Modes of innovation innovation systems and economic development

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Summary

- Firms that combine a science-based (STI-mode) with experience-based (DUI-mode) learning are more innovative than firms that are biased toward one mode.
- This points to a need for a broad definition of national innovation systems and to a broad definition of knowledge management at the level of the firm.
- To stimulate development there is a need to promote both modes of innovation.
Historical context: The learning economy

- More rapid transformation
  - shorter product life cycles
  - shorter life time for competences (halving time = 1 year for computer engineers?)
- New kind of competition
  - Learning based rather than knowledge based
  - Success of people, firms and regions reflect capability to learn
- Inherent polarisation in the Learning Economy
  - Exciting but stressful for the rapid learners - exclusion of slow learners
  - End of European regional convergence
Tacit versus explicit knowledge

- Tacit knowledge
  - Tacit by nature
  - Tacit for economic reasons - too costly to codify

- Explicit and codified knowledge
  - How much of the knowledge package can be codified?
  - How wide is the access to the codified knowledge (specialised codes, communities of practise, epistemological communities).
What matters for economic performance is competence rather than information!

- OECD has shown that in most countries a major part of the aggregate economic growth can be explained by what is going on inside firms in terms of innovation and growth.
- The diffusion of new technology and especially of new organisational characteristics is very uneven among firms in the same sector and across sectors.
- To enhance the competence and 'the absorptive capacity' of firms is a major challenge not addressed by standard economics.
An important source of competence building is the learning organisation

- Learning organisations and networking organisations (in Denmark)
  - Create more and more stable jobs
  - Are more productive
  - Are more active in terms of product innovation

- Shop stewards and middle management are strategic agents of change
Learning organisations

- We define learning organisations as those that:
  - Are flatter and allow more horizontal communication inside and outside the organisational borders
  - Establish cross-departmental and cross-functional teams and promote job-circulation between functions.
  - Delegate responsibility to workers and invest in their skills
  - Establish closer co-operation with suppliers, customers and knowledge institutions.

(In DK such firms also tend to engage in both indirect and direct forms of employee participation.)
The STI-mode and the DUI-mode of learning

- STI=Science-Technology-Innovation mode is characterised by science-approach – formalisation, explicitation and codification
- DUI=Learning by Doing, Using and Interacting mode refers to experience-based, implicit, embedded and embodied knowledge.
STI versus DUI - a tension found at all levels of knowledge politics

- Scientist as analytical machine (STI) vs. scientist as human with ‘personal knowledge’ (DUI).
- Knowledge management as computer oriented management information system (STI) vs. KM as frameworks for learning (DUI).
- Innovation systems as extended science-technology systems (STI) vs. SI as competence-building systems (DUI).
- Innovation policy as Science policy (STI) vs. as Competence building policy (DUI).
The double change in context

- ICT and access to elements from the science base becomes increasingly important for countries at all levels of development – calls for a strengthening of STI-mode of learning
- But these changes and globalisation contribute to speed up of change and to the formation of the learning economy – calls for a strengthening of DUI-mode of learning
Data and method

- Empirical analysis based on survey addressed to 6991 Danish firms in the private sector – about 2000 useable answers.
- Clustering of firms into four categories: DUI and STI – DUI – STI – Neither DUI nor STI
- Using the cluster variable together with size, sector and form of ownership in logistic regression to explain product innovation.
- Work in progress – we are now gathering new data on STI.
DUI-learning mode

*Indicators*: The organic and integrative organization

Q8: Does the firm make use of some of the following practises:

- Q8a: **Interdisciplinary workgroups**
- Q8b: **Quality circles/groups**
- Q8c: **Systems for collecting employee proposals**
- Q8f: **Autonomous groups**
- Q8g: **Integration of functions**
- Q19: *Have demarcations between employee groupings become less clear 1998-2000?*
STI-mode of innovation - indicators

Q42: To which extent has the firm developed a closer co-operation with the following actors during 1998-2000?

- Q42c: Consultancy firms
- Q42d: Knowledge centres such as universities and technological institutes

- Q43: Advanced use of information and communication technology?
- The firm employs at least one employee with master level in engineering/natural science.
Probability to introduce product innovation (after correction for sector and size)

<table>
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<th>%-share learning</th>
<th>DUI</th>
<th>STI</th>
<th>DUI/STI</th>
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<tbody>
<tr>
<td>Low share</td>
<td>0.2610</td>
<td>0.1970</td>
<td>0.2623</td>
</tr>
<tr>
<td>Odds ratios</td>
<td>1.000</td>
<td>1.798</td>
<td>5.217</td>
</tr>
<tr>
<td>P-value</td>
<td>0.0016</td>
<td>0.0019</td>
<td>&lt;.0001</td>
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Science policy as innovation policy - a self-inflicted overburdening of science?

- Ambivalence among scientists regarding the science-innovation link
- The first reports on the importance of investment in science came from natural scientists (Bernal in the UK and Vannevar Bush in the US) and they emphasized the economic effects of investment in science.
- The economists (Arrow and Nelson) entered the scene more than a decade later with the public good-argument in favor of public investment.
- Biotech-revolution has further shortened the distance from science to market in the mind of policy-makers.
- Today the focus is on STI-policy in High Tech sectors.
But both learning modes are relevant for Low tech as well as High tech-sectors

- Today the focus is on STI-policy in High Tech sectors. So far, innovation policy has given most attention to the 4th cell. Great potential also in 2nd and 3rd.

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<th>Low tech</th>
<th>High tech</th>
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<tbody>
<tr>
<td>DUI-mode</td>
<td>1.</td>
<td>2.</td>
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<tr>
<td>STI-mode</td>
<td>3.</td>
<td>4.</td>
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Implications for knowledge management

- Knowledge management needs to combine human resource management and learning organisation with R&D-management and information systems management.
  - Organise R&D and link it to internal users within the organisation as well as to external networks.
  - Codify and make explicit what is implicit - promote information sharing by means of ICT (STI)
  - Create learning organisations and let the implicit communities of practice flourish (DUI)
Policy options to stimulate DUI-learning

- The formation of firms as learning organisations with human resource planning.
- Life-long learning promoted by government (active labour market policy with training and retraining)
- New New Deal - to redistribute learning capabilities
- Emphasis on learning to learn in the education system
- New forms of collaboration between trade unions, firms and training institutions (new workers’ contracts emphasising competence building).
- Responsibility of last resort for the public sector – otherwise only the already skilled get more training.
Policy options to stimulate STI-learning

- **Supply side**
  - Enhance the volume and relevance of public research
  - Establish academic training with interaction with practise and industry
  - Stimulate knowledge institutions to interact with industry

- **Linking supply and demand**
  - Create infrastructure of knowledge mediators between universities and firms
  - Design intellectual property regime with balance between incentives to inventor’s and the interest of users.

- **Demand side**
  - Give incentives to firms to invest in R&D
  - Give incentives to firms hire academic personnel
Implications for innovation and knowledge policy

Innovation policy needs to:

- Establish the general knowledge base through investment in basic research and formal education.
- Establish links between public research and industry.
- Combine the promotion of R&D efforts in industry with the promotion of learning organisations.