Industrial Economics

Economics of Knowledge and Information

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Economics of Knowledge and Information

- Speaking of the knowledge economy we distinguish two distinct phenomena:
  1. A long-term phenomenon that involves education, training, human capital, R&D, knowhow etc.
  2. A short-term phenomenon that regards in particular the new technologies of information and communication (NTICs).

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- Combined, the two phenomena have profound effects on our economic system. This includes:
  - Increased positive externalities due to network effects
  - Acceleration of change
  - Growth of sectors with a high content of knowledge and NTICs
  - A premium on qualification and knowledge.

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- In this context, we must distinguish
  - "knowledge", a dynamic concept, and
  - "information", a static concept.
- "Knowledge can create itself new knowledge (Foray, p. 7)".
- Knowledge thus refers to a cognitive ability with a dynamic element that generates positive externalities and is associated with
  - Memory
  - Solving new tasks
  - Interaction, dialogue
  - Cognition, understanding
  - The production and reproduction (learning) of knowledge can be costly but due to positive externalities there are still increasing returns to scale also with knowledge.

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- Information instead is, in its purest definition, a statistical concept with a limited number of well-defined possible outcomes, whose characteristics are known in advance.
- Information has zero cost of reproduction.
- Its generation and codification can be costly though.
- A good definition of information is “data that have been recorded, classified, organized and related within a framework so that meaning emerges”.

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- Statistics instead would be "a type of information obtained through mathematical operations on numerical data".
- Both phenomena are characterised by strong economies of scale (stronger in the case of information). This gives them public good characteristics.
- Due to the absence of complete codification, these public good characteristics are even stronger with knowledge than with information.

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- In both cases, costs and value are very difficult to measure, also due to the phenomena of learning by doing and learning by using.
- The activity of codification turns knowledge into information or a message (software, computer code, book, CD etc.)
- NB: While the cost of transmitting information is today virtually costless (this was not always the case, think of monks copying parchments),
- assimilation, actualisation and retransformation of information into knowledge can be expensive.
- Otherwise copying a book would be equivalent to reading it.

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- Knowledge and information pose both major property rights ownership problems but not always for the same reasons :
  - Both have public good characteristics, including non-exclusivity:
  - my utility does not decrease if somebody else the information, sometimes it is quite the opposite as we have seen in network effects.
  - This then begs the question how to remunerate the inventors in a competitive market.
  - Tendency towards monopolisation which poses other issues.
  - The value and usefulness of information and knowledge is difficult to determine since they can be used several times.
  - In the case of knowledge, the value is only revealed (sometimes with a considerable time lag) after the purchase.
  - Think of a university education. However, the value of a "diploma" can also lie in its "information", as it constitutes a signal for potential employers on the labour market.

Economic Impact

- We are currently seeing the interaction of a long-trend and a short-term trend with an enormous increase in the share of intangible capital (related to information and knowledge) in the economy.
- The proportion between tangible and intangible capital was roughly $\frac{2}{3}$ to $\frac{1}{3}$ in the late 19th century.
- It has switched to $\frac{1}{4}$ and $\frac{3}{4}$ in the late 20th century accompanied by a significant growth of labour productivity.
- This is due to education, training, human capital formation, R&D, better organization of business
  - (marketing,
  - services,
  - computer control,
  - logistics...)

  and other knowledge-enhanced economic functions.

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- In parallel we witness the more short-term phenomenon of an explosion of information and knowledge-based industries
  - (computer,
  - space,
  - pharmaceuticals,
  - telecommunications,
  - finance etc.).
- They now constitute far over 50% of GDP and generate a high demand for qualified workers.
- Both tendencies are reinforced by the new technologies of information and communication (NTICs) that:
  1. Allow enormous productivity gains in the storage and processing of information;
  2. Promote the creation and growth of new industries;
  3. Allow for new and original organisational models (auto-entrepreneurs, global networking etc.).

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- In principle, these combined effects would allow for huge productivity gains.
- We are faced, however, with the Solow paradox that "you can see the computer age everywhere but in the productivity statistics."
- The paradox has been defined as the "discrepancy between measures of investment in information technology and measures of output at the national level".
- Growth declined during the 1990s when computers became ubiquitous.
- In particular, the "Solow residual", or multi-factor productivity, has been stable or even declining in advanced economies:

$$SR(t) = \frac{\partial Y/\partial t}{Y} - \left(\alpha \frac{\partial K/\partial t}{K(t)} + (1-\alpha)\frac{\partial L/\partial t}{L(t)}\right)$$

How can we explain the paradox?

- Measurement problem; as the quality of human capital increases, the residual declines but if the human capital increases due to ICTs, their effect is still there;
- Time lags; computers need time to contribute to productivity
  - (difficulties in setting up,
  - reorganization,
  - learning,
  - incompatibility,
  - connectivity,
  - losses ...).
- Organisations required change; there is a certain catch-up in the statistics from 2000 onwards.
- Bad management of ICTs as well as decreasing returns to scale.
- More fundamental problems with the quantification of technological progress and the drivers of economic growth.

The impact on distribution

- Shares in GDP between labour and capital during the 20th century were roughly 2/3 (labour) and 1/3 (capital),
- but the labour share has declined in advanced industrial economies during the past 20 years (OECD).
- Equivalently, Thomas Picketty has shown that in recent years the share of capital accumulation (r) tends to be higher than the rate of growth of the economy (g),
- which precisely means that the share of capital increases if $r > g$.
- If capital is unequally distributed, which it usually is as it tends to concentrate, this implies an increase in inequality.

The impact on distribution

- The question is whether this is a "fundamental law of capitalism" or the result of autonomous changes in the mode of production and in industrial structure.
- The knowledge economy for instance favours the emergence of information-based networks and thus the emergence of "winner takes all"-industries.
- Many study shows that the return on education has relatively increased, which also implies an increase in inequality among the working class.

The impacts on workers and organizations

- NTICS and the information society require a permanent disposition to change, permanent flexibility.
- There is no more time for learning by doing.
- Thus "agents of change" (managers, fixed costs) are required who "manage" productive workers.
- Formerly the relationship between managers and workers was 20%/80%. Today it is rather close to 80%/20%.
- And those 20% can be out-sourced to other countries.
- However, increasingly also the 80% can be out-sourced.
- Think of IT services in India.
- Change itself is becoming codified.
- Certain pharmaceutical companies outsource their research and testing.

The impacts on workers and organizations

- Change generates change, which can lead to exponential growth in change.
- This effect is called the "ratchet effect" or hysteresis.
- Consumers and competitors get used to a certain pace of change and penalize those who do not keep the rhythm.
- Change has obvious benefits such as new and cheaper products.

The impacts on workers and organizations

- However it also has costs in the form of
  - uncertainty,
  - rapid obsolescence of human,
  - social and physical capital due to the destruction of established contacts,
  - networks,
  - organizations,
  - skills,
  - ways of doing and institutions.
- Standards, contracts and conventions can slow down and manage change.

The production of knowledge (research and learning)

- The value of research is very difficult to measure due to the positive externalities that it generates.
- Research is also characterised by network effects and increasing returns (clusters of innovation), both are, of course, related to positive externalities.
- $\rightarrow$ draw figure here

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- Learning is equally characterised by increasing returns (learning by doing, experience).
- Already Adam Smith remarked that the benefits of the division of labour are due to increasing dexterity (learning), invention and faster transitions from one task to another.
- The last point is closely related to "codification".
- The positive effects of learning by doing are frequently expressed in the form of "learning curves":
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- Not everything can be codified.
- There is such thing as tacit knowledge, which might be implicit in learning by doing.
- One can dis-invent the production of certain goods.
- Consider Europe's ability to build nuclear power plants.

The importance of codification

- Codification transforms knowledge into information, a message on a physical or electromagnetic medium, so that it can be reproduced with precision an infinite number of times.
- This generates very large savings in the transitions between the initial production and reproduction.
- Re-production is, of course, not always re-actualisation, at least not with humans.

The importance of codification

- Codification is not always possible.
- Consider Messi explaining to a newcomer how to execute penalty kick).
- Some knowledge is tacit, not codified, dependent on the context or the personality, a certain "je ne sais quoi".
- However, were possible and when well managed, codification has huge economic benefits.

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- Outsourcing, complex supply chains and globalisation would not be possible without it:
  - It reduces the costs of reproduction and increases reliability;
  - the alternatives are master-student relationships through time;
  - the question is real: to which extent can Massive Open Online Courses substitute for physical presence in teaching?
  - The costs of storage, transportation and transfer, classical transaction costs, are greatly reduced.
  - The codified process can be far easier marketed and commercialized.

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- Of course, one must not forget that codification itself has costs.
- This fixed costs contributed to the increasing returns to scale prevailing in the information economy.
- Codification can thus be likened to the creation of a new language or of a community of experts.
- Codification to the extent that it constitutes a reduction of transaction costs is also essential for the creation of a market.

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- Consider the existence of negative environmental externalities, which is likened by Arrow to the non-existence of a market for the good in question.
- Environmental externalities are the paradigmatic example of a non-codified good.
- Without codification of knowledge there would be no "labour market".
- The alternative would be a community of users with tacit, personal knowledge, a romantic notion still vivid in the 19th century, the guild economy, but unsuited to modern life.

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- It is a challenge for universities to maintain the balance between the transfer of codified and non- codified knowledge.
- How do books, hand-outs videos, websites and electronic course compare to the regular attendance of a class?
- Codification and NTICS:
  - NTICS enable simple coding at low cost.
  - They provide languages for more complex coding.
  - However, most importantly, they greatly increase the benefits of successful codification.

Externalities

- An externality is an effect on the utility of another agent that is not taken into account by the agent that causes it.
- It always refers to the difference between the private and the public value of a good or an action.
- Goods that generate large amounts of positive externalities are frequently provided as public goods.
- Caution with the classical definition of a public good being a good with non-rivalry in consumption.
- That is a sufficient but not a necessary condition.
- The complexity of adequately allocating individual benefits is a more solid perspective.

Externalities

- Both knowledge and information are characterised by such externalities and public good characteristics.
- Potentially these are greater with information than with knowledge, as the former is inexhaustible and possesses a zero cost of reproduction is zero.
- Internet strongly reinforces this effect (think of Wikipedia).
- In earlier times, the costs of the re-production of information and knowledge, e.g., through books were costly.

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- The fact that information benefits more from NTICs than knowledge leads to a natural displacement of knowledge by information.
- This has negative impacts by itself, knowledge and its transmission needs to be protected.
- In fact, in earlier times knowledge and information were much less distinct than today.

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- All information was embedded in knowledge.
- The distinction we draw today is also due to the fact that we call information, the part of knowledge that benefits from NTICs.
- In the case of information, copy and original are identical.
- This is not the case with knowledge, see the Messi example, also the costs of reproduction are higher.

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- Knowledge and information also are also cumulative due to learning by doing.
- This increases the public good characteristics.
- At the same time intellectual property rights obviously seeks
  - to limit the "non-exclusive character" of information goods and
  - to reduce the public good characteristics and the externalities of knowledge and information.
- Intellectual property right must arbitrate between encouraging the production of new information and the ability to use existing information.

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- This arbitration takes the form that the governments concentrates on areas that generate the greatest externalities
  - (public research,
  - elementary education and
  - historical).
- Private provision will take place in more commercially relevant applied research with solid protection of intellectual property rights.
- These trade-offs are important.
- Private-public partnership maximising profit and social benefits of innovation can be a good solution in appropriate circumstances, i.e., the possibility to identify the benefits.