

# **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 of 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)

|             | Low learning | DUI    | STI    | DUI/STI |
|-------------|--------------|--------|--------|---------|
| %-share     | 0.2610       | 0.1970 | 0.2797 | 0.2623  |
| Odds ratios | 1.000        | 1.798  | 1.710  | 5.217   |
| P-value     |              | 0.0016 | 0.0019 | <.0001  |



# 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.

|          | Low tech | High tech |
|----------|----------|-----------|
| DUI-mode | 1.       | 2.        |
| STI-mode | 3.       | 4.        |



# 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 practise 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.