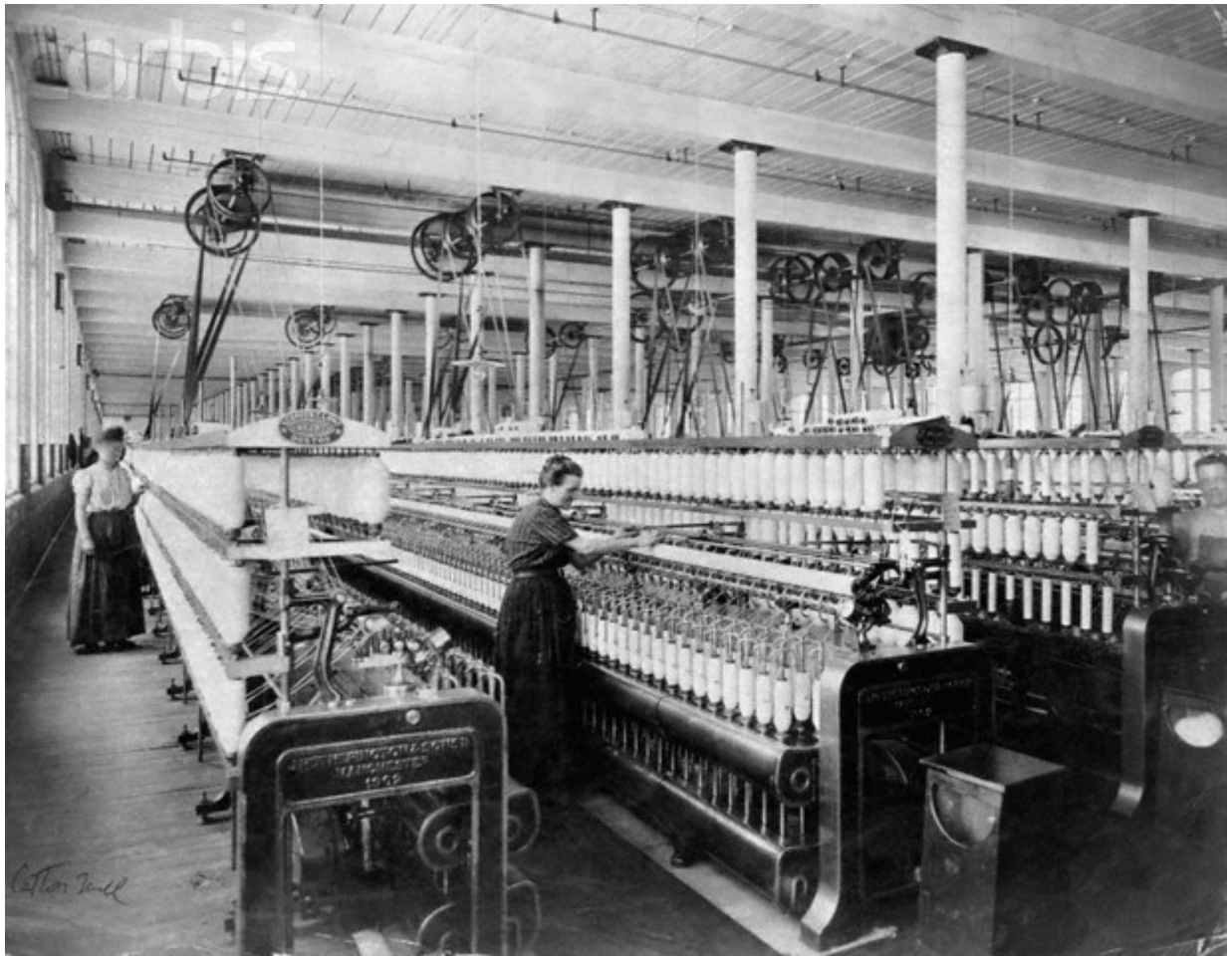
Early Industrialization in the United States



A History of British Wages

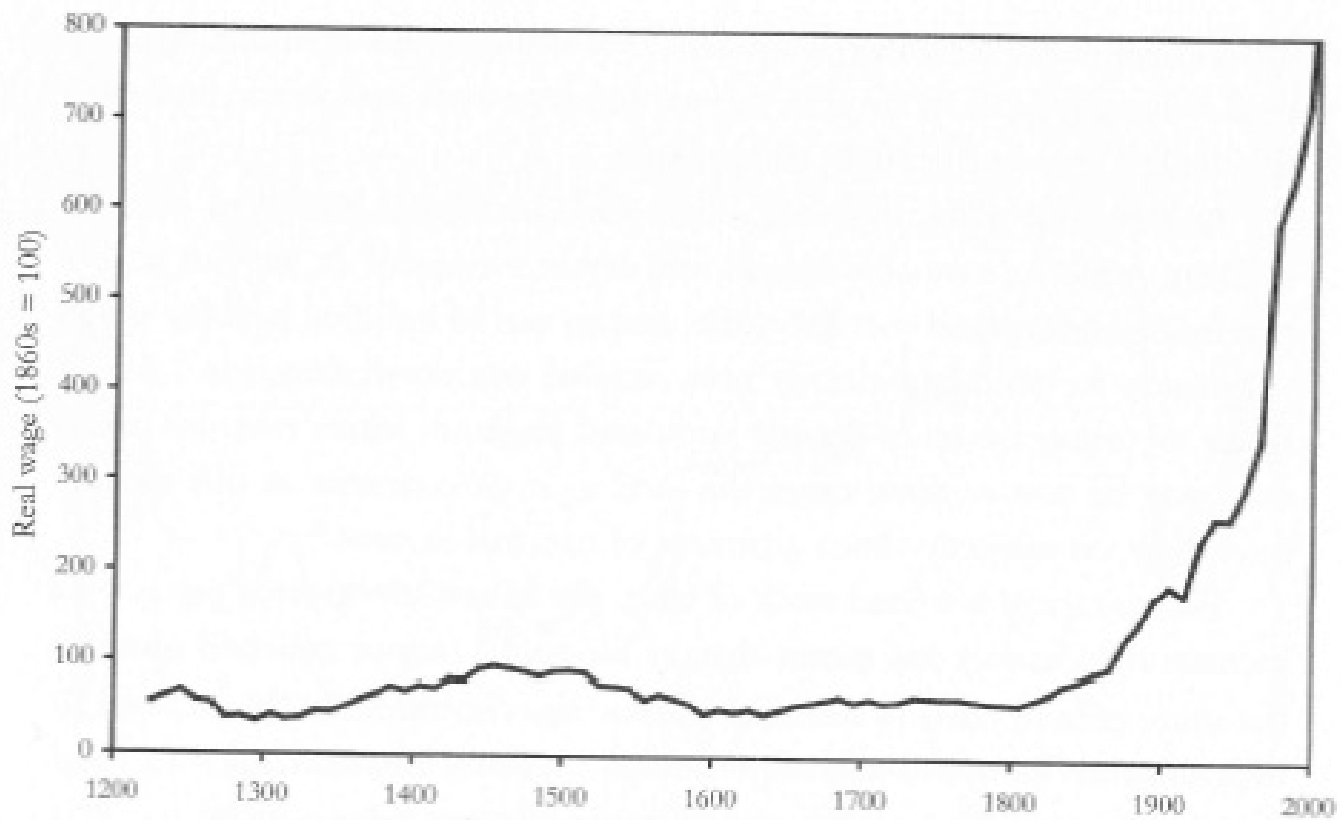
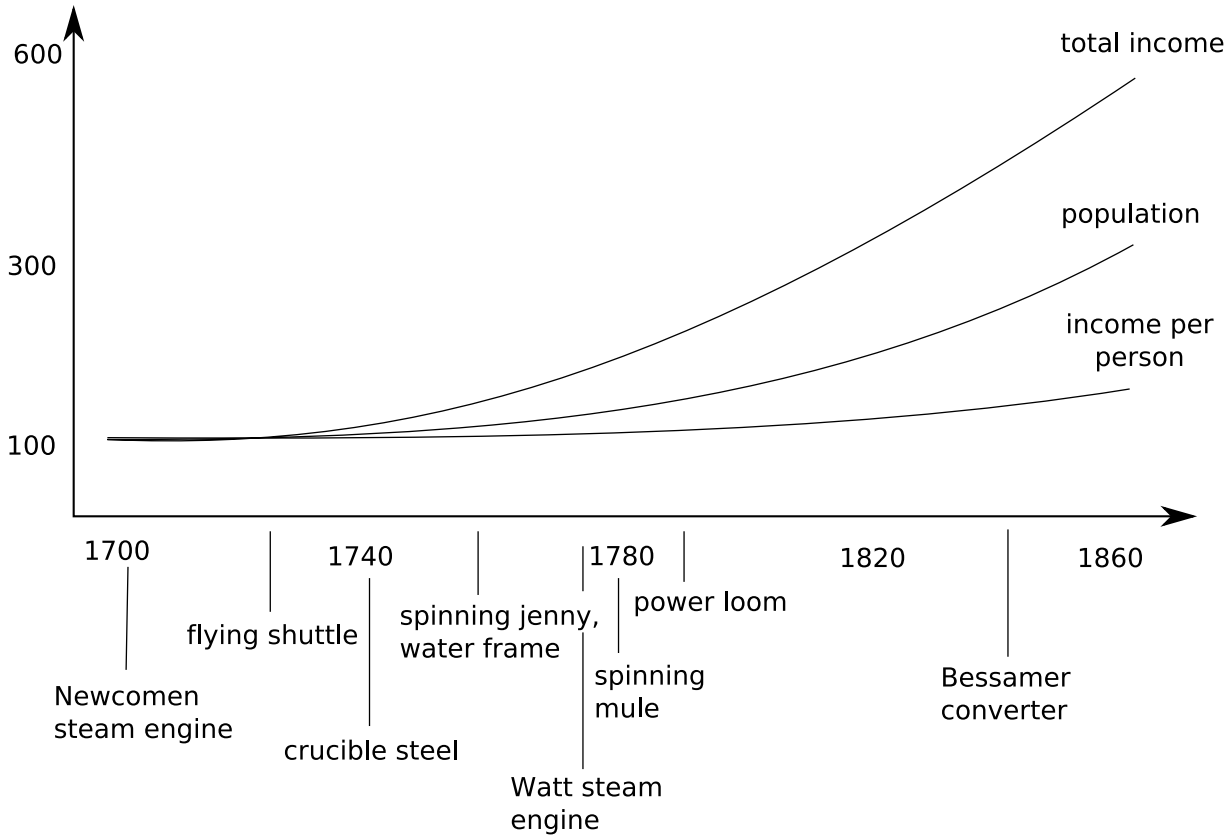


Figure 14.3 Real hourly wages for building laborers in England, 1220–2000. Data from Clark, 2005.

Inventions and British Economic Growth



A Very Brief History of the Industrial Revolution

- New inventions and techniques allowed for the use of inorganic rather than organic energy sources
- Manufacturing processes became mechanized
- Factory systems were developed
- Transportation improvements complemented these manufacturing improvements
- Women and children engaged in market production rather than home production

Females in the Labor Force

Female Labor Force Participation, Britain, 1851

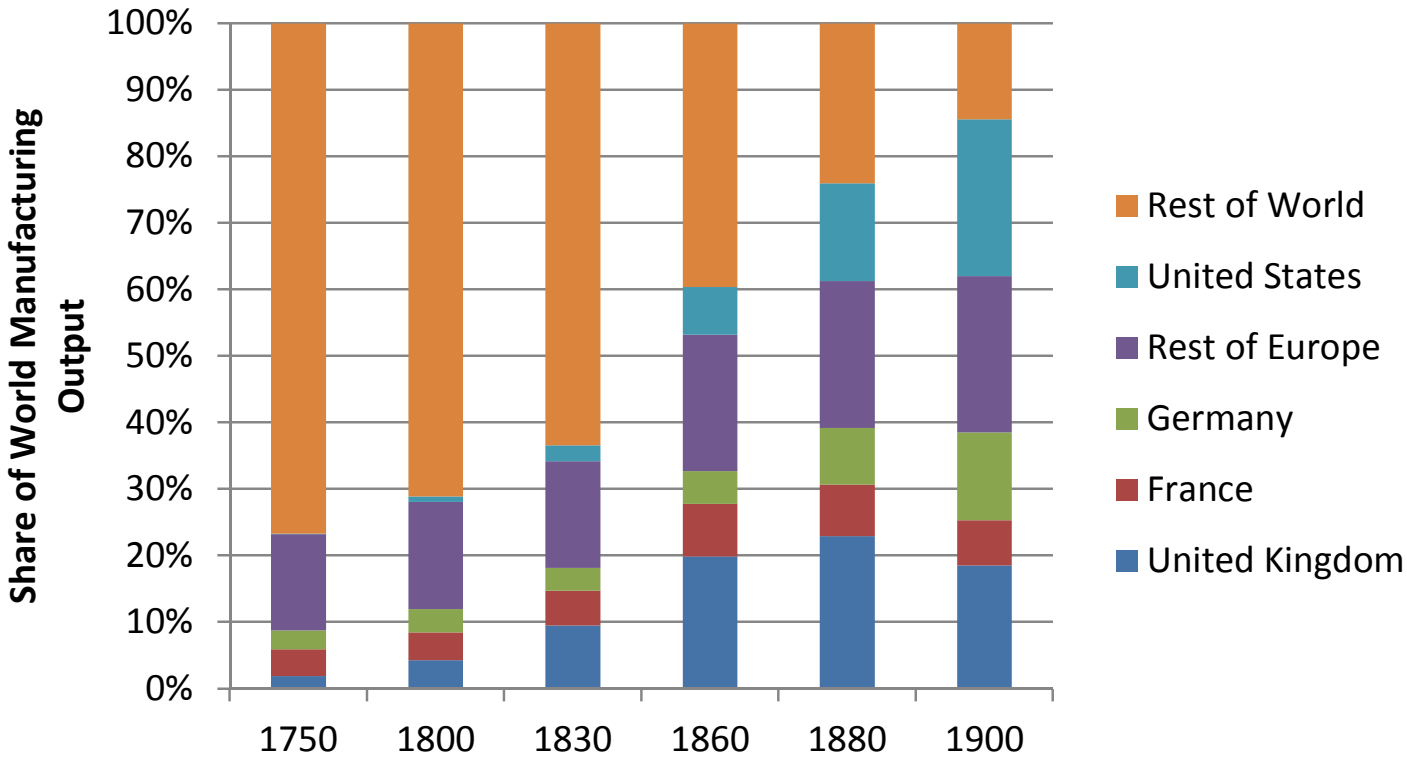
Occupational Category	Males (thousands)	Females (thousands)	Percent Female
Domestic Services	193	1135	85.5
Commercial	91	0	0
Transportation & Communications	433	13	2.9
Agriculture	1788	229	11.4
Metal Manufactures	536	36	6.3
Bricks, Cement, Pottery, Glass	75	15	16.7
Chemicals	42	4	8.7
Leather & Skins	55	5	8.3
Paper & Printing	62	16	20.5
Textiles	661	635	49
Clothing	418	491	54
Food, Drink, Lodging	348	53	13.2
Total Occupied	6545	2832	30.2
Total Unoccupied	1060	5294	83.3

Children in the Labor Force

Child Employment in Britain, 1851-1881

	1851	1861	1871	1881
Mining				
Males under 15	37,300	45,100	43,100	30,400
Females under 15	1,400	500	900	500
Percent of workforce under 15	13%	12%	10%	6%
Textiles and Dyeing				
Males under 15	93,800	80,700	78,500	58,900
Females under 15	147,700	115,700	119,800	82,600
Percent of workforce under 15	15%	19%	14%	11%

Shares of Manufacturing Output



Britain and the Export of Technology

- The industrialization in the United States was a bit delayed compared to Britain
- In colonial times, Britain protected British manufacturing at the expense of the development of colonial manufacturing
- Britain banned the export of technology and certain skilled individuals
- While it may be possible to effectively ban the export of physical machines, it's incredibly hard to ban the export of knowledge
- Despite the efforts of Britain, new technology made its way to the United States and planted the seeds of industrialization

Samuel Slater and American Textiles

The Jeffersonian Embargo

The Jeffersonian Embargo

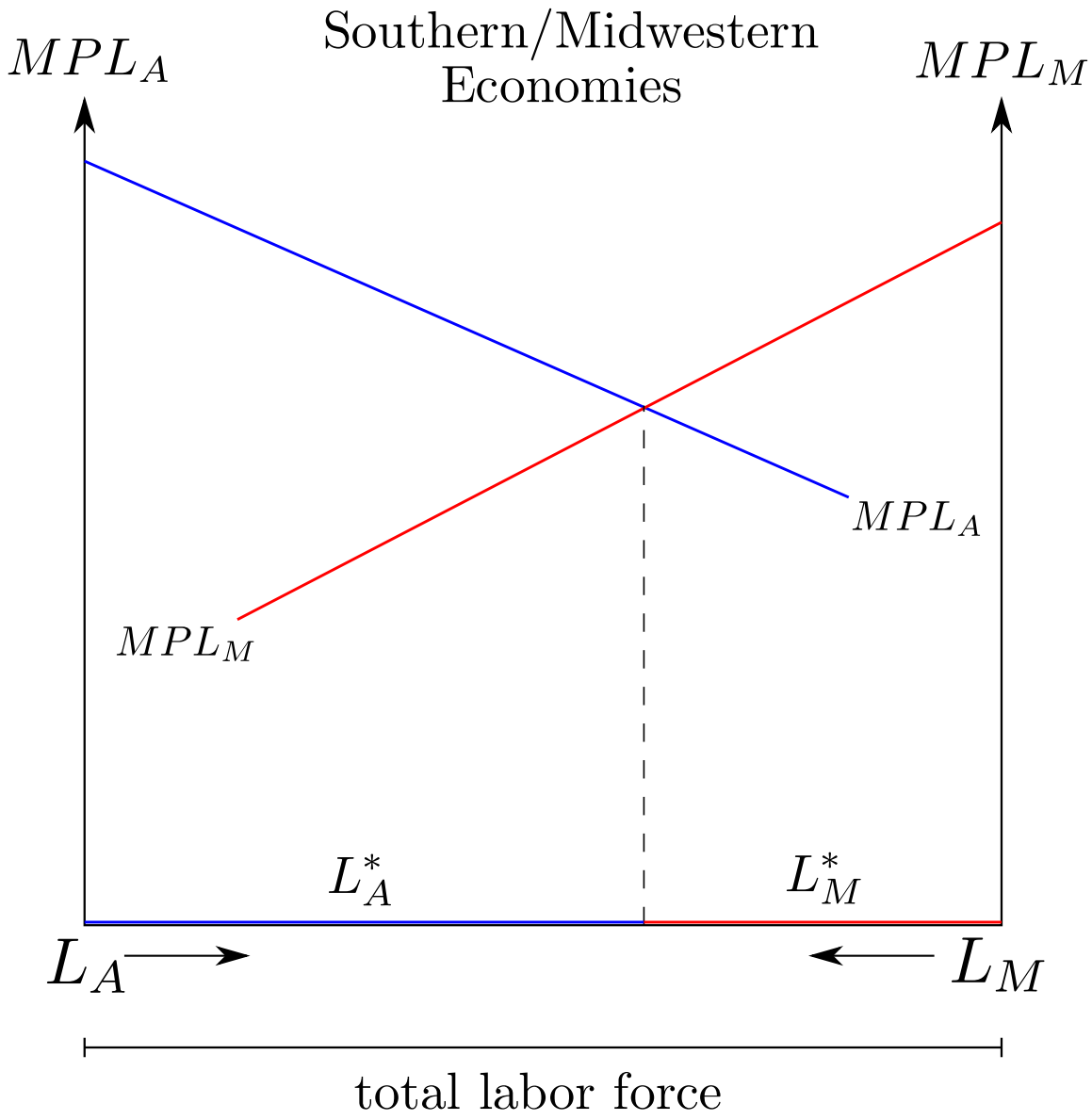
Factory Incorporations and the Jeffersonian Embargo

	Metal and Machinery	Chemicals	Textiles	Total
1800-1806	4	0	1	6
1807-1809	6	5	23	37
1809-1812	20	20	100	145
1813-1819	35	9	265	326

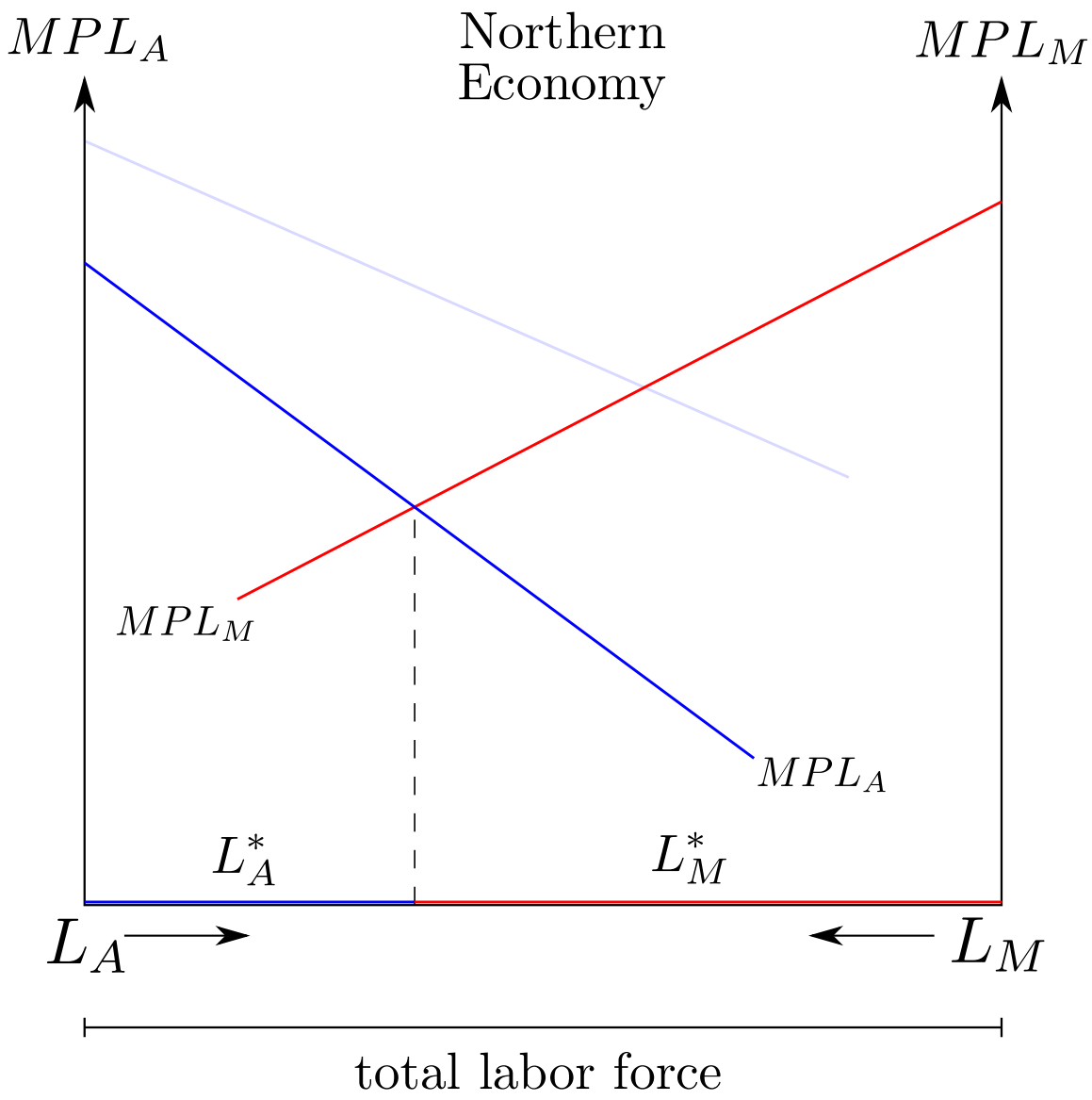
The Geography of Industrialization

- Where the marginal productivity of labor in agriculture was low, we would expect to see more industrialization
- Where the marginal productivity of labor in agriculture was high, we would expect to see the agricultural sector stay large
- As agricultural prices fall as the Midwest opens up, the value of the marginal product of Northeast agricultural workers will drop even further and more resources will be shifted to manufacturing
- As technology in manufacturing improves and increases the marginal product of manufacturing labor, more resources will be shifted into manufacturing

The Geography of Industrialization



The Geography of Industrialization



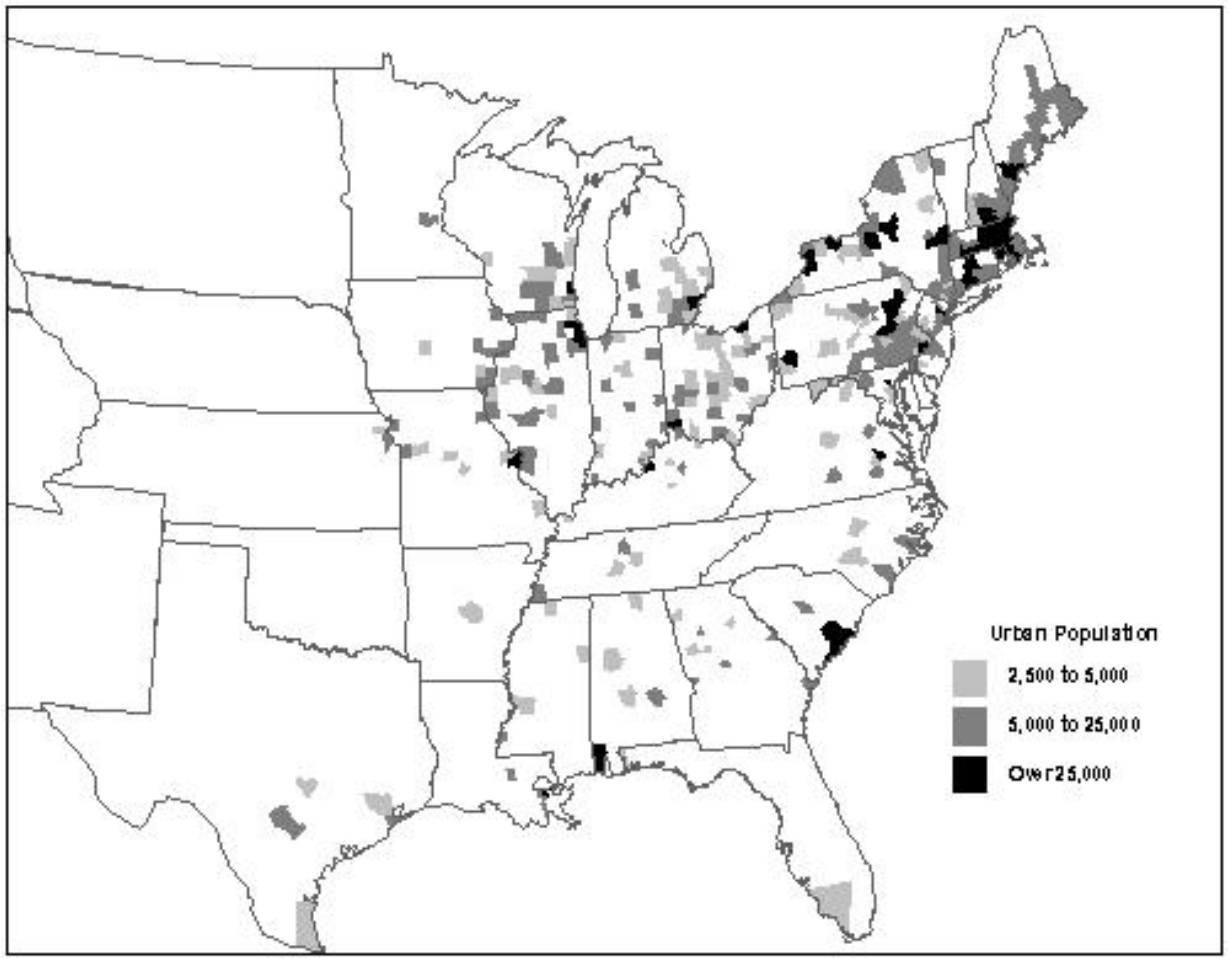
The Geography of Industrialization

Proportion of the Labor Force in Agriculture

	Middle Atlantic	New England
1820	0.74	0.73
1840	0.65	0.61
1850	0.34	0.33

The Geography of Industrialization

Map 1: Urban Population of the United States in 1860



The Geography of Industrialization - Goldin and Sokoloff

- The different mix of agricultural outputs between the North and South led to differences in the productivity of women and children relative to men
- Agriculture required more supervision and physical strength in the North; tobacco and cotton in the South required less strength and supervision and had tasks where small size was actually advantageous
- As a result, the wages of females and children relative to males were much lower in the North than in the South
- This made the North attractive to manufacturers who employed production techniques where women and children had a relatively high marginal product of labor

The Geography of Industrialization - Goldin and Sokoloff

The Geography of Industrialization - Goldin and Sokoloff

Relative Wages for Females and Boys in the Agricultural and Traditional Sectors

	Wage ratio	
Region	female/adult male	boy/adult male
Massachusetts - 1808	--	0.198
Massachusetts - 1811	--	0.366
Massachusetts - 1815	0.288	--
Middle Atlantic - 1836-40	--	<.260
Ohio - 1836-40	.191-.260*	--
South - 1860	0.584	0.446
South - 1867	0.559	0.438
South - 1868	0.573	0.483

* Wage net of board.

Relative wages of females to males during industrialization

	Middle Atlantic	New England
1815	--	0.288
1820	0.303	0.371
1832	0.411	0.421
1850	0.524	0.46

The Geography of Industrialization - Goldin and Sokoloff

- Relative wages were low in the pre-industrial North compared to the South (Wf/Wm of .3 compared to .58)
- The Northeast industrialized rapidly from 1820 to 1850, the South remained agricultural
- Relative wages rose in the North with industrial development
- Females and children comprised a large percentage of the northern manufacturing labor force
- Young, single women often migrated from rural areas to the manufacturing centers
- The ratio of manufacturing and mining to agricultural output for the North was 8.7 times that for the South by 1860
- The manufacturing sectors led to high labor force participation of females and children in the North

Other Factors Influencing the Geography of Industrialization

- Changes in relative prices (ex. the effect of the Midwest on agricultural prices)
- Availability of transportation (being close to existing railroads, canals and ports is a good thing)
- Availability of power (water power needs water, steam power needs coal or charcoal)

Growth in Industrial Production, 1790-1915

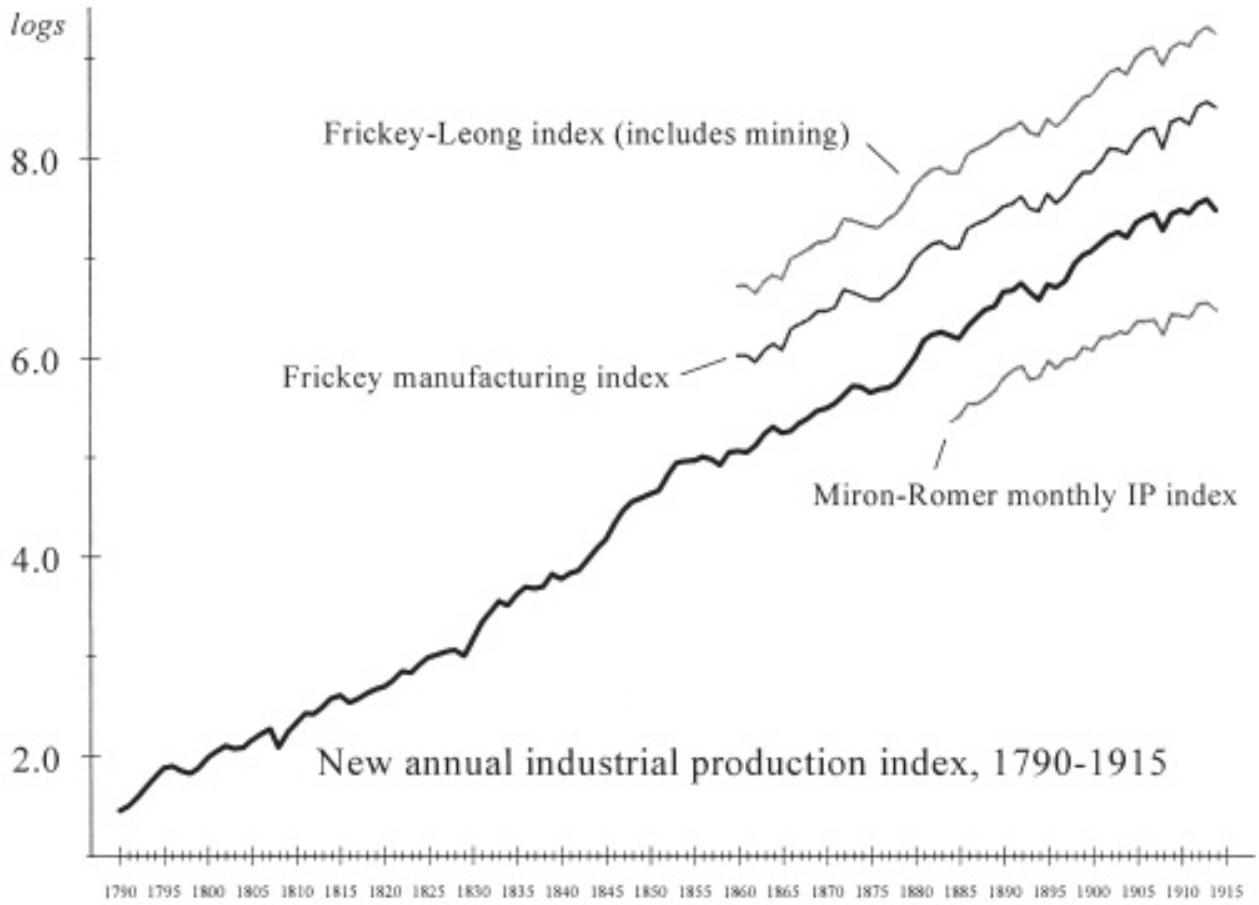


FIGURE II
Comparison with Conventional Postbellum U. S. Industrial Production Indexes

Changes in Manufacturing by Region

Growth in Manufacturing in the United States, 1850-1860

	Percent Change from 1850-1860 in:				
	Number of firms	Output	Employees per firm	Output per firm	Output per Employee
New England	-8	65	35	80	32
Middle Atlantic	-1	69	25	71	30
Midwest	33	137	50	76	39
South	17	91	20	63	59

Changes in Manufacturing by Industry

Percentage of Industry Value Added by Production Method, 1850-1870

	Artisan shops		Other nonmechanized		Mills		Factories	
Industry	1850	1870	1850	1870	1850	1870	1850	1870
Boots and shoes	39	33	61	45	0	4	0	19
Cotton goods	0	0	4	3	16	1	79	96
Flour milling	7	5	0	0	91	95	2	0
Furniture	50	18	20	14	10	26	19	41
Iron	0	0	33	1	22	10	44	89
Lumber milling	3	1	1	2	88	63	8	34
Tobacco	24	30	76	68	0	2	0	0

Changes in Manufacturing by Industry

	% of production taking place in mechanized firms	
Industry	1850	1870
Boots and shoes	0	23
Cotton goods	95	97
Flour milling	93	95
Furniture	29	67
Iron	66	99
Lumber milling	96	97
Tobacco	0	2

Changes in Manufacturing

- One thing that is clear is that many industries were moving towards mechanization which required inanimate sources of power
- The power sources available were water power or steam power (electricity would come later)
- Water power was generated by water wheels and later turbines
- Efficiency of water power was improved during industrialization but the usefulness of water power was limited by availability of water sources
- Steam power could be used anywhere but required high fuel costs

Adoption of Steam Power

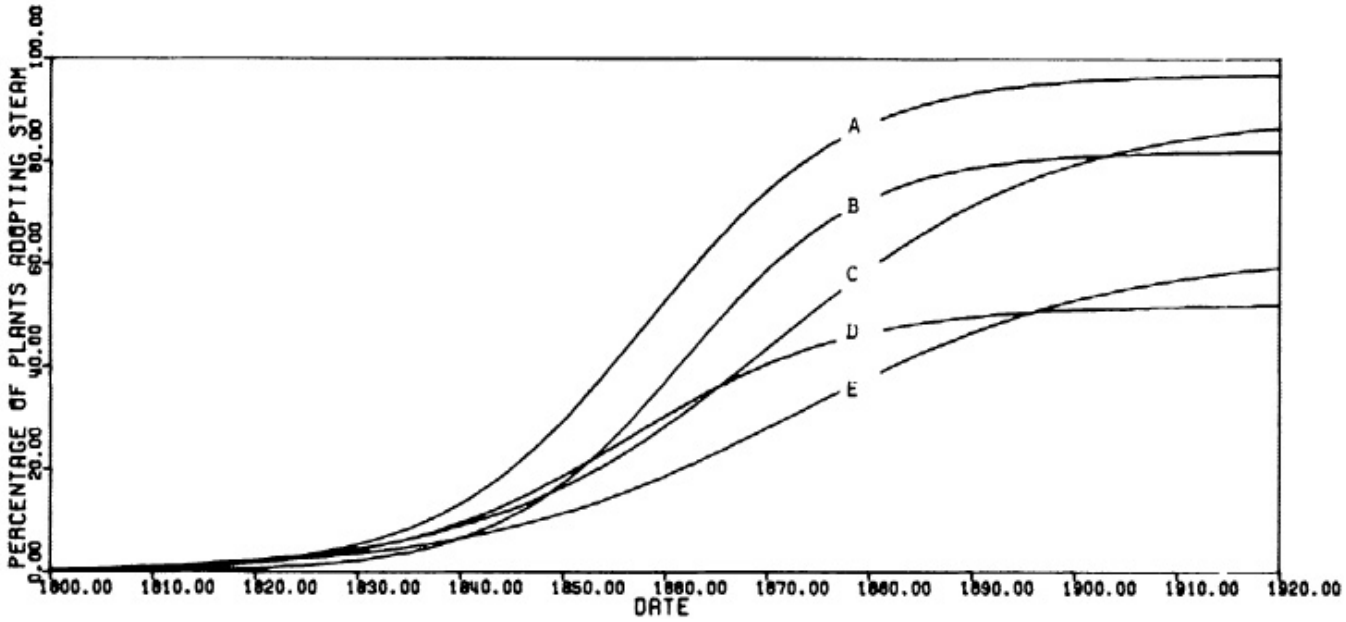


FIGURE 1
PERCENTAGE OF ALL PLANTS ADOPTING STEAM BY REGION

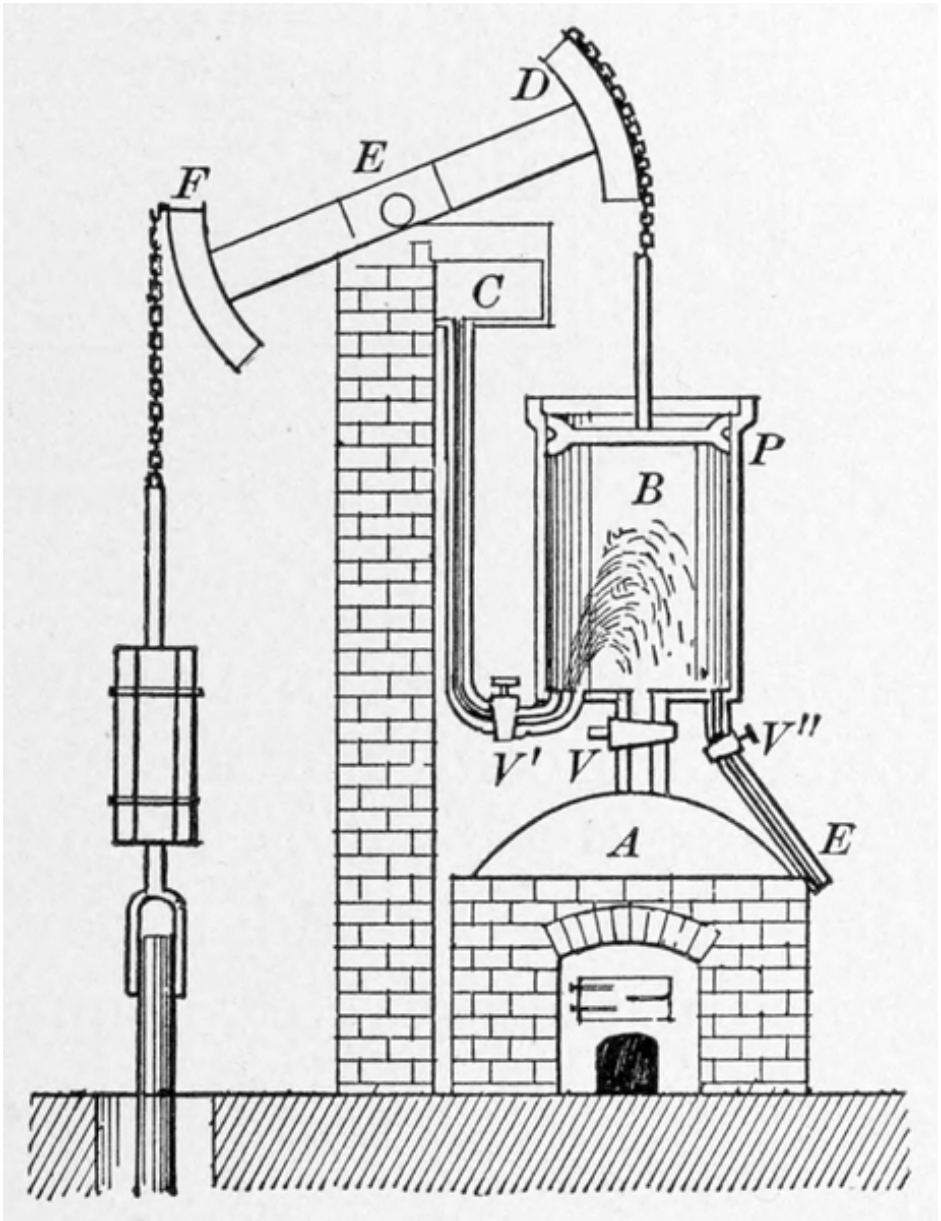
Legend

A = Midwest
B = Mountain and Pacific
C = South
D = Middle Atlantic
E = New England

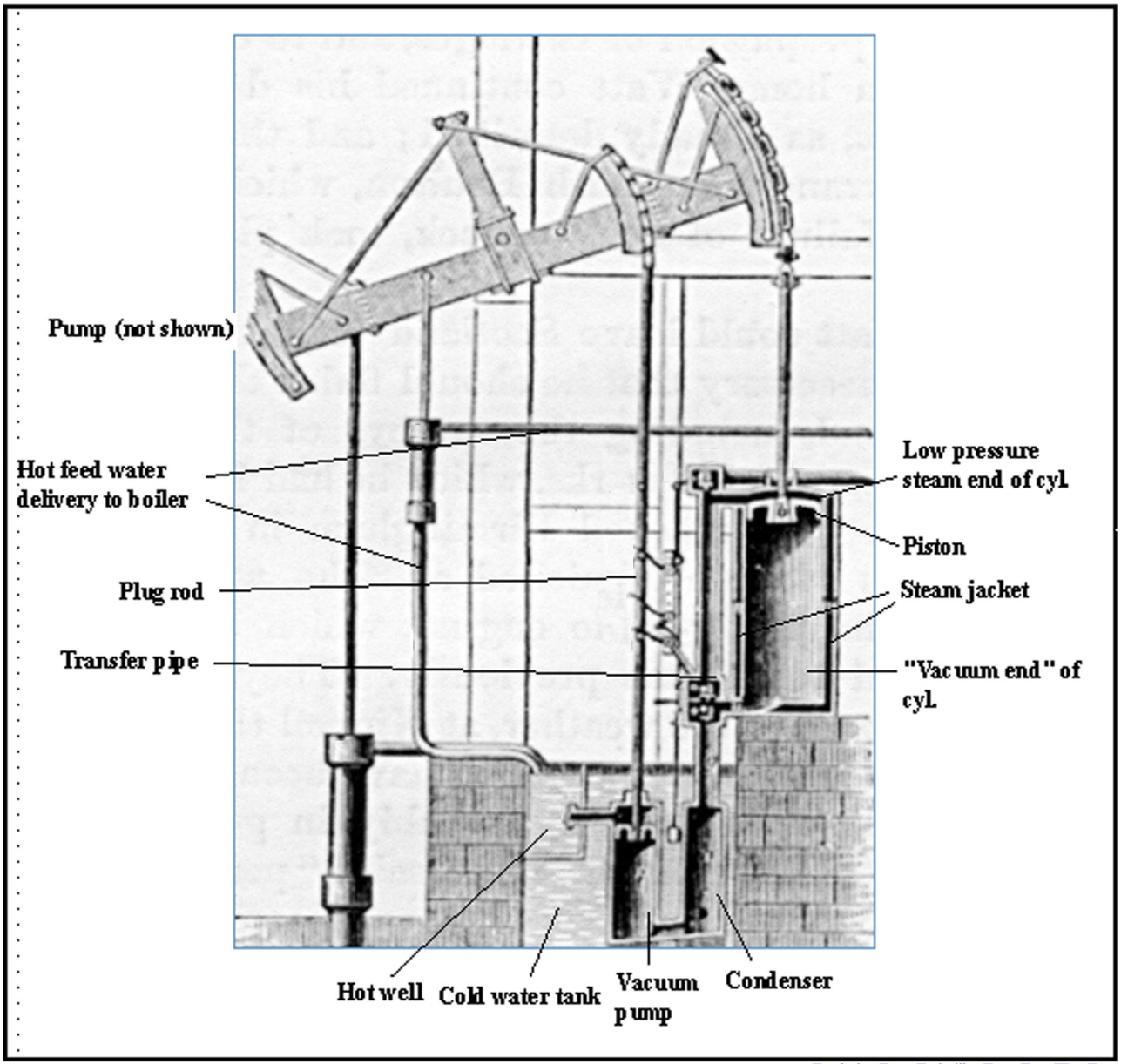
Power Technology in America and Abroad

- Efficiency gains were being seen in both water and steam power in the US and in England
- Water power advanced in the same direction, with Americans adapting and improving on European technology
- However, the two countries took two very different paths to steam engine development
- These paths diverged largely because of exogenous historical events and led to very different outcomes

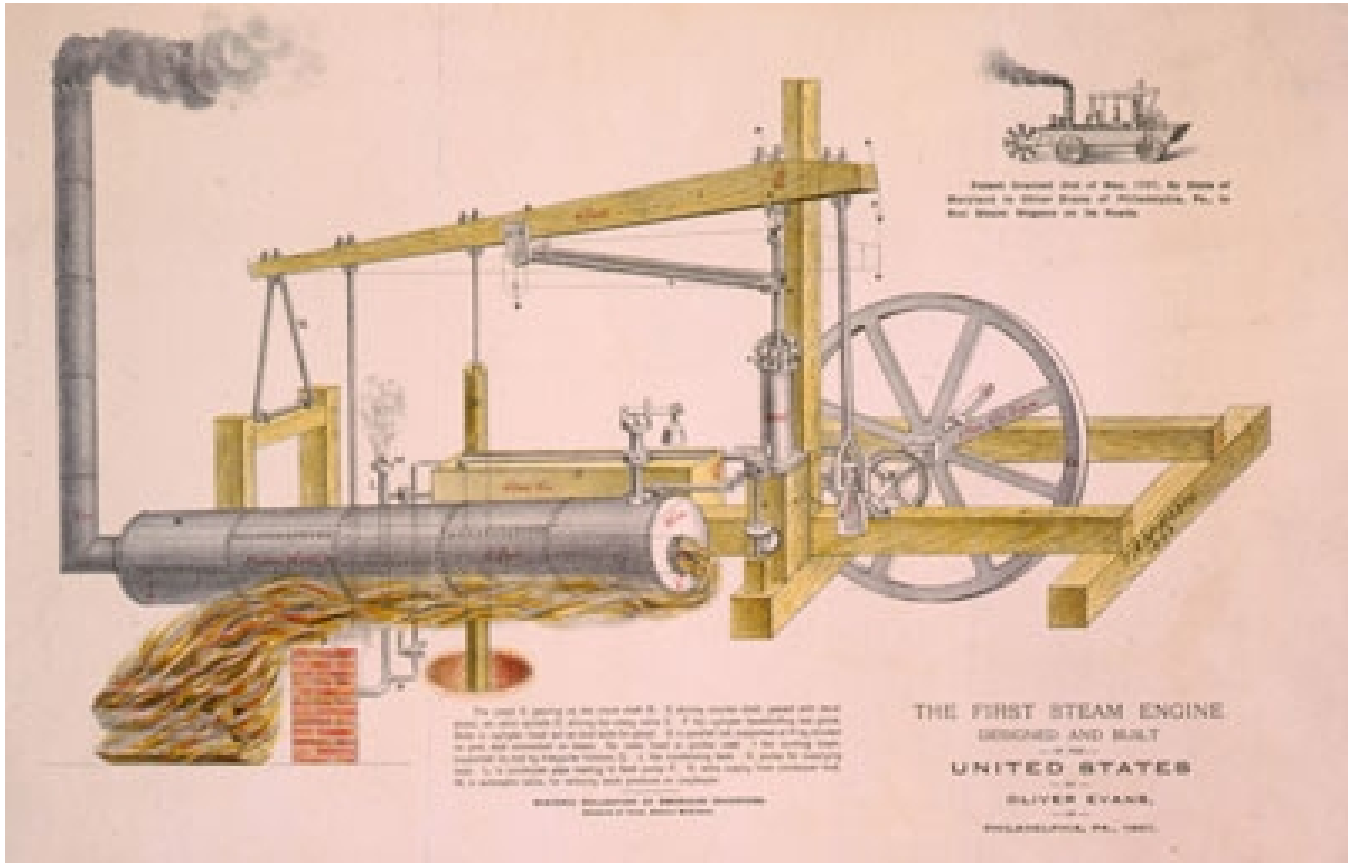
British Steam Technology - Newcomen Engine (1712)



British Steam Technology - Watt Engine (1775)



American Steam Technology - Evans Engine (1802)



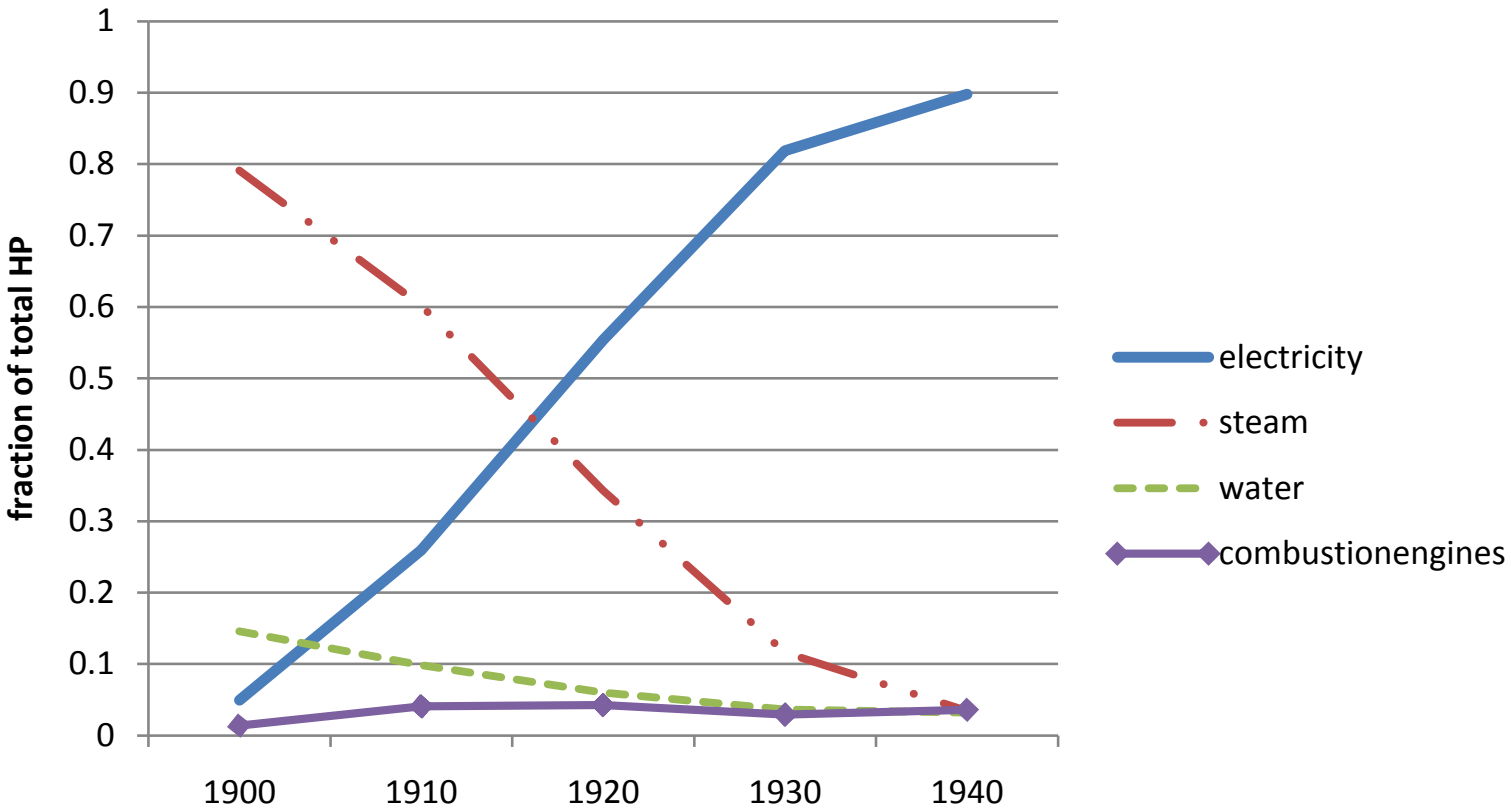
The Divergence of American and British Steam Power

- Without technology innovations flowing freely at the time of the Revolution, American steam technology diverged from British technology
- High pressure engines were developed rather than the low pressure engines in England
- The high pressure engines had the advantage of being smaller, lighter, and cheaper to produce
- This made steam power useful for river travel and factories of all sizes

The Divergence of American and British Steam Power

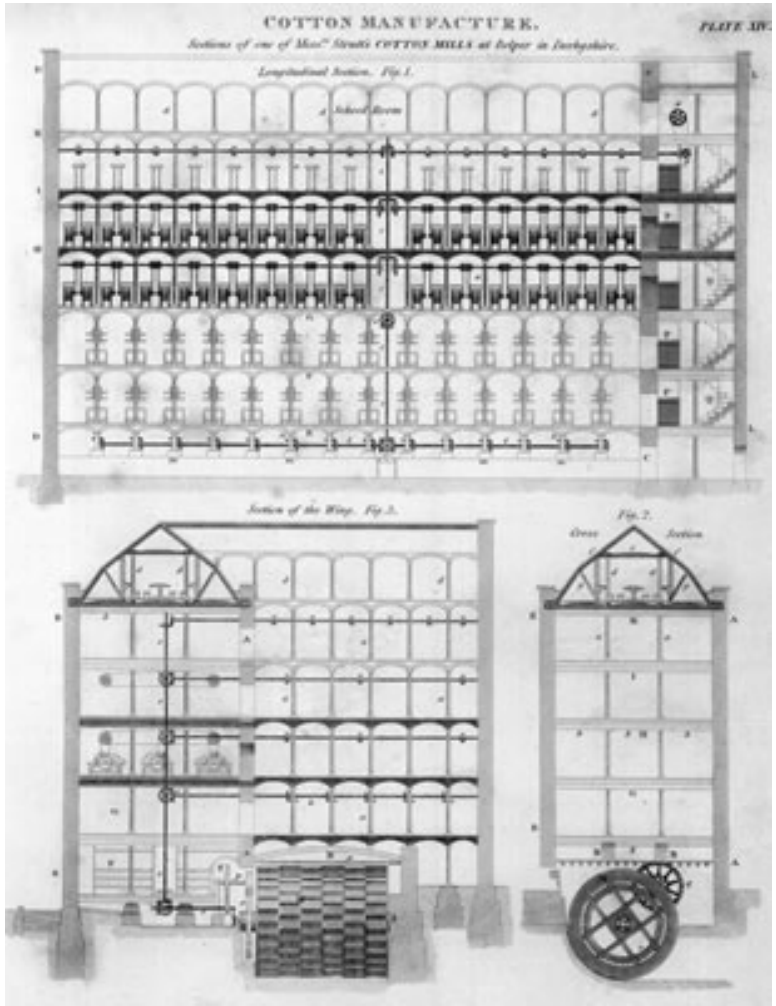
- The two big disadvantages of high pressure steam were that it was fuel inefficient and it wore equipment out quickly
- However, these weren't as problematic as one might think:
  - America had cheap fuel and more expensive capital and labor, so fuel efficiency wasn't a big concern
  - Equipment wearing down meant more rapid replacement but this also meant staying closer to the technological frontier

The Decline of Steam Power



Electrification and Productivity

Electrification and Productivity



Electrification and Productivity

- Electrification lowered energy costs (less energy lost to belt friction, ability to drive just a handful of machines, etc.)
- It also increased productivity by changing the way production took place
- No more belts and shafts everywhere meant more usable space, more efficient layouts
- Allowed for variation in speed of machines
- Easier to expand factory

Electrification and the Nature of Work

- Electrification directly displaced some workers (overhead cranes replacing manual workers, eliminating certain maintenance workers)
- It also changed the demands for different types of workers
- Electrification led to more intensive mechanization and faster paces of manufacturing
- This led to skilled workers being replaced by unskilled workers plus machines and a general 'hollowing out' of the skill distribution