The role of Universities in National Innovation Systems

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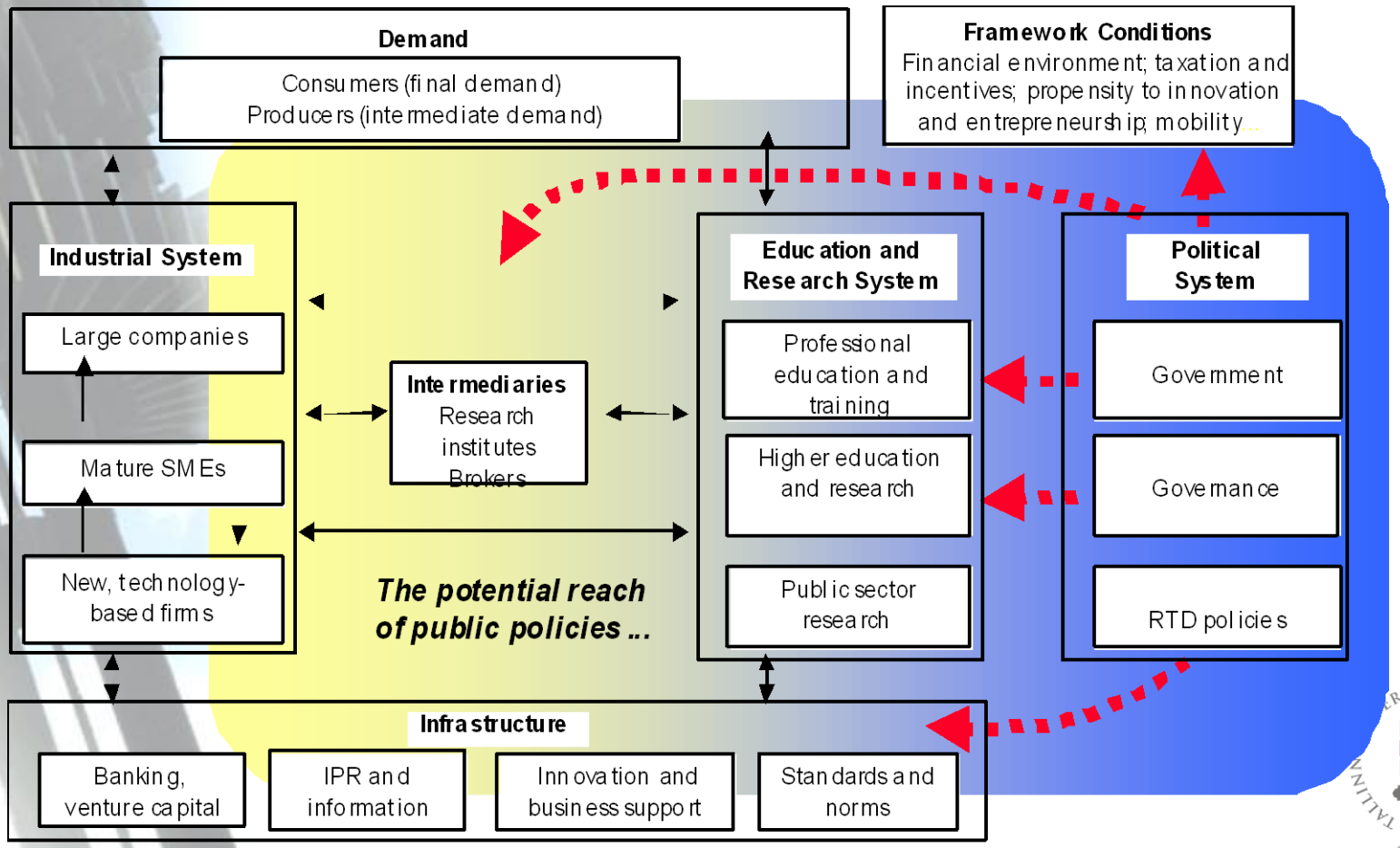
Outlines

- National innovation systems
- Universities and industrial innovation in knowledge-based ecxonomies
- Characteristiccs of the university-industry technology transfer process
- Conclusions

We've made life difficult for ourselves by adopting a complex systems view of research and innovation in society



Why do universities matter?

- They perform a substantial share of R&D, especially basic research, in most OECD economies.
- Innovation now draws more heavily on fundamental knowledge, an important output of universities.
- Important sources of trained S&Es and potentially, new firms.
  - Combination of research & training provides an important channel for flows of knowledge, practice, knowhow between university and industry.
- Important institutions in the absorption of technology from external sources.
  - Stronger international IPR will increase importance of domestic innovation, “inventing around” patents.
- Governments in OECD & developing economies see universities as important engines of economic development.
- But, consistent with the “NSI view,” universities cannot be analyzed in isolation from other components of a national innovation system.
  - Overall higher education system (including other institutions for “tertiary” education, such as community colleges, technical schools, etc.).
    - “Bridging” institutions may be especially important for SMEs.
  - Systems of finance for industrial innovation.
  - Labor markets.
  - Broader “demand for innovation” from domestic firms, which in turn may reflect macroeconomic policy, influences on capital investment.

The role of academic research in industrial innovation

- Surveys of US industrial R&D managers: patents & licenses are not the most important channels for access to university research for innovation (Cohen et al. 2002, Levin et al., 1987).
- All agree that “biomedical research is different”: links are more direct and industrial innovation depends on academic research.
  - A “linear model” in this sector?
- In other sectors, relationship is more indirect and the supply of trained graduates, publications, faculty consulting, conferences are all more important than patents & licenses in knowledge flow (Cohen et al., 2002).
- Patents and licensing contracts rarely convey the necessary know-how for commercialization.

Universities in economic "catchup": common themes and contrasts

- Rapid enrollment growth, particularly undergraduate enrollment, is common in early years of catchup.
- Other than Germany, universities often are weak in research during the early catchup period.
  - A major economic contribution is through training, especially in engineering, rather than research.
- Primary focus of training is industry, not gov't.
- Universities' research role often complemented by other types of "tertiary education" institutions, public labs in early period.
  - But over time, greater pressure on universities to expand quality, importance of their research role, generally at the expense of public labs.
- Access by qualified students to university systems in "catchup" economies generally is open to large segments of population.
  - Relatively low fees and/or availability of financial aid, loans.
- Universities are linked into global S&T system, especially through international flows of faculty & researchers.
  - Hiring foreign scholars, bringing back expatriate S&Es.
- Great contrasts in structure of higher education systems, extent of centralized control, linkages between universities and industry, among these 6 economies.

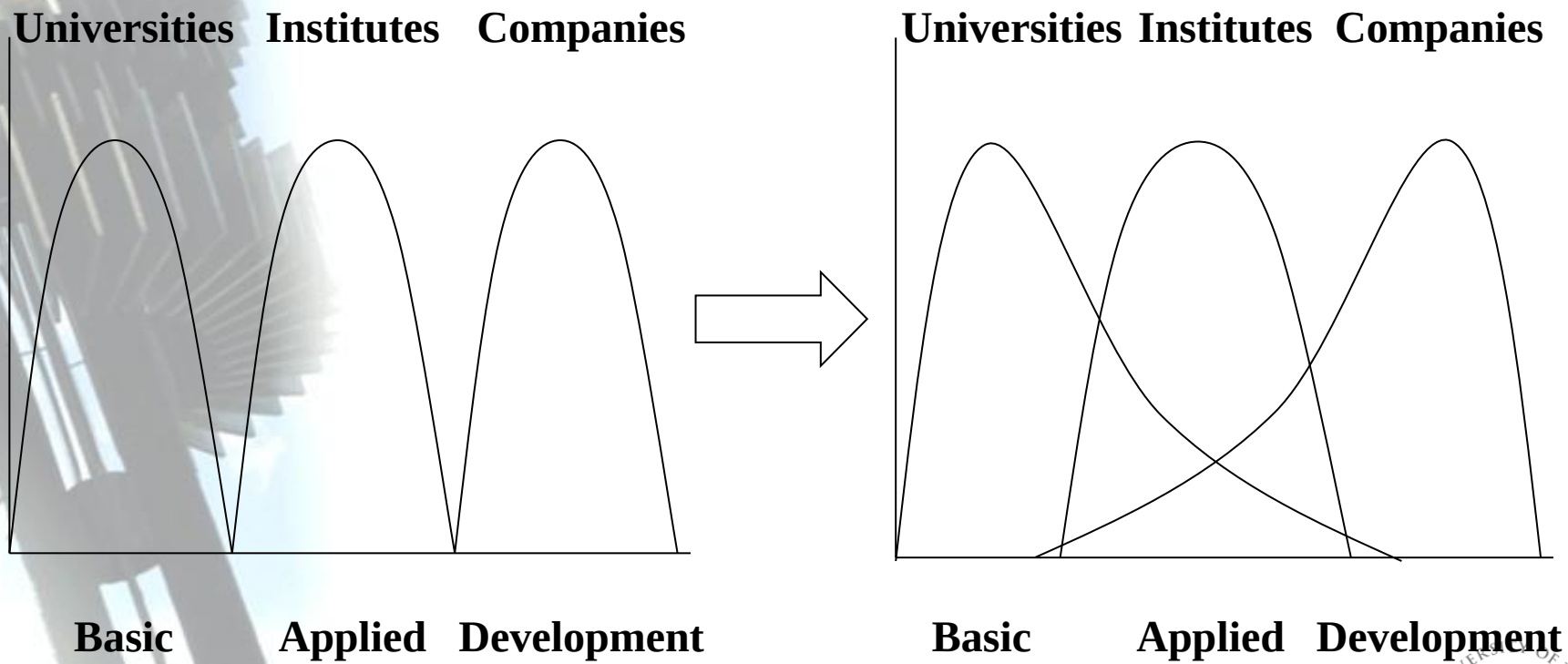
Universities in NSIs

- Universities are among the oldest institutional organizations in most European economies.
  - A key characteristic of 11th & 12th universities was self-governance.
  - "Self-governance" makes universities very conservative, often resistant to structural change.
- The "modern" research university first emerged in 19th-century Germany.
  - "German model" characterized by strong disciplinary, departmental structure, emphasis on graduate education, and classroom & laboratory instruction rather than tutorial coursework.
  - "German model" influenced Japanese, U.S., Nordic university systems.
    - But US system differs significantly from Japanese, German, most Nordic systems in scale, decentralization, institutional autonomy.
- National higher education systems are one of the most "nationally idiosyncratic" elements of NSIs throughout the industrial economies.

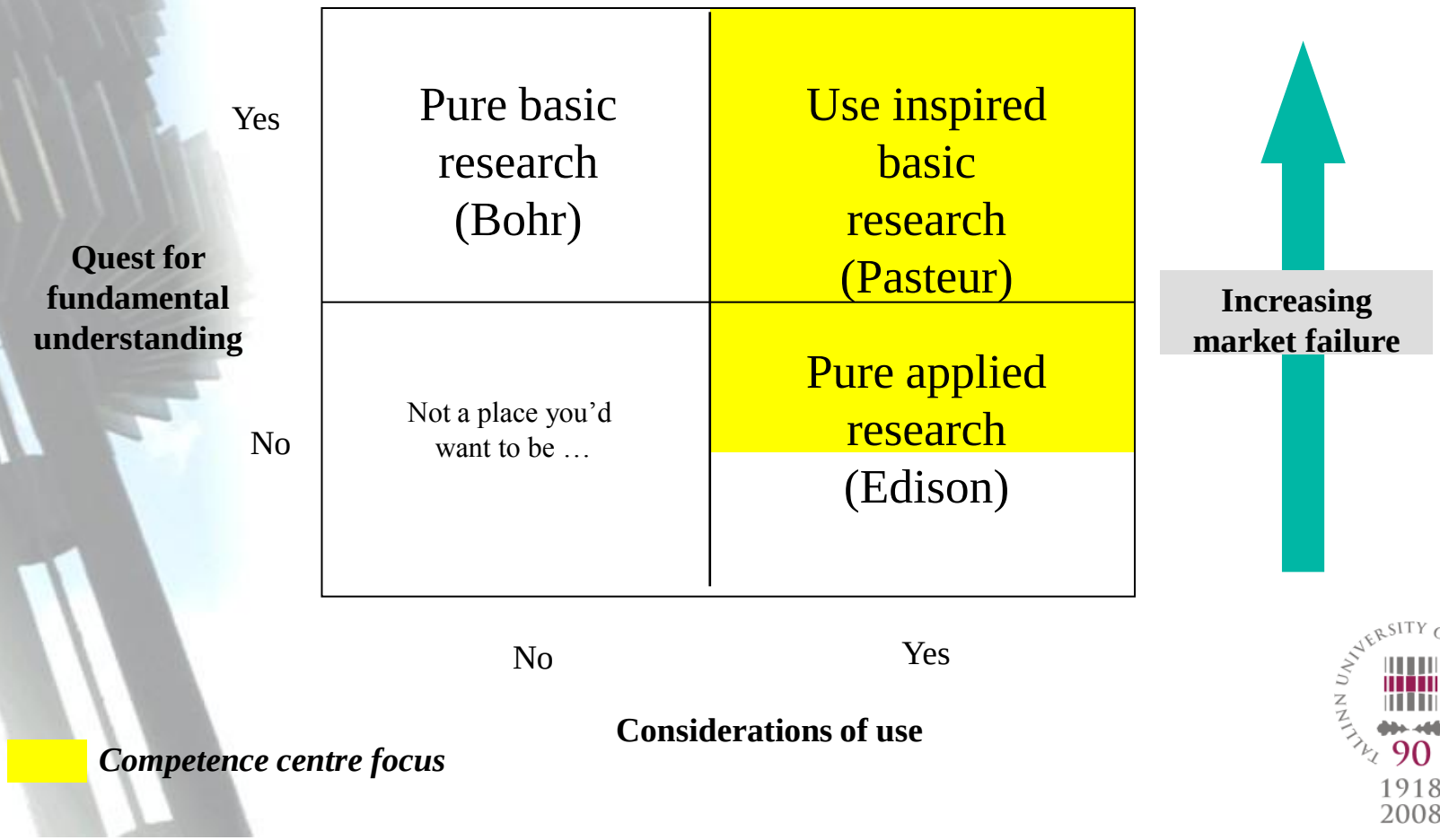
Universities, knowledge production, and innovation

- Conceptual frameworks for understanding the role of universities in industrial innovation:
  - "linear model" (V. Bush, 1945; embodied in Bayh-Dole).
  - "Mode 2" (Gibbons, 1994; emphasizes economic motivation, interdisciplinarity and inter-institutional collaboration).
  - The "republic of science" and contrasting norms of disclosure and dissemination of research in industry and academia (Dasgupta and David, 1994).
  - "Pasteur's Quadrant" (Stokes, 1995): Much academic research involves problem-focused basic research, linked to specific societal or industrial challenges (Pasteur and the phylloxera epidemic).
- Each conceptual framework => a different view of the nature of the economic benefits of academic research and the channels through which these benefits are realized:
  - Linear model: Economic benefits flow mainly from basic research.
  - "Mode 2": In the New Economy, universities must collaborate with other actors in networks and teams, focusing on applied and basic research.
  - "Republic of science": University research differs from industrial research because of the strong academic incentives for disclosure of results from basic or applied research.
  - "Pasteur's Quadrant": University research is a complex mix of basic & applied work.

The universities and the institutes need new roles as the old ‘three hump model’ breaks down (if, indeed, it ever worked)



They work in both Edison's and Pasteur's Quadrants



Characteristics of the university-industry technology transfer process

- Most university faculty inventions require substantial development investment and time to approach even prototype status.
- Inventor involvement is essential to transfer, exploitation of licensed inventions.
- Technology transfer relies on a two-way flow of knowledge, knowhow, funding, and people.
- Much of the most important “knowledge output” from academic research for industrial innovation involves the research techniques, exposure to frontier science & engineering that graduates obtain.
  - Graduates are an important linkage to industry, other parts of an NSI.
  - Flow of postgraduates (postdoctoral fellows, faculty) between universities and other institutions another important linkage that is lacking in many public research laboratories.
  - Both types of personnel flow aid technology transfer.

Now: Thinking outside of the box

- Widening the web of innovators – universities and partners
- Co-invention model
- Major move: joint research collaboration and laboratory facility between Nokia and the Massachusetts Institute of Technology (MIT)
- Brings together 40 researchers from MIT and 20 researchers from Nokia
- A fresh approach to the research collaborat each project depends on both MIT and Nokia people
- Openness: Do most of the work in an open environment – essential for a university
- Develop and exploit technologies beyond the commercial horizon

Strategic Importance of Research Cooperation

- With Research Institutions
  - Generate genuine new knowledge
  - Create long term views for Nokia
  - IPR's
  - Get good people
  - **Functions quite well**
- With Partnership Companies
  - Complementary competencies to improve products etc
  - Strengthen partnership
  - Create shared picture of future
  - **Not much happening**
- With Competitors, Research Consortiums
  - Create new standards
  - Create wider public acceptance of direction
  - **Pretty good progress made**

What does industry expect from universities?

- **Top-level knowledge of own scientific field**
- Broad, cross-disciplinary understanding, understanding broader perspectives
- Being international, global - competition is increasingly global also for universities
- Excellent and relevant education to nurture new talent and to succeed in international competition
- Atmosphere of enthusiasm and renewal, hard work
- Innovativeness, capability to create innovations from research results
- Streamlined contract research policies and practices
- Clear and motivating IPR policies

What can industry give to universities?

- Employ researchers and students
- Teach courses at universities
- Be member of Council, Board, Trustee
- Finance and participate in research projects

- Increase the industrial relevance of education
- Increase the motivation to researchers by showing the relevance of research
- Help in getting innovations out of research
- Help in establishing new enterprises

- PS. At European level interesting new cooperation forms are being established: Technology Platforms and Joint Undertakings (eg. ARTEMIS)

Conclusions

- Universities have played an important historic role in innovation and growth within the NSIs of developed, newly-industrialized economies.
  - But the structure of university systems and their historic roles differ considerably.
- The importance of universities' role seems likely to increase.
- An important basis for university contributions to economic & technological growth since the 19th century is their links to the international S&T system.
- Their combined performance of advanced research and training in many NSIs is another important source of university contributions to economic growth.
- Channels for knowledge flow, technology transfer between universities and domestic firms are numerous and involve much more than codified knowledge.
  - Relative importance of different mechanisms, channels for knowledge interaction between universities and industry also differs among technologies.

Conclusions (2)

- Institutions outside the university system play a key role in the effectiveness of university systems in research, training within NSIs.
  - Other tertiary education institutions, as well as “bridging” institutions (extension services; Frauenhofer Institutes, etc.).
  - Public research laboratories.
  - Domestic labor-market flexibility, mobility; industrial finance systems.
- Essential design decisions:
  - Balance between domestic universities, public laboratories in performance of publicly funded R&D.
  - Postgraduate vs. undergraduate training.
  - Differentiation within national “tertiary education” systems.
  - Strengthening links with the international science system, including other developing-economy universities.
- There is no single formula for success; principles for successful policy design include
  - Competition among domestic research performers.
  - Greater labor mobility between university and industry, as well as between universities and the international R&D system.
  - A variety of types of tertiary educational and “bridging” institutions.
  - Improved access (for both entry and completion) for all groups within a nation to tertiary education.

- Thank you!

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