Third Einstein-Cartan-Evans (ECE) Conference Swansea and Aberystwyth, Wales July 2013

Stephen C. Bannister
Department of Economics
University of Utah
Salt Lake City, Utah 84112
USA
steve.bannister@econ.utah.edu

"All truth passes through three stages. First, it is ridiculed. Second, it is violently opposed. Third, it is accepted as being self-evident." Schopenhauer

Agenda

- Economics – what is it, what are our challenges?
- Intersection of physics and economics
    - Methodologies
    - Thermodynamics
    - Shared people
- South Wales industrial history
- My interests
- Importance of energy in economic systems; hence, the importance of ECE theory in future economic systems
- The role of AIAS in the next great positive supply shock

What do economists do?

- Attempt to model complex social systems – Macroeconomics – equilibrium-based models
- Attempt to explain individual (consumer/firm) behaviour – Microeconomics – constrained optimization
- Attempt to link them – microfoundations of macroeconomics, network systems with emergent behaviours, stochastic agent-based models.
  N.B. the “Fallacy of Composition” makes the emergent properties of network systems (graph theory) a very compelling methodology, at least in economics

Challenges of economics

- Macro models do not forecast well
- Macro models (DSGE) tend to have many adjustable parameters, are very complex
- Empirical (statistical) models offer some relief, but . . .
- Few repeatable experiments

Similarities/dissimilarities with physics

- Use maths in several ways (physics envy?)
  - Theory – so use mostly the same algebras you do (especially linear), although so far no tensor calculus
  - Applied – since difficult to repeat experiments, have evolved a wide set of statistical methods
  - Simulation
- Use scientific methods, processes (publish, etc.)
- Have models with many adjustable parameters – Myron's admonitions apply equally well to economics
- Share people – Fredrick Soddy, Wall Streen "quants"

Similarities/**dissimilarities** with physics

- Narrow vein of thermodynamicists (Sergei Podolinski, Georgescu-Roegen, Timothy Garrett) to whom economics is a thermodynamic system
- Must incorporate institutions and history
- Again, very little repeatability – difficult to “rewind” a macroeconomy since people are involved

Industrial history of South Wales

Century	Company	Location	Product	Customer
16^{th}–17^{th}	Mineral and Battery Company	Tintern	brass, wire	woolcards
	Mines Royal	Cornwall Neath	copper mining copper smelting (coal)	
	various	Swansea,Tenby	coal mining	export
	various	Brecon, Monmouth	iron (charcoal)	
18^{th} (1^{st} half)	various	Pontypool	tinplate	
	Humphrey Mackworth	Melincryddan	lead,copper	
	John Lane	Landore	copper smelting	
	various	Swansea	copper smelting	
	various	Taibach	copper smelting	
	various (16)	various (small)	iron (charcoal)	
1750–1850	Powicke Forge	Hirwaun	iron (coal)	Seven Years' War
	Llanishen Merthyr Furnace	Merthyr Dowalis	mineral lease (iron) iron (coal)	Merthyr Furnace war
	Cyfarthfa Pennydarren Plymouth Works	Merthyr Merthyr Merthyr	mineral lease (iron) mineral lease (iron) mineral lease (iron)	war war war
	Cyfartha Works	Merthyr	cannon	US Revolution
	Cyfartha Works	Merthyr	puddlling process	wrought iron
	various (4)	various	tramroad canals	transport
	Pen-y-Darren Ironworks Richard Trevithick (1804)	Merthyr Tydfil	steam engine locomotive	hammer transport
1815-1850	various	various	iron,tinplate,copper,coal	
1727-	Robert Morris, others	Swansea	non-ferrous smelting	input story cheap coal near ores

Pen-y-darren engine replica, National Waterfront Museum, Swansea

Blast furnaces 1709 (coke), Blists Hill, Coalbrookdale, Shropshire

My interests

- Long time background physics interest, bemusement over great divide

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

My interests

- Long time background physics interest, bemusement over great divide
- Inet surfing ("unified field theory" or "TOE") on ↑ led me to Myron's site at least seven years ago

---

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

My interests

- Long time background physics interest, bemusement over great divide
- Inet surfing ("unified field theory" or "TOE") on ↑ led me to Myron's site at least seven years ago
- The details on spacetime resonance energy (UFT87) completely hooked me as it fed my other passion . . .

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

My interests

- Long time background physics interest, bemusement over great divide
- Inet surfing ("unified field theory" or "TOE") on $\uparrow$ led me to Myron's site at least seven years ago
- The details on spacetime resonance energy (UFT87) completely hooked me as it fed my other passion . . .
- Instead of retirement, I decided to complete my Ph.D. in economics to pursue {energy, development, growth}.

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

My interests

- Long time background physics interest, bemusement over great divide
- Inet surfing ("unified field theory" or "TOE") on $\uparrow$ led me to Myron's site at least seven years ago
- The details on spacetime resonance energy (UFT87) completely hooked me as it fed my other passion ...
- Instead of retirement, I decided to complete my Ph.D. in economics to pursue {energy, development, growth}. Along the way, I learned to "surrender" to the maths

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

My interests

- Long time background physics interest, bemusement over great divide
- Inet surfing ("unified field theory" or "TOE") on ↑ led me to Myron's site at least seven years ago
- The details on spacetime resonance energy (UFT87) completely hooked me as it fed my other passion . . .
- Instead of retirement, I decided to complete my Ph.D. in economics to pursue {energy, development, growth}. Along the way, I learned to "surrender" to the maths
- Last year I "came out of the heterodox closet" by writing Myron on cold fusion; I am humbled by the response and truly feel I am on the sidelines of a revolution

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

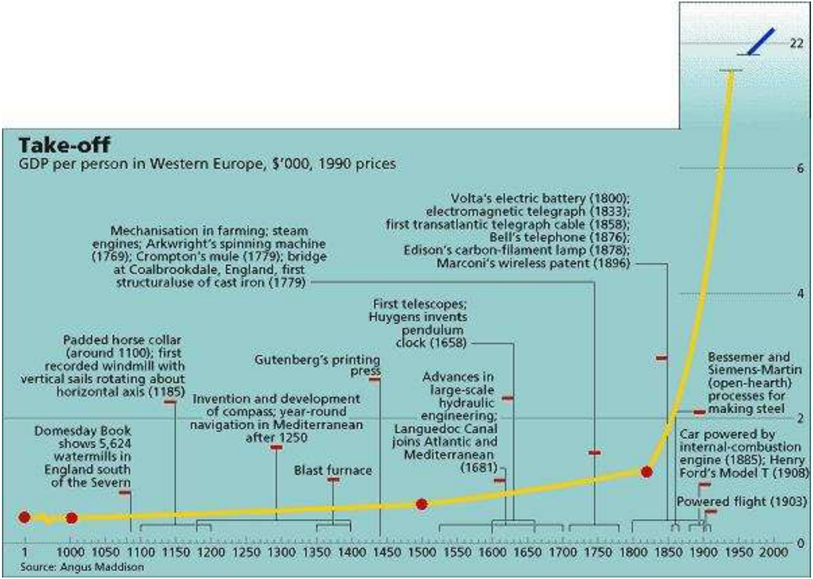
My interests

- Long time background physics interest, bemusement over great divide
- Inet surfing ("unified field theory" or "TOE") on $\uparrow$ led me to Myron's site at least seven years ago
- The details on spacetime resonance energy (UFT87) completely hooked me as it fed my other passion ...
- Instead of retirement, I decided to complete my Ph.D. in economics to pursue $\{$energy, development, growth$\}$. Along the way, I learned to "surrender" to the maths
- Last year I "came out of the heterodox closet" by writing Myron on cold fusion; I am humbled by the response and truly feel I am on the sidelines of a revolution
- So, onto the importance of energy in economic systems: [1]

[1] A note on the University of Utah: one of the most heterodox economic programs in the world; also the home of Fleischmann and Pons experiments

English Industrial Revolution, 1590 - 1876

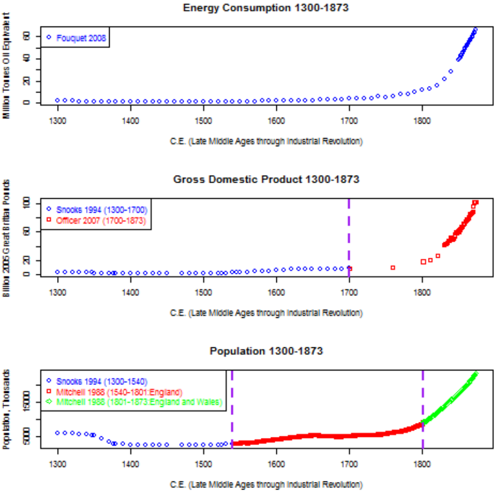
- Modern economic growth
- Unconstrained quantity of fossil carbon energy – an *energy* revolution (in fact two!) led by a demand revolution
- Little statistical space for institutional or cultural events – except to explain structural breaks


Take-off
GDP per person in Western Europe, $'000, 1990 prices
Volta's electric battery (1800); electromagnetic telegraph (1833); first transatlantic telegraph cable (1858); Bell's telephone (1876); Edison's carbon-filament lamp (1878); Marconi's wireless patent (1896)
Mechanisation in farming; steam engines; Arkwright's spinning machine (1769); Crompton's mule (1779); bridge at Coalbrookdale, England, first structuraluse of cast iron (1779)
First telescopes; Huygens invents pendulum clock (1658)
Padded horse collar (around 1100); first recorded windmill with vertical sails rotating about horizontal axis (1185)
Gutenberg's printing press
Advances in large-scale hydraulic engineering; Languedoc Canal joins Atlantic and Mediterranean (1681)
Bessemer and Siemens-Martin (open-hearth) processes for making steel
Invention and development of compass; year-round navigation in Mediterranean after 1250
Domesday Book shows 5,624 watermills in England south of the Severn
Blast furnace
Car powered by internal-combustion engine (1885); Henry Ford's Model T (1908)
Powered flight (1903)
22
6
4
2
0
1 1000 1050 1100 1150 1200 1250 1300 1350 1400 1450 1500 1550 1600 1650 1700 1750 1800 1850 1900 1950 2000
Source: Angus Maddison

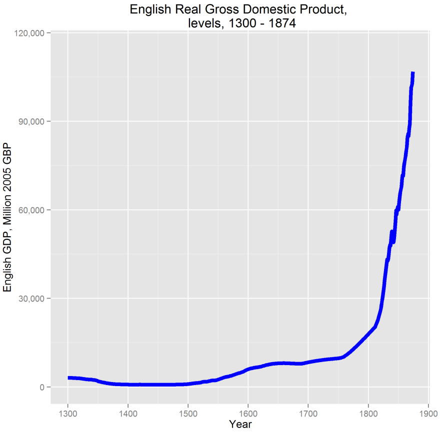
Taxonomy of EIR explanations

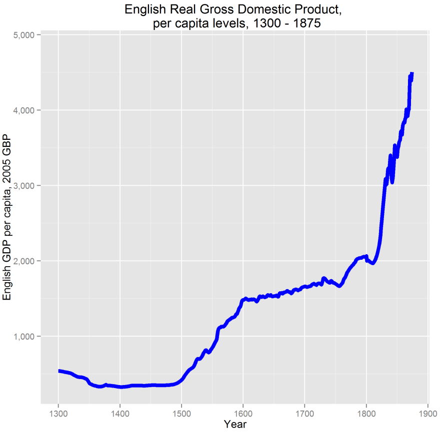
Label	Examples
English exceptionalists	Landes (1969), McCloskey (2010), Mokyr (1992,2010)
Partial culturalists	Cipolla (1966), Pomeranz (2001), Allen (2009)
Primarily energetic	Cottrell (1955), Wrigley (1988,2010), Malanima (2010), Nef (1932)
Thermodynamicists	Georgescu-Roegen (1975), Ayres (2003), Garrett (2009)

Author/time-span series of energy consumption, GDP, and population

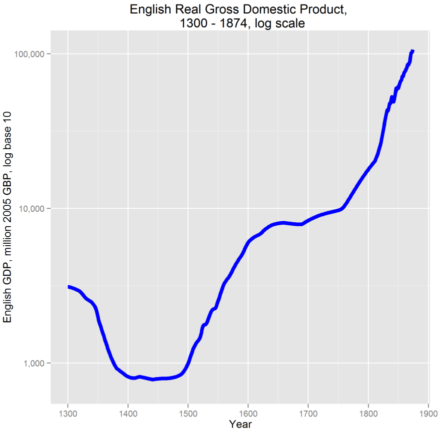


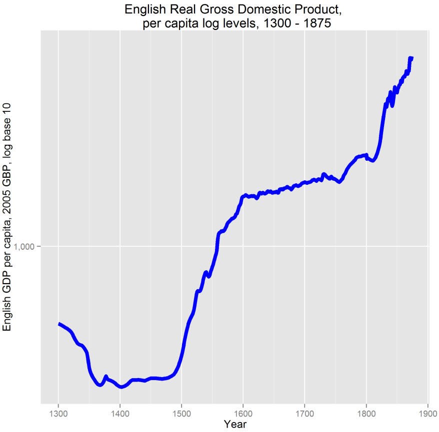
English real gross domestic product, levels and per–capita



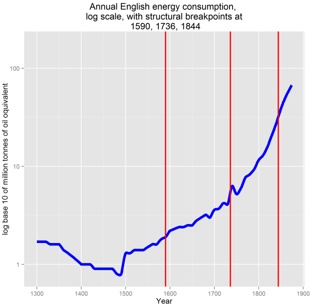


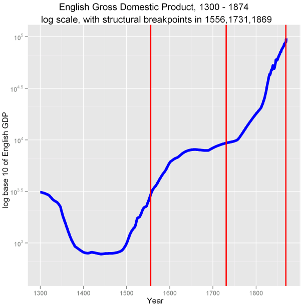
English real gross domestic product, log levels and log per–capita

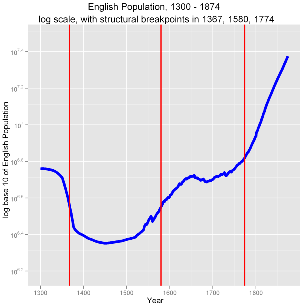




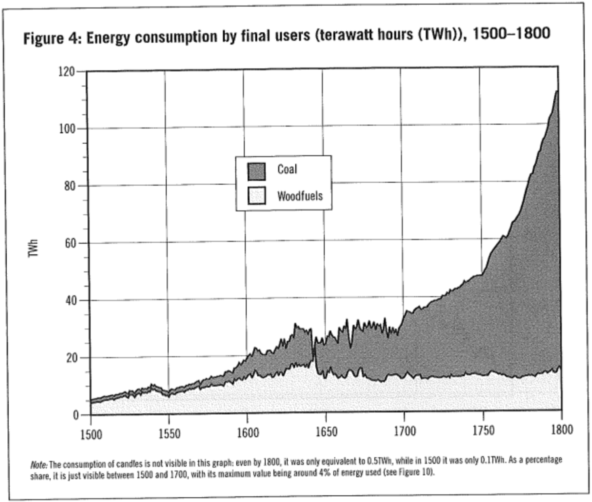
Structural break comparison



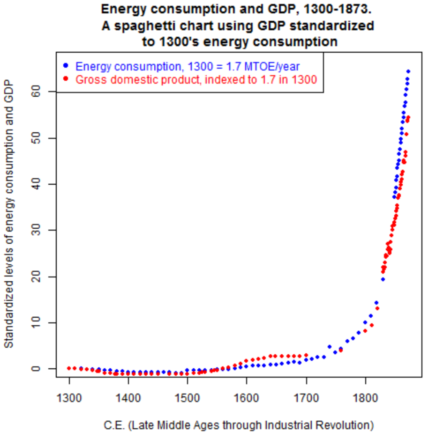


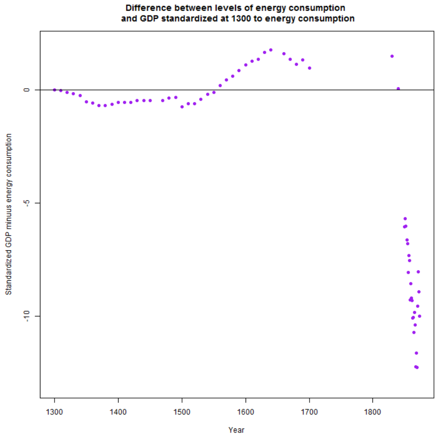


Coal and wood energy sources
Source: Pearson & Fouquet

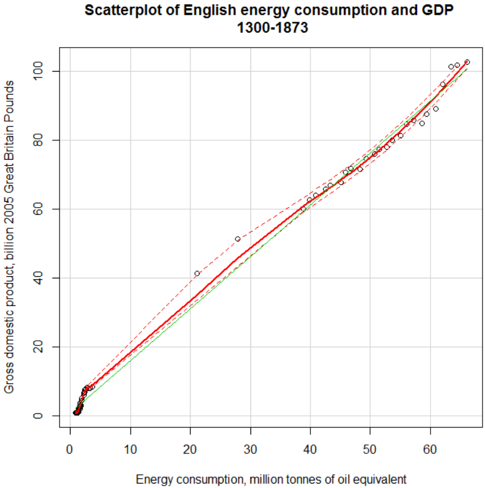


Energy consumption vs. standarized GDP





Scatterplot of energy consumption vs. GDP



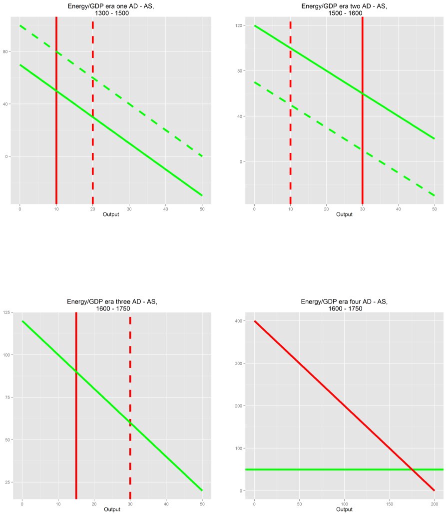
No “Solow” residual

Granger tests of energy/GDP dynamics

Era	Energy ∼ GDP Pr(>F)	GDP ∼ Energy Pr(>F)	AS/AD regime
1300 – 1500	0.0106	0.0003	EMP [2], Black Death: increasing wages, family income
1500 – 1600	0.1939	0.6126	Positive demand shock
1600 – 1750	0.3529	0.5185	Energy supply constraint
1750 – 1873	0.0024	0.1100	Positive supply shock: “virtuous” macro feedback cycle
1300 – 1873	0.0002	0.0361	Total study period

[2] European marriage pattern (Hajnal)

Aggregate Supply - Aggregate Demand
Four energy/GDP regimes



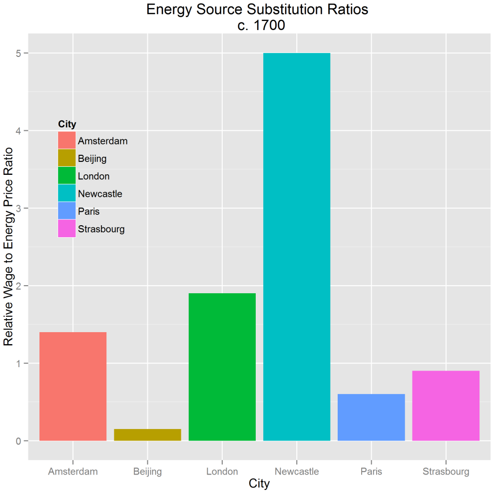
Desaguliers manuscript

rection P *p*, and a Quantity of Water propor[...]
be lifted up, and run out at P. This may be done 15 or 16 times in a
Minute, because each Man would pull down but 30 Pounds at a time,
after the manner that People ring Bells. But as no Time is to be lost, lest
the Mine be overflow'd by the Springs below, there must be 100 more
Men to relieve these when they are weary. Now as it must be a rich
Mine indeed whose Profit can afford to keep 200 Men at this Work; that

Lect. XII. Plate 36.

that Thought must be laid aside. We'll consider therefore what can be done by Horses. As an Horse is equal to five Men, we must work 20 Horses at a time to raise the Water requir'd; and as Horses must be reliev'd even more than Men, about 50 Horses must be kept to carry on this Work constantly, and bring down the End of the Beam *b*, 16 times in a Minute, and make the number of Strokes requir'd in the Pump, the Weight of whose Rod after every Stroke will bring down the End *b* 2, by drawing along the Tangent *i* H. It is plain to any body, that tho' the Horses may be had cheaper than Men, yet that will be a very expensive way. For the next Contrivance, we'll suppose a Philosopher to come, and find a means to bring down the End of the Beam, without Men or Horses, in this manner. To the Chain H L he fixes a

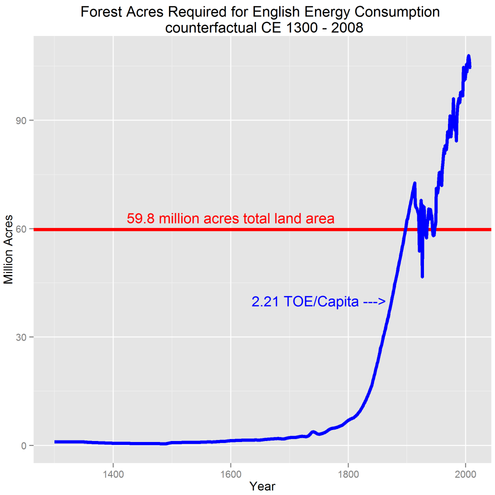
Real wage to energy ratios
Source: Robert Allen (2009)



Microeconomic theory

$$\frac{\text{Marginal Revenue Product}_{\text{organic energy joule}}}{\text{Price}_{\text{organic energy joule}}} = \frac{\text{Marginal Revenue Product}_{\text{fossil energy joule}}}{\text{Price}_{\text{fossil energy joule}}} \tag{1}$$

English wood energy supply constraint



The role of AIAS in future economic systems

- There is no (economic) activity without energy input, it is the only non-substitutable input

The role of AIAS in future economic systems

- There is no (economic) activity without energy input, it is the only non-substitutable input
- Spacetime energy, essentially unlimited and free, will propel us into a new economic regime

The role of AIAS in future economic systems

- There is no (economic) activity without energy input, it is the only non-substitutable input
- Spacetime energy, essentially unlimited and free, will propel us into a new economic regime
- Andrea Rossi may be able to commercialize LENR without theoretical support, but such support will affect the speed of acceptance

The role of AIAS in future economic systems

- There is no (economic) activity without energy input, it is the only non-substitutable input
- Spacetime energy, essentially unlimited and free, will propel us into a new economic regime
- Andrea Rossi may be able to commercialize LENR without theoretical support, but such support will affect the speed of acceptance
- At the moment, I am trying to be the economic historian who best explains the EIR, on my way to being the economist of space-energy economics

The role of AIAS in future economic systems

- There is no (economic) activity without energy input, it is the only non-substitutable input
- Spacetime energy, essentially unlimited and free, will propel us into a new economic regime
- Andrea Rossi may be able to commercialize LENR without theoretical support, but such support will affect the speed of acceptance
- At the moment, I am trying to be the economic historian who best explains the EIR, on my way to being the economist of space-energy economics
- What can I do to help?

Figure: Standardized English energy intensity of GDP

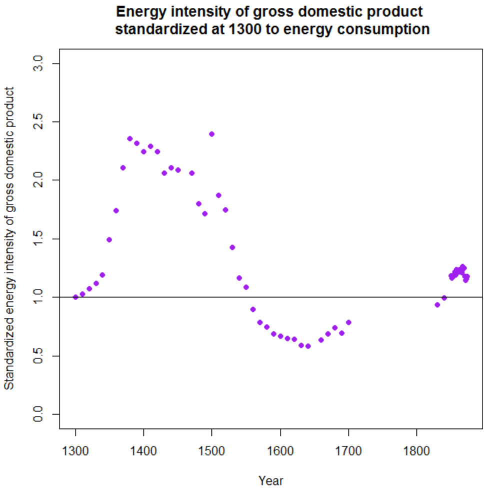


Figure: Log of GDP, with structural breaks

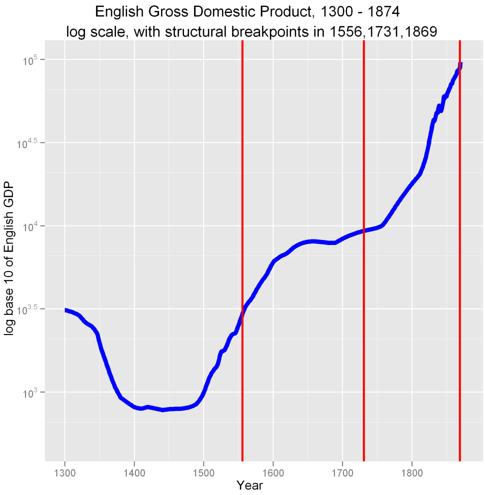
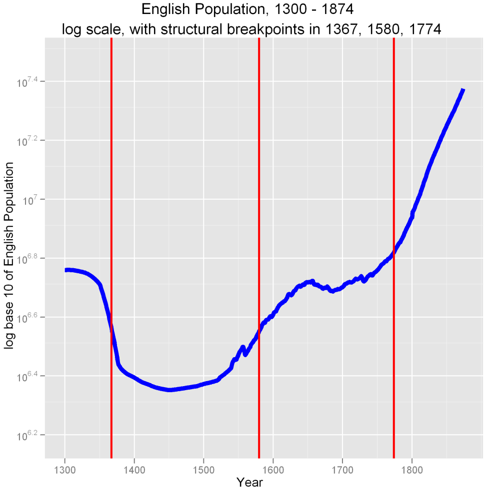


Figure: Log of population, with structural breaks



Data Sources

Data series	Year range	Geography	Source
Energy consumption	1300 – 1873	England/Wales	Roger Fouquet (2008)
Gross domestic product	1300 – 1700	England	Graeme Snooks (1994)
	1741 – 1873	England/Wales	Lawrence Officer (2009)
Population	1300 – 1540	England	Graeme Snooks (1994)
	1541 – 1800	England	B. R. Mitchell (1988)
	1801 – 1873	England/Wales	B. R. Mitchell (1988)

Table: growth rates by century

Year	1300	1400	1500	1600	1700	1801	1873	Total
GDP Million 2005 GBP	3114.7541	815.1288	994.4571	6031.953	8361.5911	18110	102811	
Century-over-century rate of growth		-0.738	0.220	5.066	0.386	1.166	4.677	32.008
Compounded annual rate of growth		-0.013	0.002	0.018	0.003	0.008	0.024	0.006
Energy consumption	1.7	1	1.3	2.2	3.6	11.6	66.1	
Century-over-century rate of growth		-0.412	0.300	0.692	0.636	2.222	4.698	37.882
Compounded annual rate of growth		-0.005	0.0026	0.005	0.005	0.012	0.024	0.006
Per-capita GDP 2005 GBP	542	329	421	1,484	1,663	1,999	4,392	
Century-over-century rate of growth		-0.393	0.282	2.521	0.121	0.202	1.198	7.108
Compounded annual rate of growth		-0.005	0.002	0.013	0.001	0.002	0.011	0.004

Table: Energy and GDP fit tests

Test	Statistic	p-value
Pearson's correlation	0.998	
Paired t-test	5.592	4.991e-07
Chi-square	2864	0.0004998