AI as a GPT: An Historical Perspective

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The Impact of Machine Learning and AI on the UK Economy
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General Purpose Technologies

- Pervasive impact but macro-productivity implications modest initially: arithmetic of growth accounting and time to realise full potential and make complementary investments/innovations

- Impact lags have become shorter; society better at exploiting GPTs more rapidly and diffusion has speeded up

- Quite possible these comments apply to AI and that fairly soon its productivity impact will become significant (Brynjolfsson et al., 2019)

GPTs: Contributions to Labour Productivity Growth

(% per year)

	K/L	*TFP*	*Total*
Steam (UK)			
1760-1830	**0.011**	**0.003**	**0.014**
1830-1870	**0.18**	**0.12**	**0.30**
1870-1910	**0.15**	**0.16**	**0.31**
Electricity (USA)			
1899-1919	**0.04**	**0.06**	**0.10**
1919-1929 (1)	**0.07**	**0.07**	**0.14**
1919-1929 (2)	**0.07**	**0.30**	**0.37**
1929-1941	**0.04**	**0.16**	**0.20**
ICT (USA)			
1974-1995	**0.41**	**0.36**	**0.77**
1995-2004	**0.78**	**0.72**	**1.50**
2004-2012	**0.36**	**0.28**	**0.64**

Sources: Bakker et al. (2019), Byrne et al. (2013) and Crafts (2004).

Estimates of Adoption Lags

(Comin & Mestieri 2018)

	Invention Year	Mean Lag (Years)
Railway	1825	71
Electricity	1882	47
Cars	1885	36
Synthetic Fibre	1931	29
Personal Computer	1973	14
Internet	1983	6

Is the 'Great Inventions' Story Really True?

- **Gordon (2016):** U.S. productivity growth in the 20th and 21st centuries is dominated by the flow and ebb of 'great inventions' whose impact peaked following the 2nd industrial revolution

BUT

- These claims are not evidence based and may be misconceived

- **Harberger (1998):** TFP growth is a 'mushrooms' process of many disparate decreases in real costs rather than the pervasive impact of GPTs (cf. 'electricity age')

A View from the 1930s

(Bakker et al., 2019)

- A ‘technologically progressive’ decade; ‘great inventions’ and **broadly based TFP growth**

- ICT is surely a ‘great invention’; the so-called ‘great inventions’ only outperform it if distribution is included

- ‘Other TFP growth’ has been weak recently - (too few mushrooms) - but was strong then

- We need to address issues like ‘economic dynamism’ not just wait for GPT

Contributions to TFP Growth in the U. S. Business Sector (% per year)

	1929-1941	*1899-1941*
TFP Growth	**1.86**	**1.29**
Great Inventions	**0.84 (0.35)**	**0.49 (0.27)**
Other	**1.02 (1.51)**	**0.80 (1.02)**

	1974-1995	*1995-2004*	*2004-2012*	*1974-2012*
TFP Growth	**0.50**	**1.61**	**0.34**	**0.73**
IT Sectors	**0.36**	**0.72**	**0.28**	**0.43**
Other	**0.14**	**0.89**	**0.06**	**0.30**

Note: 'great inventions' comprise technology clusters around electricity, internal combustion engine, re-arranging molecules, communications & entertainment. Figures in parentheses re-classify distribution as other.

Sources: Bakker et al. (2017); Byrne et al. (2013)

The First Industrial Revolution

- Is not rapid productivity growth and not the Steam Age

- Is not a Rostow-type ‘take-off’

BUT

- Is transition to ‘modern economic growth’

- Is outcome of the Enlightenment (Mokyr, 2016)

Sources of Growth, 1700-1873

(% per year) (Crafts, 2019)

	Capital Deepening	Labour Quality	TFP	Y/HW Growth
1700-60	0.10	0.01	0.14	0.25
1760-80	-0.06	-0.01	0.06	-0.01
1780-1800	0.19	-0.01	0.28	0.46
1800-30	0.10	0.01	0.18	0.29
1830-56	0.65	0.08	0.38	1.11
1856-73	0.72	0.32	1.02	2.06

Industrial Revolutions as New Methods of Invention

- **1st :** empiricism of practical applied knowledge
- **2nd :** science-based technology from R & D
- **3rd :** much cheaper computing
- NB: all entail reduced costs of access to knowledge and better ideas production function

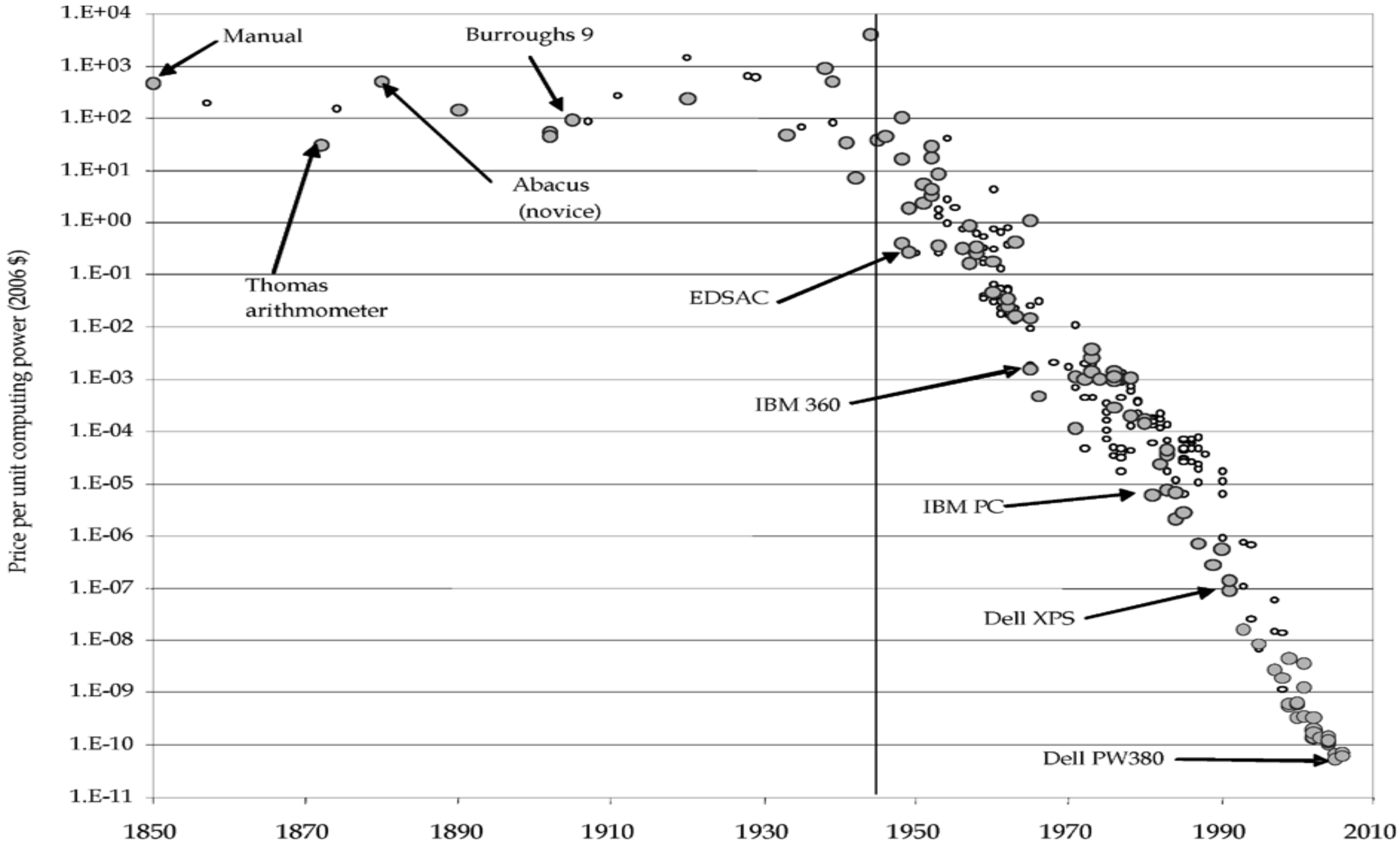

FIGURE 3
THE PROGRESS OF COMPUTING MEASURED IN COST PER COMPUTATION PER SECOND DEFLATED BY THE PRICE INDEX FOR GDP IN 2006 PRICES

Notes: The larger circles are estimates that have been judged relatively reliable, while the small circles are estimates in the literature that have not been independently verified. The vertical line is placed at 1944, which is the estimated breakpoint in productivity growth.

Source: Nordhaus (2007)

Are Ideas Getting Much Harder to Find?

- **Bloom et al. (2017): Yes!** – since 1930s rising research intensity but falling TFP growth such that the number of researchers has to double every 13 years just to maintain TFP growth

- It's a semi-endogenous growth story where past TFP growth largely reflects the transitory impact of increases in R & D/GDP

- If this is the right model, given that U.S. employment growth will decline markedly, Gordon is too optimistic; steady state TFP growth could be as slow as 0.25% per year (Kruse-Andersen, 2017)

Perhaps Not?

- **TFP ≠ technological progress;** 1930s' TFP growth not highly correlated with R & D and exit an important aspect (Bakker et al., 2019)

- Other indicators are less pessimistic for growth prospects; half-life for patents = 194 years and for tech books no diminishing returns

- Productivity of R & D might increase significantly in context of **AI as an IMI** (invention of a method of invention) (Cockburn et al., 2019)

4th IR: AI as General Purpose IMI

- Data analysis with deep learning may have more profound effects than robotics

- Tiny needles in giant haystacks, e.g., **Halicin**

- Antidote to ‘ideas becoming harder to find’; much improved ideas production function

- ‘Unaccounted’ impact on TFP growth