

The Industrial Revolution in Theory and in History: World Economic Growth Since 10,000 BC

Gregory Clark, University of California, Davis, CA 95616
gclark@ucdavis.edu
www.econ.ucdavis.edu/faculty/gclark

Lecture 1: The Malthusian Economy

Figures and Tables

Figure 1: A Schematized World Economic History Since 2,000 BC

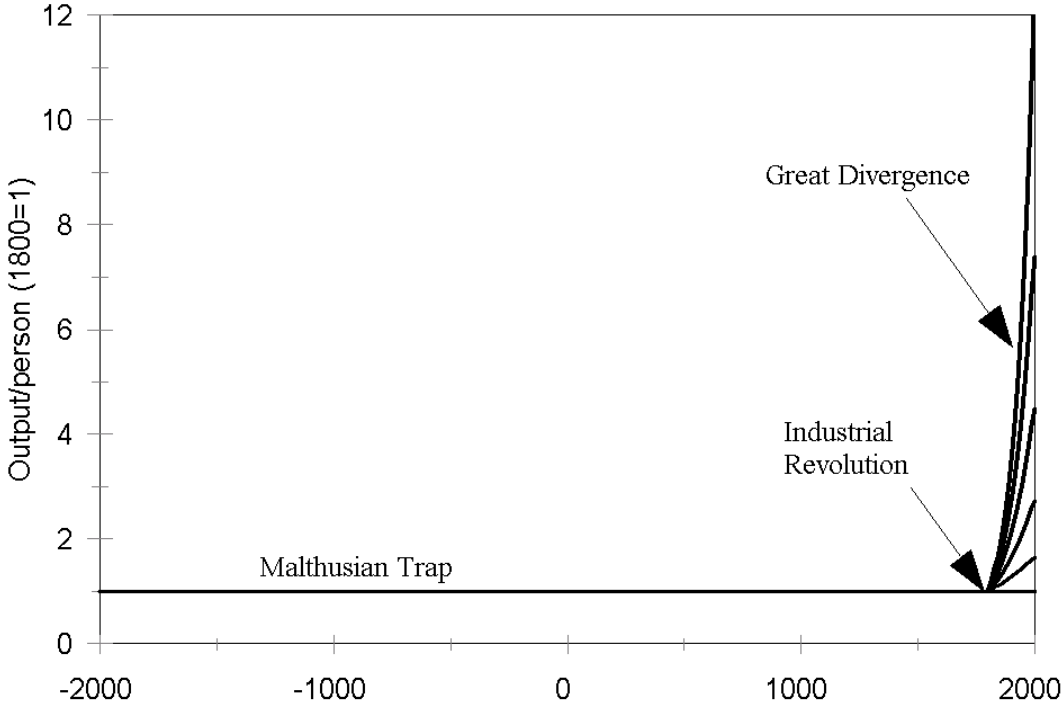


Figure 2: The Long Run Effect of Technological Advance

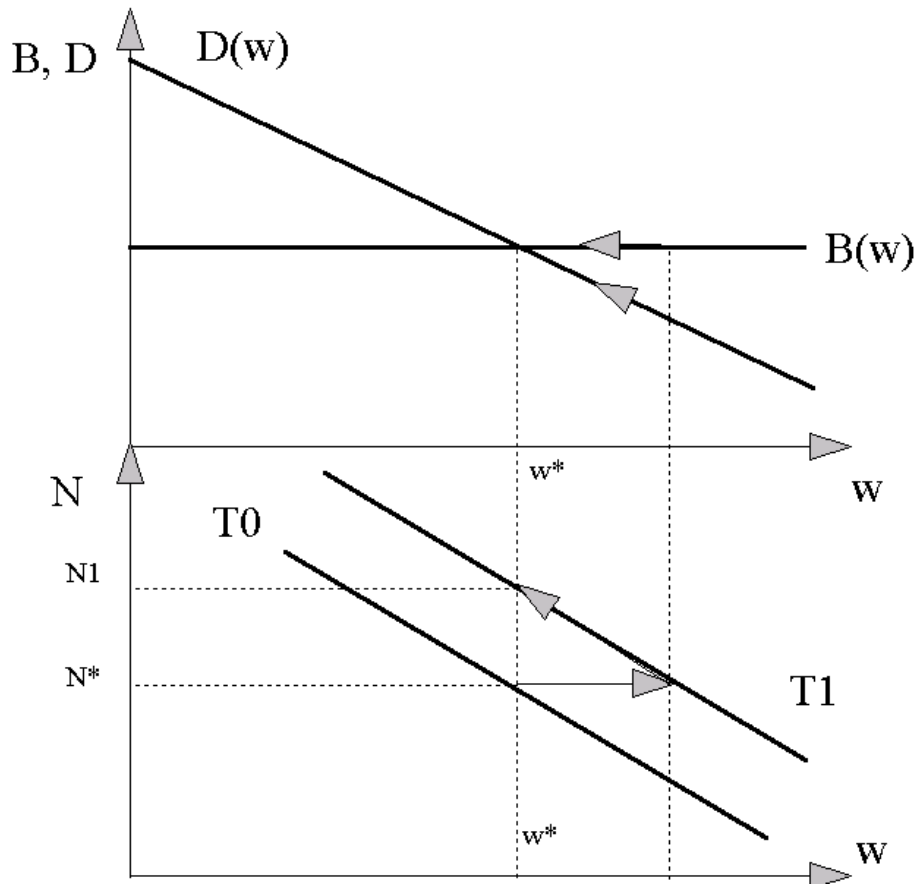


Figure 3: The Americas, Height Index for each sample, 0AD to 1799

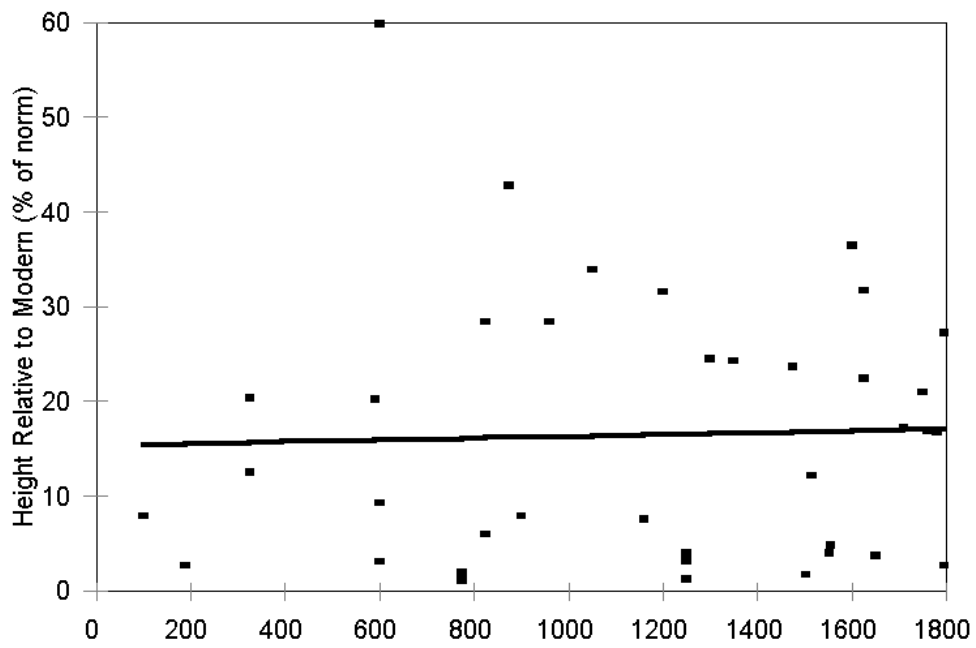


Figure 4: Average of Height Index by Seven Periods

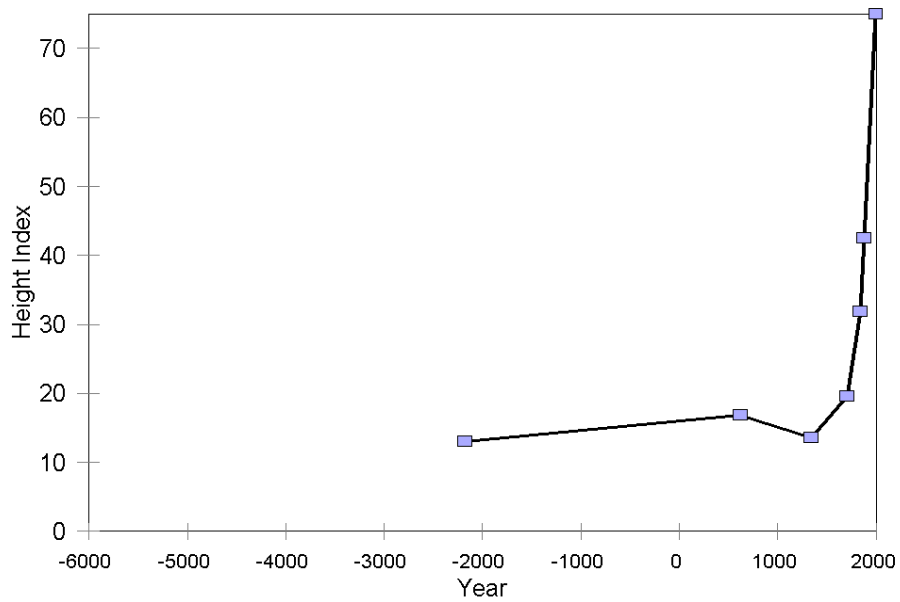


Table 1: GDP per Capita in England Relative to Modern Economies.

Country	Year	Income per capita (1992 \$)
UK	1992	16,302
Mexico	1992	7,867
Bulgaria	1992	6,774
Iran	1992	4,161
South Africa	1992	3,885
England	1860s	2,982
Indonesia	1992	2,601
England	1400s	2,382
England	1760s	2,359
Egypt	1992	2,274
Bolivia	1992	2,066
India	1992	1,633
England	1300s	1,464
Ghana	1992	1,249
Kenya	1992	1,176
Nigeria	1992	1,132
Malawi	1992	607
Chad	1992	504

Modern Economic Growth - Formulas

$$Q = AF(K, N, Z) \quad (1)$$

$$\Rightarrow g_{Q/N} = \alpha \cdot g_{K/N} + \gamma \cdot g_{Z/N} + g_A \quad (2)$$

where α is the share of capital in factor costs, and γ is the share of land.

If all technical progress is the result of capital accumulation

$$g_{Q/N} = \alpha \cdot g_{K/N} + \gamma \cdot g_{Z/N} \quad (3)$$

Capital Accumulation Caused by Technological Advance

$$mp_K = AF_K(K, N, Z)$$

If $F(\cdot)$ is Cobb-Douglas, for example,

$$mp_K = \alpha \frac{Q}{K}$$

\Rightarrow

$$K = \frac{\alpha}{r} Q$$

\Rightarrow

$$g_{Q/N} = \left(\frac{1}{1-\alpha} \right) g_A + \left(\frac{\gamma}{1-\alpha} \right) g_{Z/N} \quad (4)$$

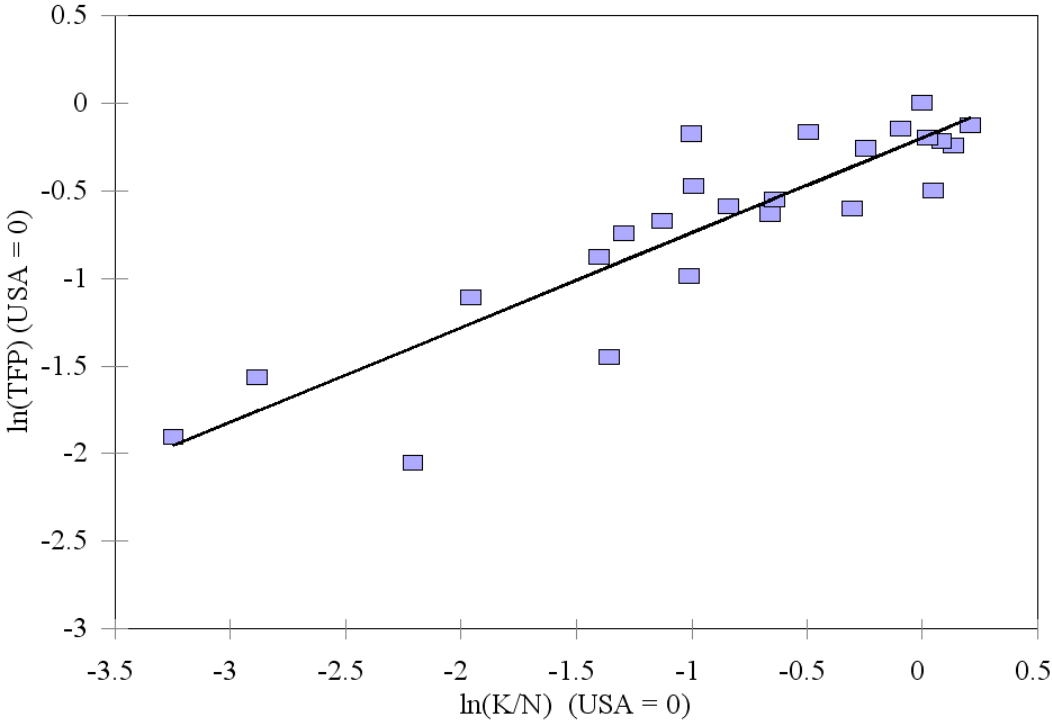
Malthusian Era

$$g_{Q/N} = 0$$

\Rightarrow

$$g_A = \gamma g_N \quad (5)$$

Figure 5: Efficiency versus Capital per Worker, Countries, 1990



Notes: Efficiency (TFP) is calculated as $\ln(Q/N) - 0.3\ln(K/N)$.

Source: Penn World Tables, 5.2.

Figure 6: Capital Accumulation and Tehcnological Advance

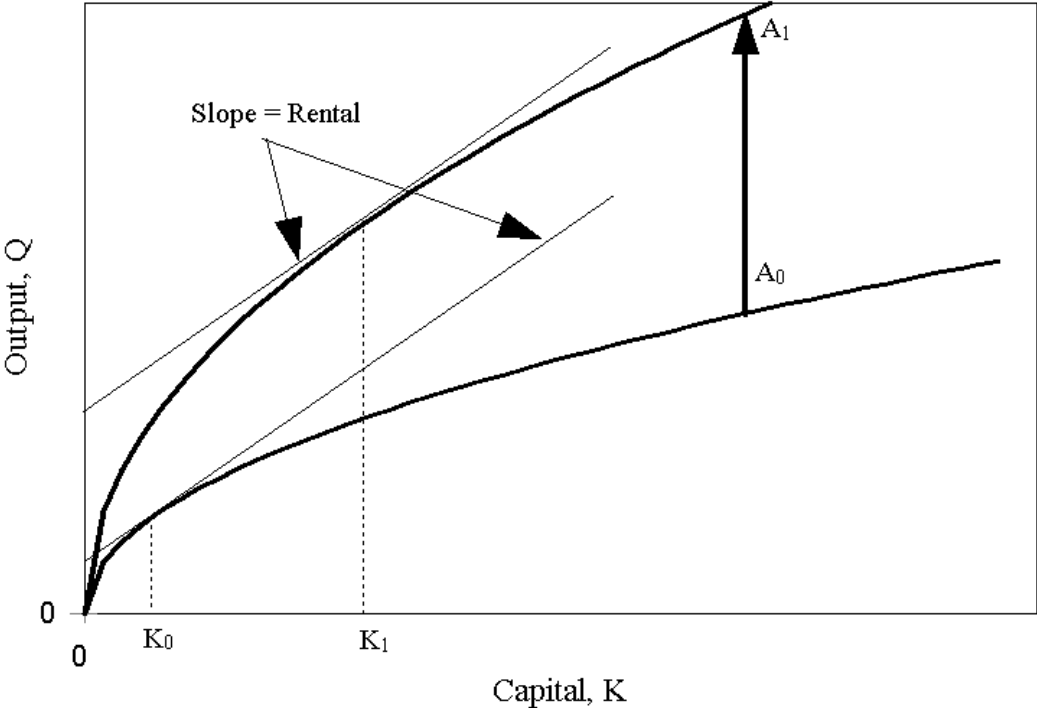
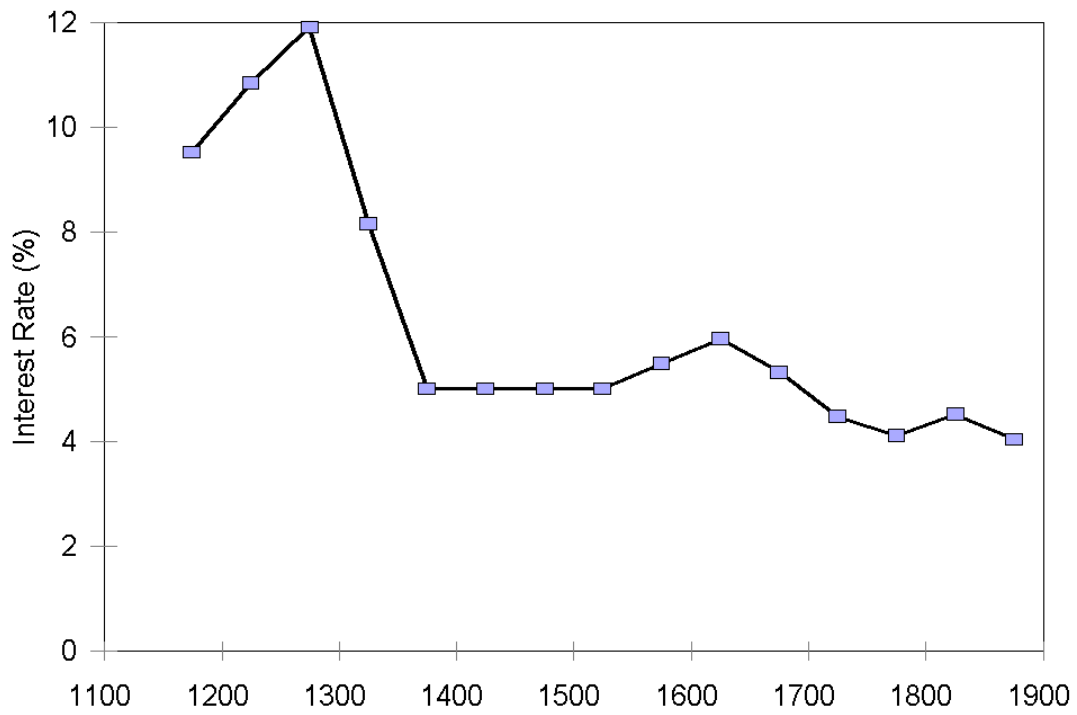
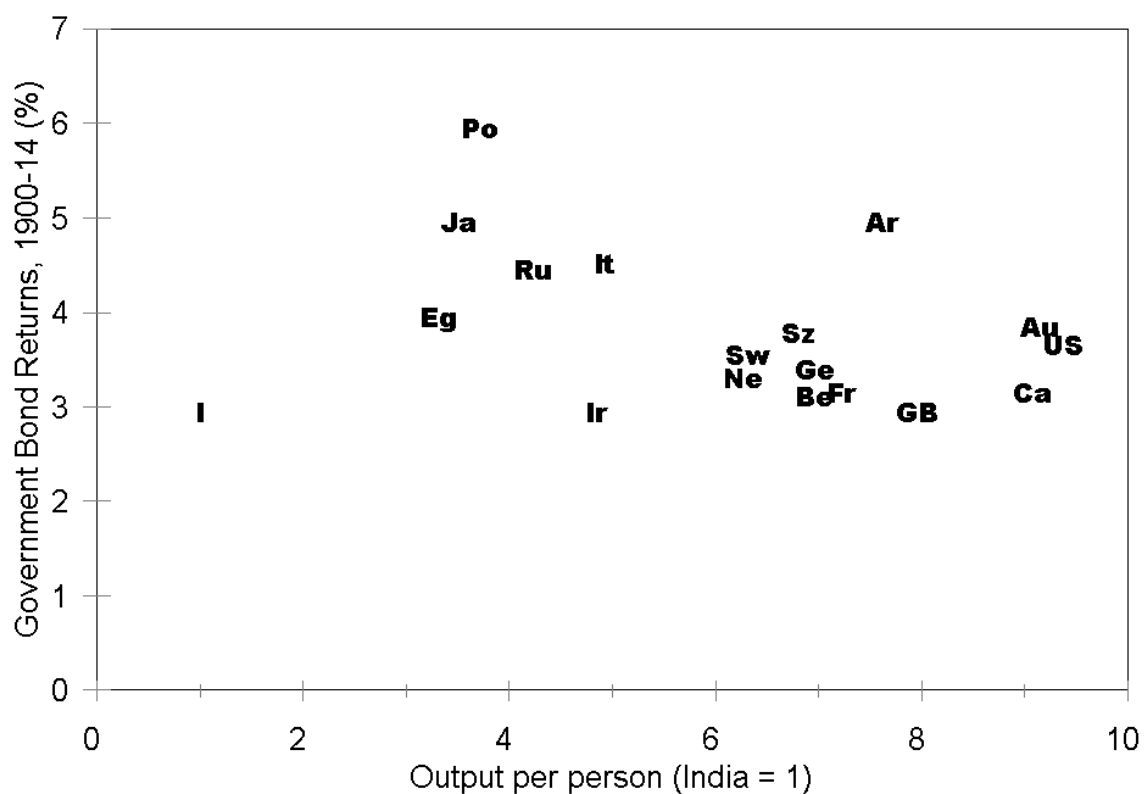


Figure 7: Interest Rate on Rent Charges, 1150-1900, England



Notes: Nominal Rates as 50 year averages.

Figure 8: Government Bond Returns, 1900-14



Notes: Output per person is measured as an index with India set equal to 1. USA, Municipal Bonds, Egyptian Income assumed same as Ottoman Empire, Irish and Indian returns assumed same as British. Au, Australia, Ar, Argentina, Be, Belgium, Ca, Canada, Eg, Egypt, Fr, France, Ge, Germany, GB, Great Britain, Ir, Ireland, It, Italy, Ja, Japan, Ne, Netherlands, Po, Portugal, Ru, Russia, Sw, Sweden, Sz, Switzerland, US, United States of America.

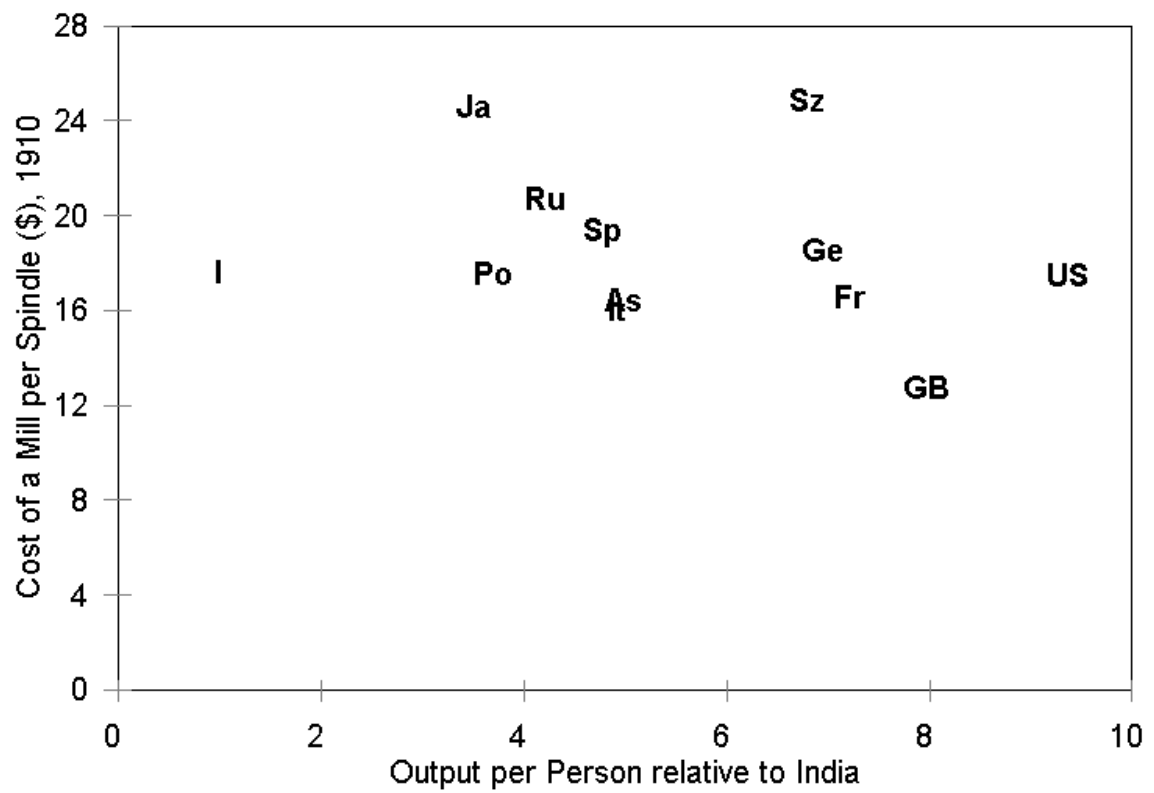
Sources: Homer and Sylla (1996) – Britain, Ireland, USA, France, Germany, Belgium, Netherlands, Canada, Italy, Switzerland. Mauro, Sussman and Yafeh (2001) – Argentina, Egypt, Japan, Russia, Sweden, Portugal, Australia (sterling bonds in London).

Table 2: Rates of Return on Railway Debentures, 1870-1913

Country or Region	Relative Output per Capita (India = 1)	Rate of Return (%)
USA	9.4	6.03
Canada	9.1	4.99
United Kingdom	7.9	3.74
Argentina	7.6	5.13
Brazil	-	5.10
Western Europe	6.1	5.28
Eastern Europe	4.1	5.33
British India	1.0	3.65

Source: Table 1. Edelstein (1982), p. 125.

Figure 9: The Estimated Purchase Price of Capital in 1910



Notes: Output per person is measured as an index with India set equal to 1. The symbols used are: As, Austria, Fr, France, Ge, Germany, GB, Great Britain, I, India, It, Italy, Ja, Japan, Po, Portugal, Ru, Russia, Sp, Spain, Sz, Switzerland, US, United States of America.

Sources: Table 1, Clark (1987).

Figure 10: Land Rents as a Share of Income, England 1280-1869

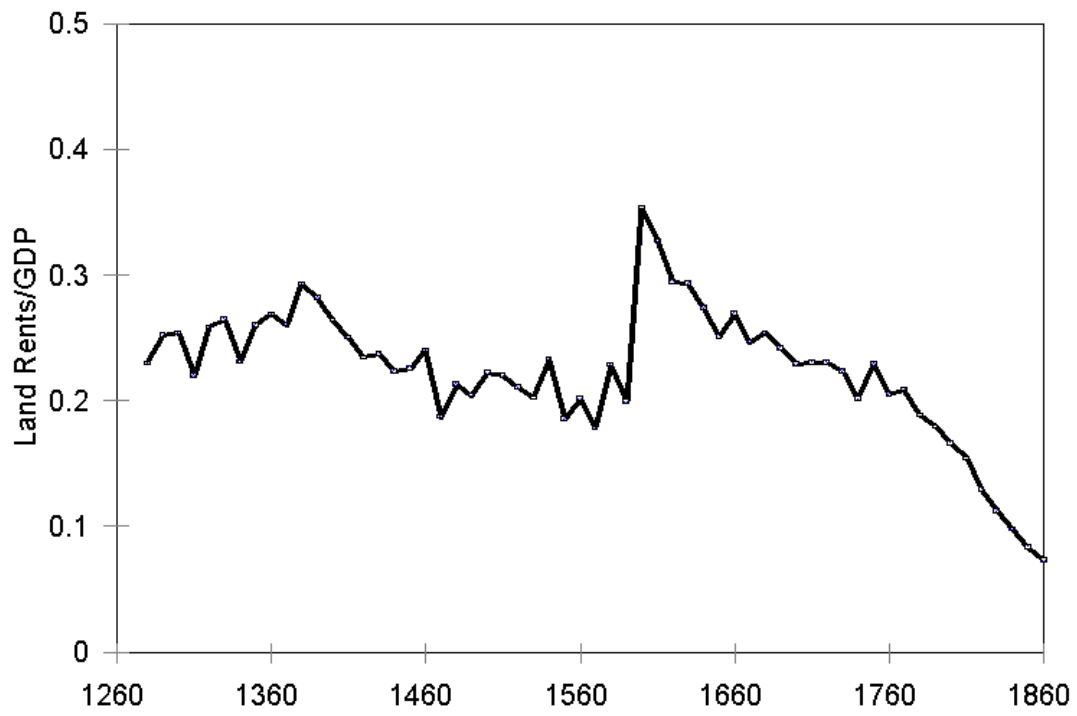


Table 3: Growth Rate of World Population

Year	Population (m.)	Growth Rate of Population (%/year) ξ_N	Growth Rate of Income/Person (%/year) $\xi_{Q/N}$	Implied Rate of Technological Progress (%/year) ξ_A
-10,000	4	-	-	-
-500	100	0.03	0	0.01
1	170	0.11	0	0.03
1,000	265	0.04	0	0.01
1,300	360	0.10	0	0.02
1,400	350	-0.03	0	-0.01
1,500	425	0.19	0	0.05
1,600	545	0.25	0	0.06
1,700	610	0.11	0	0.03
1,800	900	0.39	0	0.10
1,900	1,625	0.59	*0.62	*0.48
2,000	5,500	1.22	**1.54	**1.14

Note: *England, **United Kingdom.

Source: Population estimates are summarized in Michael Kremer, "Population Growth and Technological Change: One Million B.C. to 1990," *Quarterly Journal of Economics*, 108 (3) (Aug., 1993): 681-716.