From Physics to Daily Life

Innovation and Big Data

Edwin Morley-Fletcher

LYNKEUS

STRATEGY CONSULTING
POLICY ADVICE
DATA ANALYTICS

Wealth in economics: agriculture and division of labour

- Some thought that wealth resided in agriculture, the only activity generating a ‘net product’, while industry was deemed to be ‘sterile’

François Quesnay

Nicolas de Condorcet

- And others saw wealth as correlative to the division of labour

Adam Smith

Wealth in economics: profits and exploitation

- Some posited that wealth corresponded to profits, in opposition to rents and wages

David Ricardo

- For others, industrialization became synonymous with exploitation

Karl Marx

Wealth in economics: the economies of scale

Many seemed to agree that economies of scale were the great factor increasing returns and operating as the engine of economic growth

This pleased at the same time:

- Free-traders  Richard Cobden
- Empire builders  Cecil Rhodes  Alfred Milner
- Socialists  Karl Kautsky
- Communists  Vladimir Lenin

(the latter two both striving to “transform the whole of society into a single factory”)

Wealth in economics: perfect competition

The so-called Marginalists redirected the economic discourse away from the dangerous connection between profits and exploitation, positing that ultimately wealth depended on:

- the degree by which society could approach perfect competition
- where marginal returns on all forms of resource investment would eventually be equalized.


Jevons


Menger


Böhm-Bawerk


Walras


Pareto

Wealth in economics: innovation

However, if perfect competition reduced to nought profit differentials, then the engine of development had to be elsewhere:

- In the quasi-rent made temporarily possible by innovation
- i.e., in Schmpeter's entrepreneurial «distructive creation»

Joseph Schumpeter

The bounded rationality paradigm shift

- Schumpeter still thought that the likelihood of an innovation was as knowable as the prospects faced by established products. There would not be any chance of misjudgement, provided there were due diligence.

- However, innovation now appears to be inherently unpredictable:
  - not only are the market applications for disruptive technologies unknown at the time of their development,
  - they are unknowable
- Amidst all the uncertainty surrounding disruptive technologies,
  - "managers can always count that experts' forecasts will always be wrong"

Clayton Christensen, *The Innovator's Dilemma*, 2000

Herbert Simon 

C. Christensen 

Risk and uncertainty

- Frank Knight had posited that it was precisely "true uncertainty that was 'preventing the theoretically perfect outworking of the tendencies of competition"
- Had there not been such uncertainty, the entrepreneur's income would not be "what is left, after the others are determined"

Frank Knight, *Risk, Uncertainty and Profit*, 1921

Frank Knight

Wealth growth requires stabilisation: the government‘s job

- Keynes’ prescription would follow Knight’s distinction between risk and uncertainty.
- Under capitalism, uncertainty is generated by the system itself, because it is an engine for accumulating capital goods whose rewards come not now but later.
- The engine of wealth creation is at the same time the source of economic and social instability.
- In general terms, Keynes thought that risk could be left to look after itself; the government’s job was to reduce the impact of uncertainty by controlling demand, while not interfering with the supply of goods.

John Maynard Keynes

John Stuart Mill

Wealth in economics: the planned economy experiment

- The disquieting association of profits, innovation and uncertainty, that was coming to maturity in those years, was meanwhile looked at in a dismissive way by those who were pursuing the maximum economies of scale through economic planning.
- Ironically, the process which had had as grand goal:
  - the “universal development of productive forces”
  - leading to a situation where “with the all-around development of the individual, [...]all the springs of cooperative wealth [would] flow more abundantly”
  - endogenously turned, through centralized planning, into a system which in 1980 would be bluntly characterized by Janos Kornai as the *Economics of Shortage*.

Joseph Stalin

Janos Kornai

Wealth in economics: euphoric globalisation

- The “demise of socialism” induced many to believe that globalization, in conjunction with the free flow of capitals, would bring about increasing wealth, provided economic growth could be channelled into boundaries of ecological sustainability.
- The theory of efficient market expectations assumed that ‘financial markets were equivalent to insurance markets, until the financial crisis of 2008 proved once more that financial stability was still an inherently uncertain precondition for securing further growth and a larger diffusion of wealth.

A new paradigm wins through: the knowledge economy

- The key driver should be believed to be none of those referred to until then.
- Rather,
  - knowledge,
  - its continuous translation into innovation
  - knowledge and technology transfer
- These are instead to be seen as the real engines of long-term economic growth.
- Friedrich Hayek had laid the ground for this new way of looking at development:
  - Introducing already in the 1930s the idea that, in a complex economy, know-how had necessarily to be highly dispersed and no central planner would ever be able to put it all together;
  - Coming in 1968 to dub competition itself as a “discovery procedure”.

Friedrich von Hayek

Paul Romer: knowledge is the endogenous factor of economic growth

- Knowledge accumulation and deepening are the source of increasing returns, which explain why economic growth can be accelerating in rich countries.
- History teaches us that economic growth springs from better recipes, not just from more cooking.
- Every generation has perceived the limits to growth that finite resources and undesirable side effects would pose if no new recipes or ideas were discovered.
- And every generation has underestimated the potential for finding new recipes and ideas.
- We consistently fail to grasp how many ideas remain to be discovered.
- Possibilities do not add up. They multiply.

Paul Romer

Disruptive implications of cognitive capitalism: post-scarcity

- This knowledge-based approach implies the need to understand:
  - what interconnected set of market and non-market institutions could best make the innovation process work effectively.
  - what type of strategies governments should follow in order to foster highly innovative economic systems.
- The openness to innovation processes implies:
  - specific forms of organization that develop, test, and prove ideas
  - regulatory environments that do not impede capital and labour movements nor place unnecessary burdens on firm creation and dissolution
  - a general frame of mind truly taking into account that the economic death of old sectors is part and parcel of the advance of new sectors.
- While, with industrial development, economic growth was based on the usage of limited natural resources, knowledge, being immaterial, appears to be limitless.
- The passage “from atoms to bits” seems to imply also that the number of bytes we make use of can continue to grow exponentially.

New issues triggered by cognitive capitalism

- The non-rivalness, non-excludability, cumulativeness, and network characteristics of knowledge have the potential of creating a combinatorial explosion.
- A knowledge-based economy would seem to prevent natural market incentives from achieving allocatively efficient outcomes, determining a “tragedy of the commons”.
- For managing “knowledge commons” the social regulations which are needed are fundamentally different from those used for regulating systems founded on exhaustible resources.

Different organisational modes recur to different strategies

- Markets reduce uncertainty regarding allocation decisions through prices
- Firms or hierarchical organizations resolve uncertainty by ordering information about which actions are to be followed.
- Both are, however, “lossy” mediums: much of the information not introduced in a form or at a location that entitled it to “count” toward an agent’s decision is lost.
- Human creativity linked with the usage of Big Data Analytics based on information handled as public good is difficult to specify within the contracts customarily employed for either market-cleared or hierarchically organized production.

Two approaches to abundance thinking: Chris Anderson

- For Anderson abundance means:
  - Not only discovering what will become cheaper
  - Also looking for what will become more valuable as a result of that shift
  - Moving to that, past the abundance to find the adjacent scarcity.

- Abundance is to be perceived as the hidden engine of growth:
  - David Ricardo had defined it as “comparative advantage”, i.e. yesterday’s abundance consisted of products from another country with more plentiful resources or cheaper labour.
  - Today’s abundance consists of products from the land of silicon and glass threads.

Chris Anderson

C. Anderson, *Free: The Future of a Radical Idea*, 2009.

Two approaches to abundance thinking: Jeremy Rifkin

- Rifkin sees the Internet of Things as having the potential of pushing increasing segments of economic life to near zero marginal cost:
  - Making goods and services nearly priceless, abundant, and less and less subject to market forces.
  - Spawning a hybrid economy – residually capitalist market and growingly Collaborative Commons.

- Capitalism will have an increasingly streamlined role, primarily as an aggregator of network services and solutions, and as a niche player.
  - More and more people will learn to live 'beyond markets', triggering far reaching implications:
    - Social capital and crowdsourcing becoming as important as financial capital and banking
    - Access trumping ownership,
    - Sustainability superseding consumerism, C
    - Cooperation ousting competition
    - Sharable value increasingly replacing exchange value
    - Traditional educational institutions being substituted by free Massive Open Online Courses
    - Etc.

J. Rifkin, *The Zero Marginal Cost Society: The Internet of Things, the Collaborative Commons, and the Eclipse of Capitalism*, 2014.

Jeremy Rifkin

We are in the era of Big Data Analytics

- Where information is growingly becoming a public good
- Where the primary scarce resource is human creativity
- An era in which peering becomes a more cost-effective institutional form than either markets or hierarchical organizations.

Yochai Benkler: four conceptual moves

1. Ronald Coase asked why clusters of individuals operate under the direction of hierarchies and not purely under the guidance of prices, and answered that using the price system is costly (in terms of 'transaction costs').
2. Assuming that the cost of organization increases with size, Coase consequently posited that 'any given firm will cease to grow when the increased complexity of its organization makes its internal decision costs higher than the costs that a smaller firm would incur to achieve the same marginal result'.
3. Coase could assume, this way, to have a "natural" limit on the size and number of organizations.
4. Harold Demsetz's added a specific element of explanation:
   - property in a resource emerges if the social cost of having no property in that resource exceeds the social cost of implementing a property system in it.
   - When the social cost of using existing information as an input into new information production is zero, and the decline in communications costs radically reduces the cost of peering, the centrality of human capital to information production and its variability becomes the primary source of efficiency gains from moving from markets or hierarchical organization to peering.

"Commons-based peer production creates better information about available human capital and can better allocate creative effort to resources and projects".


Ronald Coase


Harold Demsetz


Yochai Benkler

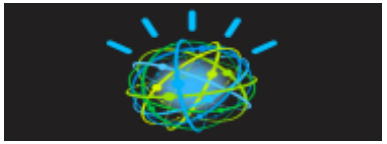
Steven Johnson: *Where Good Ideas Come From*, 2010

- We are better served by connecting ideas rather than by protecting them.
- Ideas want to complete each other as much as they want to compete.
- Perhaps “commons” is the wrong word.
- Another metaphor is preferable: the coral reef.
- The most extraordinary engine of biological innovation:
  - coral reefs make up about one-tenth of one percent of the earth’s surface
  - yet roughly a quarter of the known species of marine life make their homes there.
- What makes them so inventive is not the struggle between the organisms but the way they have learned to collaborate.

Steven Johnson

CERN's 60 years: a good example of «Technium»

- Kuhn's paradigms of research are like coral reefs, raised by myriads of tiny architects, which provide fertile environments for new developments and represent the scientific world's equivalent of a software platform.
- Interesting applications in medicine, at different scales, are the Human Brain Project, IBM's Watson, MD-Paedigree.
- Biomedical Big Data and computational modelling in medicine have the potential to provide intriguing insights into the complementary and synergistic relationship between computational and living systems.
- Biomedical research institutions and related industries, as well as the whole healthcare and pharmaceutical sectors, are the key stakeholders in the process leading to the next generation of data-centric systems.
- Whether these are systems capable of learning from data, or data-analysis products and applications become capable of translating medical knowledge discovery into widespread medical practice, they will put predictive power in the hands of clinicians and healthcare policy makers



MD-PAEDIGREE

The Long Tail approach to medicine

- Big Data applications in medicine radically change the capacity for going beyond the average patient population, searching for specific cohorts of patients fitting into very peculiar niches of their own.
- Such an approach can show the way to truly personalized medicine leading to:
  - People receiving treatments and drugs specifically targeted to their own genomic, proteomic, and metagenomic characterization.
  - Drugs with enhanced personalized information content, based on customized algorithms tackling the individual disease conditions that can be best addressed only by personalized treatment.

C. Anderson, *The Long Tail*, 2006.