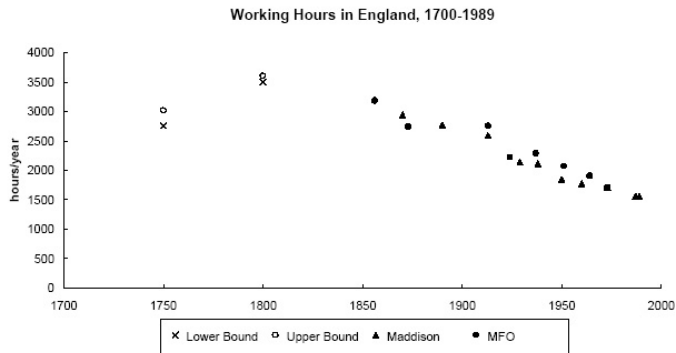


# Work Hours during the Industrial Revolution

Table 4: Working hours/year, 1760 and 1800

	<i>1760</i>	<i>1800</i>	$\Delta$
<i>Lower Bound</i>	2,288	3,366	1,078
<i>Upper Bound</i>	2,631	3,538	907

# Work Hours, 1700-1989



# Modern Work Hours

**Work hours per week in the United States, 2003**

Time use category	Males		Females	
	High school grad or less	College educated	High school grad or less	College educated
Total market work	37.5	43.4	22.8	29.8
Total non-market work	13.7	13.9	24.1	21.4
Leisure	114.0	107.2	116.5	112.0
Annual hours of market work	1952.1	2256.3	1186.1	1550.6
Annual hours of total work	2661.9	2979.6	2438.8	2661.4