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From linear models to the Triple/Quadruple/Quintuple/N-tuple Helix

JRC workshop

Strengthening University-Industry-Government cooperation

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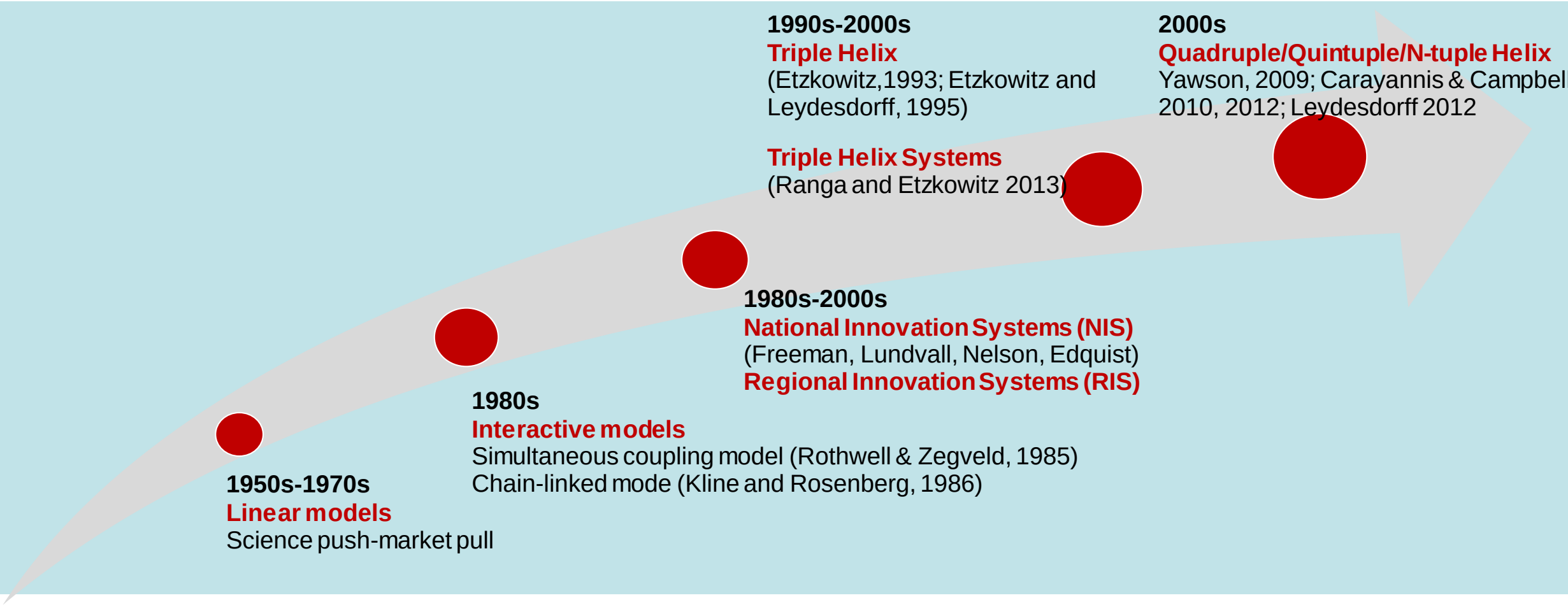
17 November 2020

European Commission

Innovation models



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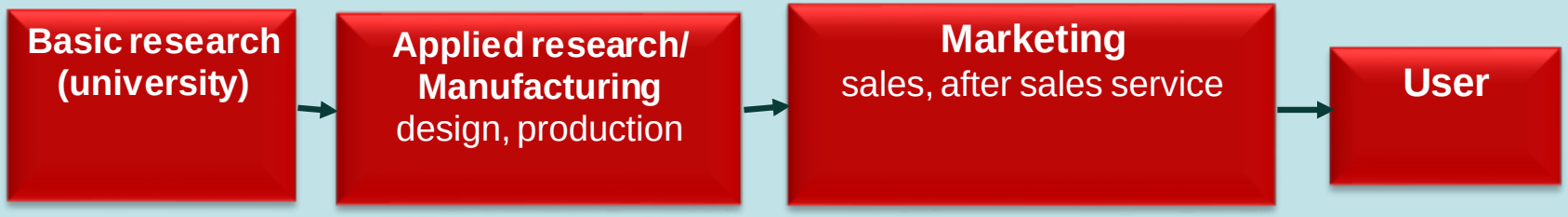
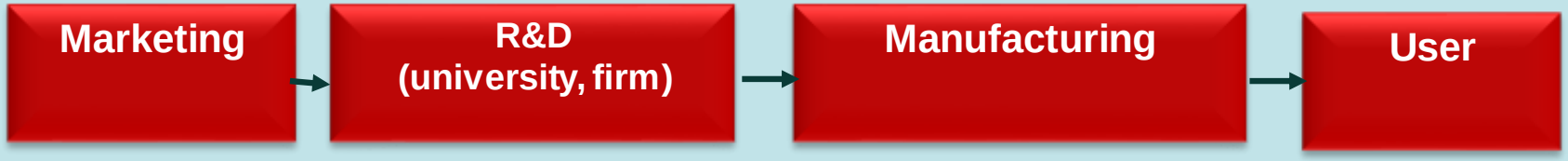
1950s-1970s: Linear models

Science (Technology) Push



- Science "feeds" technological change
- Scientific discoveries → prototypes for testing → manufacturing and marketing →user
- Relevant to some science-intensive industries, e.g. pharma, but hard to apply to other industries
- **Universities as 'prime mover' in technological development**

Market pull

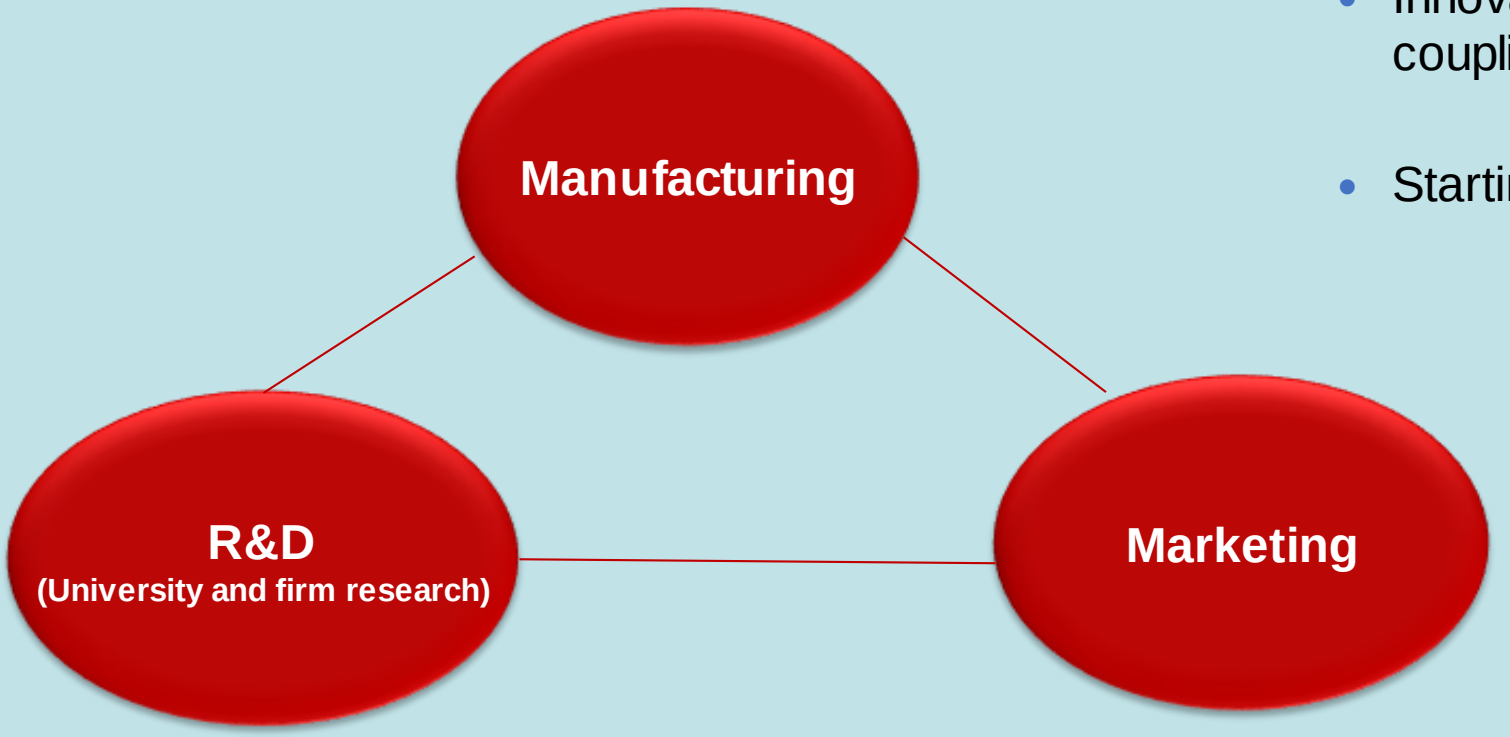


- Marketing initiates new ideas from users → R&D for design/engineering → manufacturing for production → user

- Emerged in the US after WWII, later spread to the world
- Science fairly autonomous, largely publicly-funded,
- **Science exogenous to the evolution of technologies within the firm, exogenous to market or institutions**

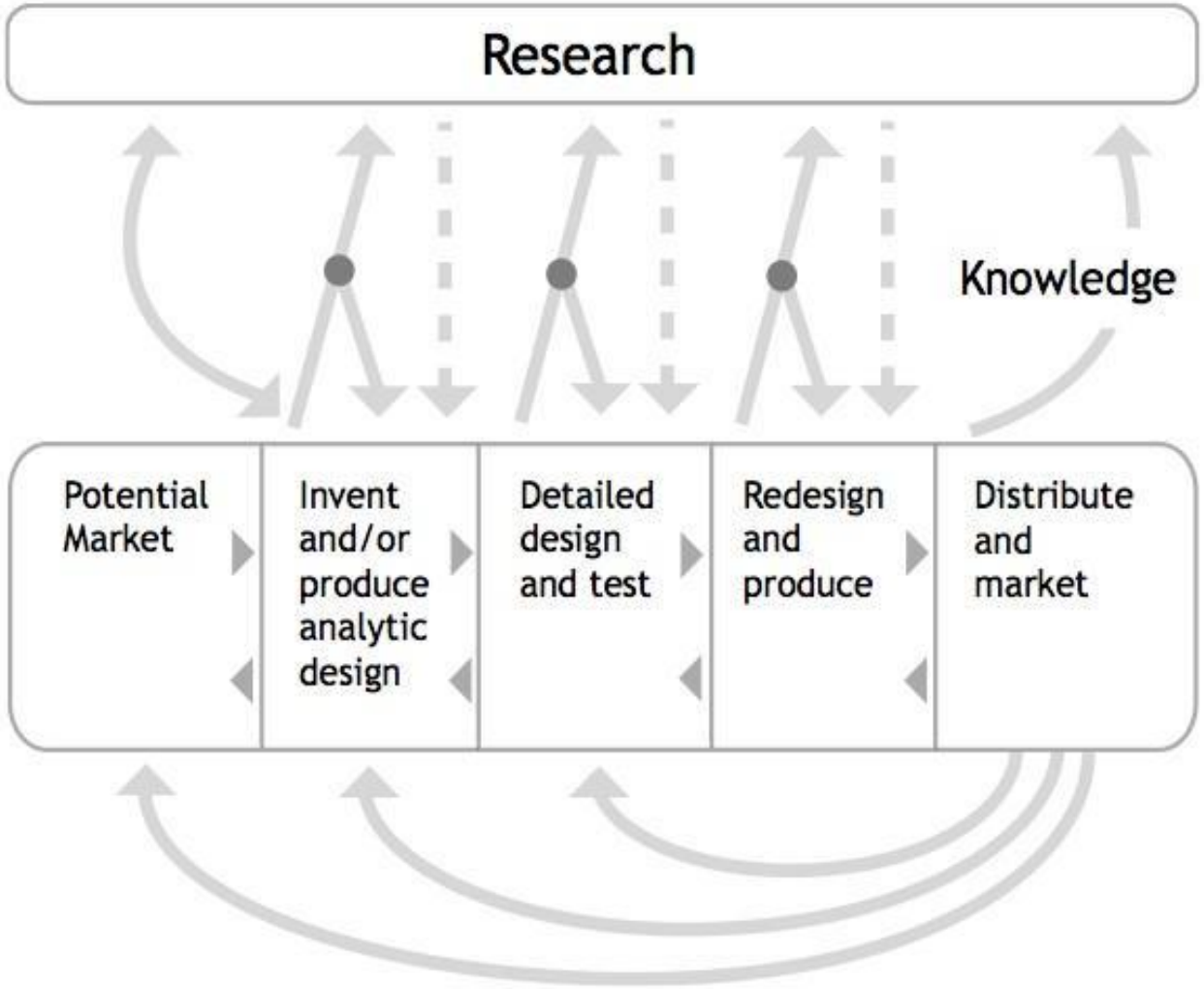
1980s-1990s: Simultaneous coupling model

(Rothwell & Ziegweld, 1985)



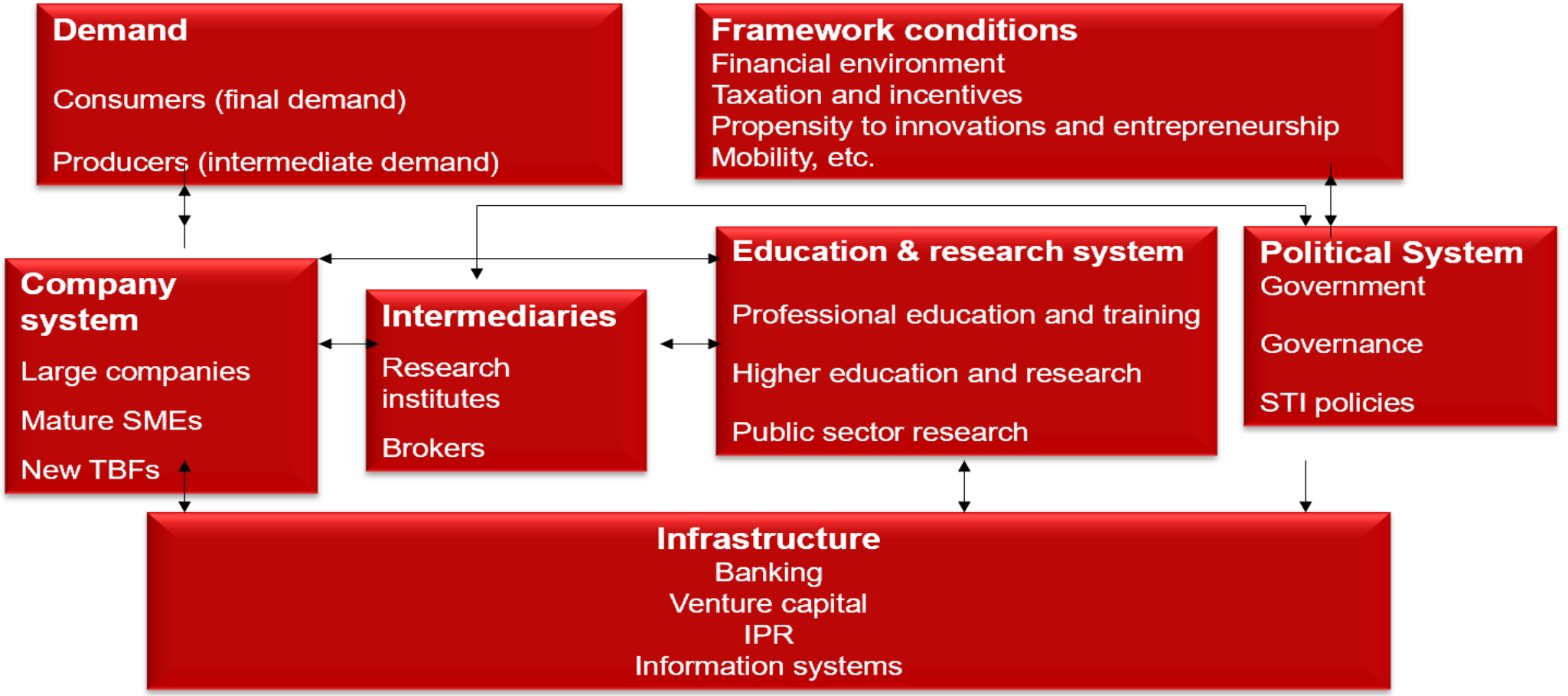
- Innovation occurs as a result of simultaneous coupling of R&D, marketing and manufacturing
- Starting point of innovation not known in advance

1980s-1990s: The chain-linked model (Kline & Rosenberg, 1986)



- Designed to capture complexity in commercial industrial settings, but applicable also in other settings, e.g. military technology development.
- Innovation process starts from an unfilled market need → research and design → redesign and production → marketing
- Continuous feedback loops of knowledge throughout the innovation process between all stages
- New knowledge not always necessary → **universities lose their monopoly as "the first mover" of technological innovation**

1980s-2000s: National Innovation Systems



Generic model of a National Innovation System (OECD, 2003)

National Innovation Systems: key principles

- **Innovation is the main factor for competitiveness (evolutionary), not cuts in production costs and prices (neoclassical)**
  - Co-evolution of science, markets and institutions
  - Endogenous role of science (evolutionary), vs. exogenous role of science (neo-classical)
  - Interactive learning throughout economy, institutions determines the rate and direction of innovative change
  - Long-term relationships between the innovative organisation and its environment
  - Close interactions within the organisation (departments, management and workers)
- **Innovation behaviour influenced by country-specific institutions, cultural & historical factors**

• Concept rapidly adopted by national governments around the world as an analytical framework and practical tool to manage innovation processes in local economies

- Economic growth is not an economic spontaneous process simply driven by the 'invisible hand' of market
- Can be managed by strategic policy visions, management skills and governance competences.

NIS strengths and weaknesses

Strengths:

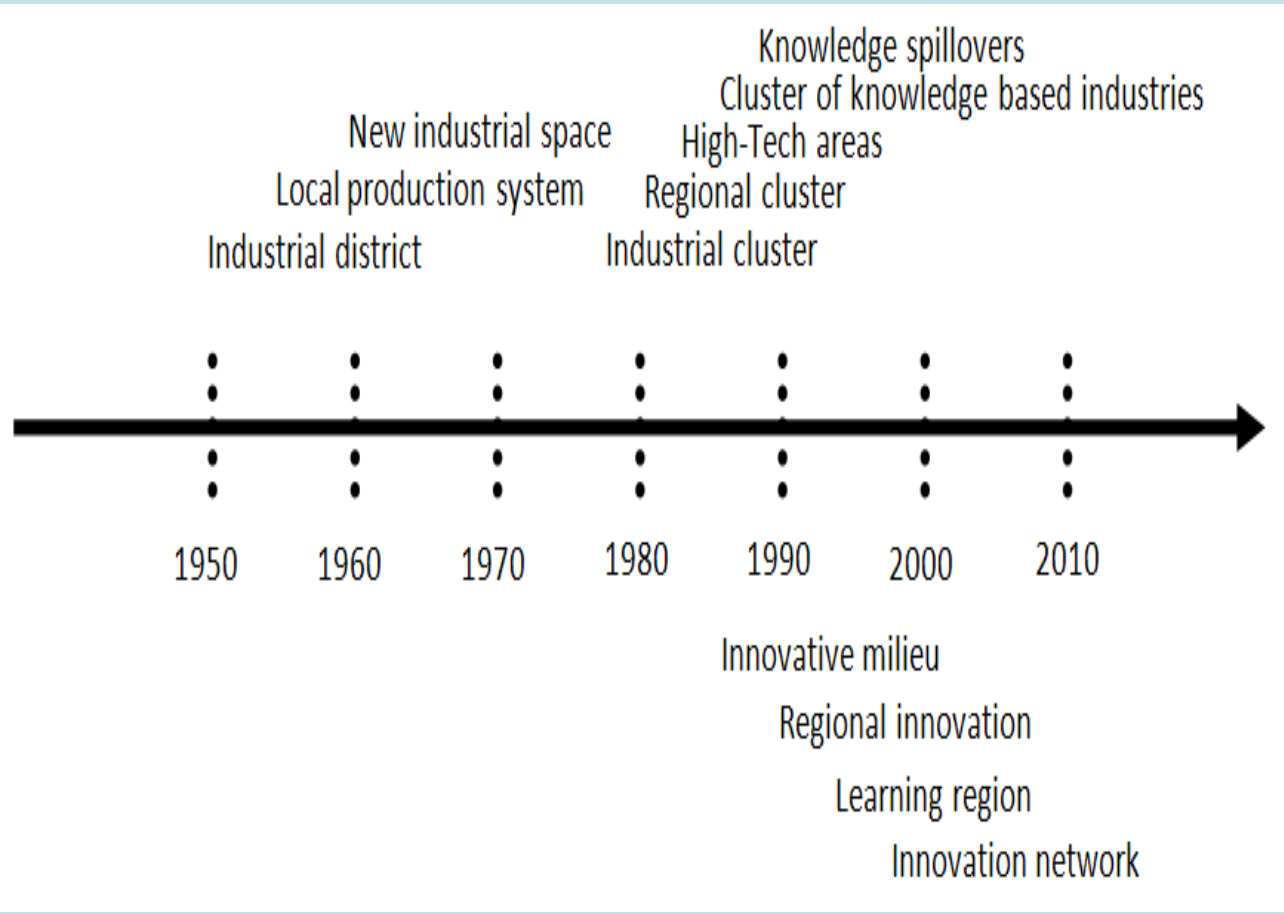
- Holistic and interdisciplinary
- Based on historical and evolutionary perspectives
- Interdependent and non-linear
- Considers all types of innovation (e.g. product, process, etc.)
- Focused on institutions
- Useful for political and policy-making objectives by identifying 'system failure' (mismatches between regional and national institutions that create poor conditions for innovation

Weaknesses:

- Diffuseness: vague links between actors, available indicators poorly capture links
- Too static to explain the dynamic nature of innovation
- Heavy firm-centric vision, no focus on the individual innovator
- Little relevance at sectoral, regional, technology levels
- Limited applicability in dealing with globalisation and internationalisation

Regional Innovation Systems (RIS)

- Framework for understanding innovation in regional economies (clusters) since the 1950s
- Improving performance in local SMEs, interactive learning between innovation actors
- Easier to manage economic policy at regional level rather than national level
- Several units of analysis:
  - **City**, **Metropolitan regions, Local districts**
  - **Nomenclature of territorial units** by Eurostat (NUTS II)
  - **Supra-regional/sub-national scale**



Naghizadeh, Ranga et al. (2013)

RIS advantages vs. NIS

• **More fine-grained perspective from RIS than from NIS**, given regional disparities within countries (Regional Innovation Scoreboard vs. European Innovation Scoreboard).

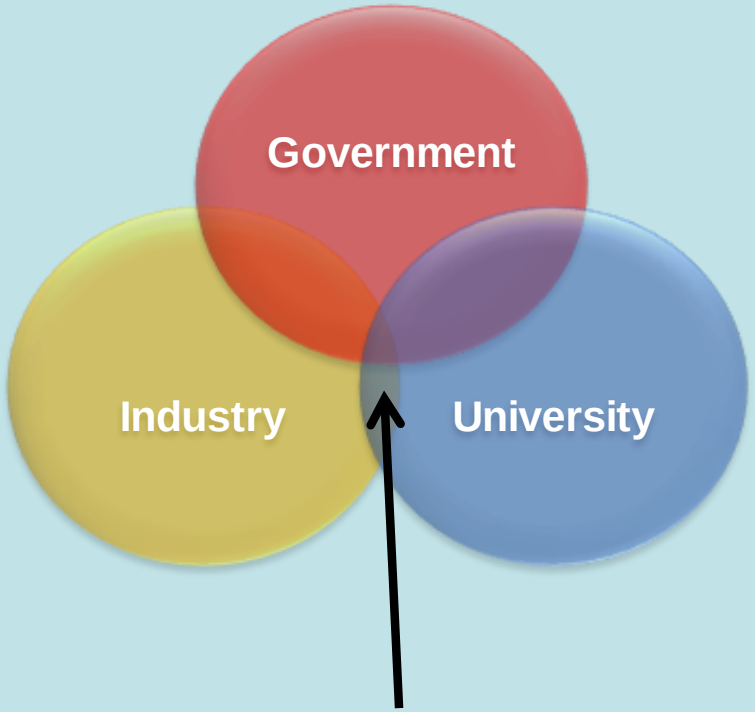
• **RIS better explains differences in sectoral innovation patterns** by the ability of innovators to exploit technological trajectories, technology transfer, in-house R&D, spillovers, networking, demand factors, etc.

• **Regional proximity facilitates relationships and interactive learning between local actors**, faster responses to changes in market demand

• **Regional business diversification provides safety from sector economic shocks, resilience (see regional S3 priorities)**.

• **Regional differentiation is a precondition of competitive advantage (see regional S3 priorities)**: diversity of people, land types, services to support a variety of businesses, easy access to specialized infrastructure, educational institutions, staff.

1990s-2000s: The Triple Helix model



Innovation at the intersection of U-I-G

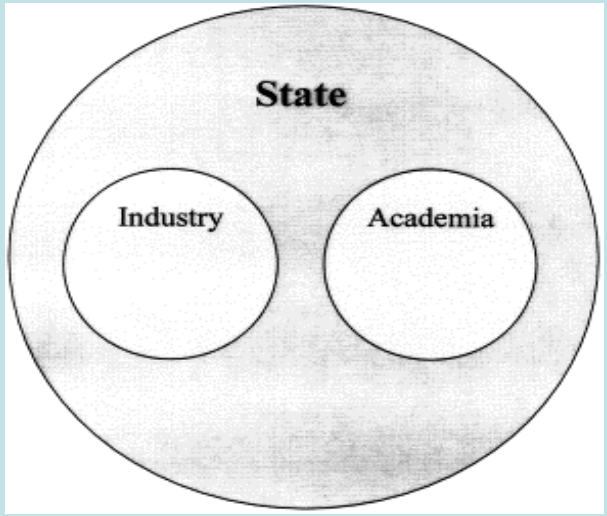
- Shift from a dominating I-G dyad in the Industrial Society to a U-I-G triad in the Knowledge Society.
- **Enhanced role of U in the Knowledge Society**, as equal partner to I and G, or even taking a lead role
- **University 'third mission', Entrepreneurial university**
- **Innovation results from non-linear U-I-G interactions → *"endless transition"***
- **U, I, G institutional spheres "take the role of the other"** for promoting innovation when the other is weak or absent
- **TH model widely accepted by policy-makers → legitimization of G role** Neo-classical and evolutionary economics do not provide a rationale for G intervention in the economy, only for discrete policy interventions in case of system or market failure → *key role of TH in innovation policy.*

The Triple Helix model: two main approaches

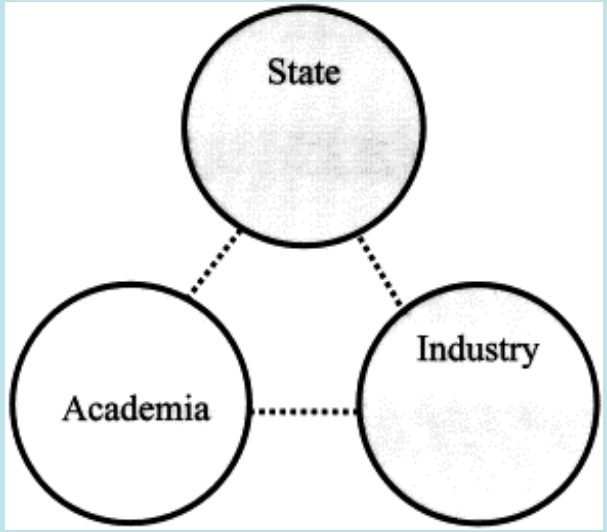
(i) (Neo) institutional perspective (based on Henry Ezkowitz's work):

- Prominence of U in innovation through national and regional case studies, comparative historical analyses
- University 'third mission': forms, stakeholders, drivers, barriers, benefits, impact, university technology transfer and entrepreneurship, contribution to regional development, government policies aimed to strengthen U-I links, etc.

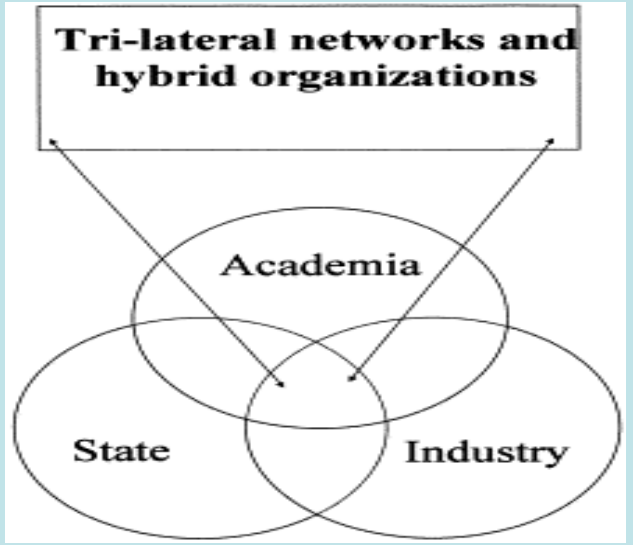
- **Three main configurations:**



(1) A 'statist' model



(2) A 'laissez-faire' model



(3) A 'balanced' Triple Helix model

Etzkowitz and Leydesdorff (2000)

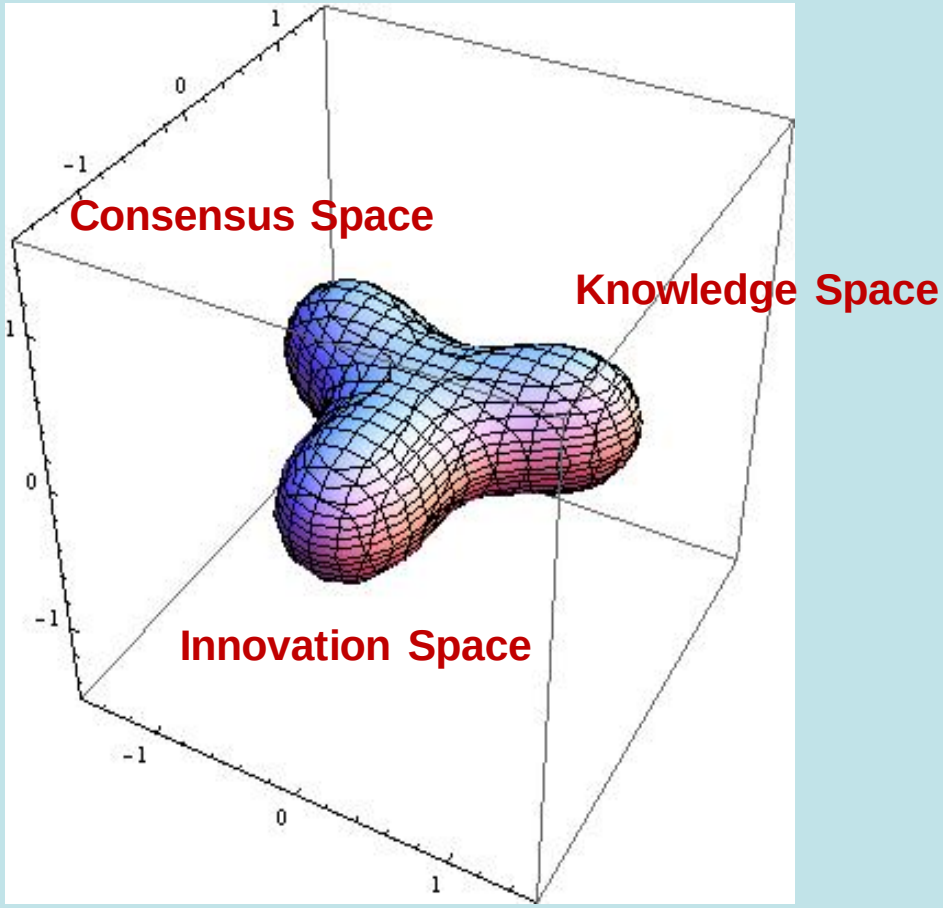
The Triple Helix model: two main approaches

(ii) (Neo) evolutionary perspective (based on Loet Leydesdorff's work):

- Inspired by the theory of *social systems of communication and mathematical theory of communication*
- U, I, G as co-evolving sub-sets of social systems that interact through *recursive networks* which reshape institutional arrangements through *reflexive sub-dynamics* (e.g. markets and technological innovations)
- *Functional* communication and differentiation between science and markets
- *Institutional* communication and differentiation between private and public control in U, I, G →various degrees of selective mutual adjustment.
- *Internal differentiation* within each sphere generates new types of links and structures between the spheres, e.g. ILOs in universities, strategic alliances among companies → new network integration mechanisms
- Institutional spheres act as *selection environments*, communications between them act as *selection mechanisms*, which may generate new innovation environments and 'regenerate' the system
- TH Interactions measured in terms of probabilistic entropy and specific indicators (bibliometrics, patents)

2013: Triple Helix Systems model - From 'spheres' to 'spaces'

(Ranga and Etzkowitz, 2013)



- **TH Systems is an analytical construct that puts TH model into an 'innovation system' format:**
  - (i) **components**
  - (ii) **relationships**
  - (iii) **functions**

- Fills the gap between the TH model and innovation systems theory (TH model lacked an explicit systemic vision)

- TH Spaces do not replace the 'spheres', they incorporate the spheres plus other relations → a new paradigm for regional development

- Fine-grained view of innovation actors and relationships between them

- Innovation emerges from dynamic knowledge flows through TH Spaces

time

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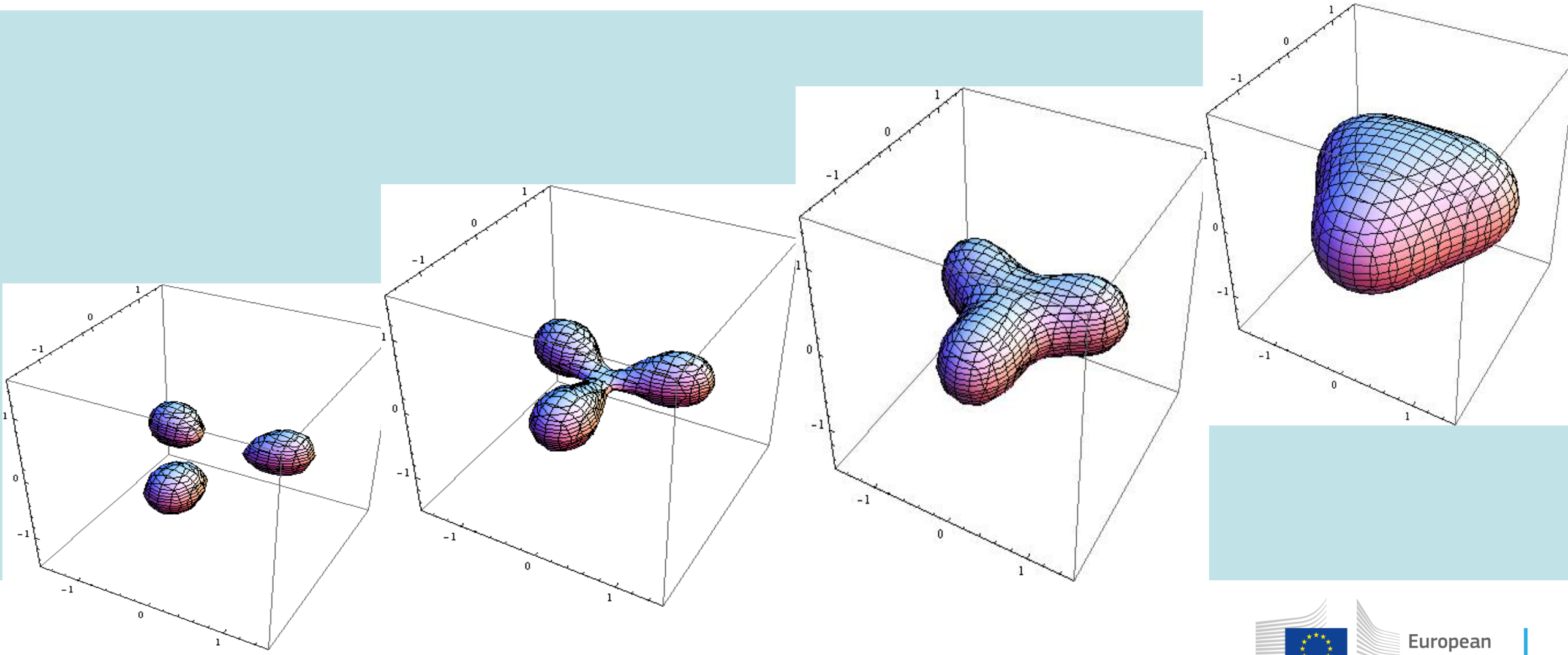
Formation of Triple Helix Spaces



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Triple Helix Spaces

1. COMPONENTS:

U-I-G institutional spheres and specific actors

- **R&D and non-R&D ("hidden") innovators**
- **"Single-sphere" and "multi-sphere" (hybrid) institutions**
- **Individual innovators: '**Innovation Organizer', Entrepreneurial Scientist, individual entrepreneur
- **Institutional innovators**: 'Collective entrepreneur'

2. RELATIONSHIPS

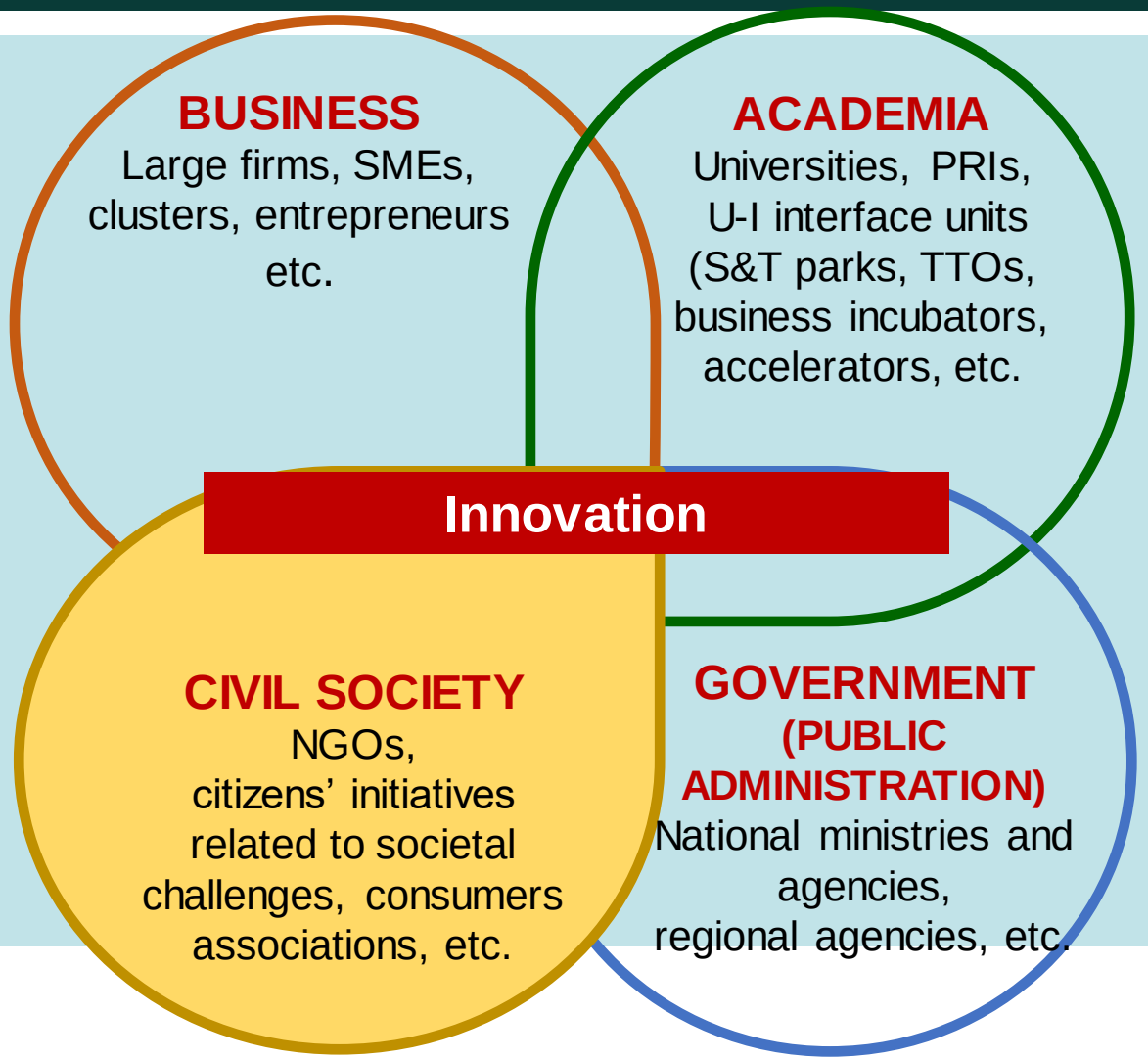
- **Technology transfer**
- **Collaboration and conflict moderation**
- **Collaborative leadership**
- **Substitution**
- **Networking** into national, regional and international structures

3. FUNCTIONS:

Knowledge, Innovation and Consensus

- **Knowledge Space**: knowledge flows from R&D and non-R&D activities
- **Innovation Space***:* hybrid organizations that promote innovation.
- **Consensus Space***:* formal and informal governance in UIG spheres
- **Time as the 4th dimension (four-dimensional spaces)**

The Quadruple Helix



- **Fourth Helix**: **civil society (citizens, users) and the "media- and culture-based public".**
- ***"Knowledge democracy"-*** Government policies emphasis on greater public involvement in innovation to better respond to societal challenges, science closer to society
- **EU policies**: science **for** and **with** society, social inclusion, openness, taking advantage of creativity
- **EU Cohesion policy (S3)**: civil society involvement to:
  - Boost the innovation potential of European regions
  - Include demand-side perspective of users in the strategy development process →EDP
  - Strengthen innovation process by including non-R&D innovation

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QH and Smart Specialisation

Carayannis and Rakhmatullin (2014)

- Greater emphasis on **cooperation in innovation**, in particular on "**the dynamically intertwined processes of co-opetition**, **co-evolution** and **co-specialisation** within and across regional and sectoral innovation ecosystems…..that could serve as the foundation for diverse S3 (and introduce a move towards systemic and user-centric innovation structures)".

- QH provides **top-down and bottom-up approach in S3 operationalization**, to include S&T and social innovation.

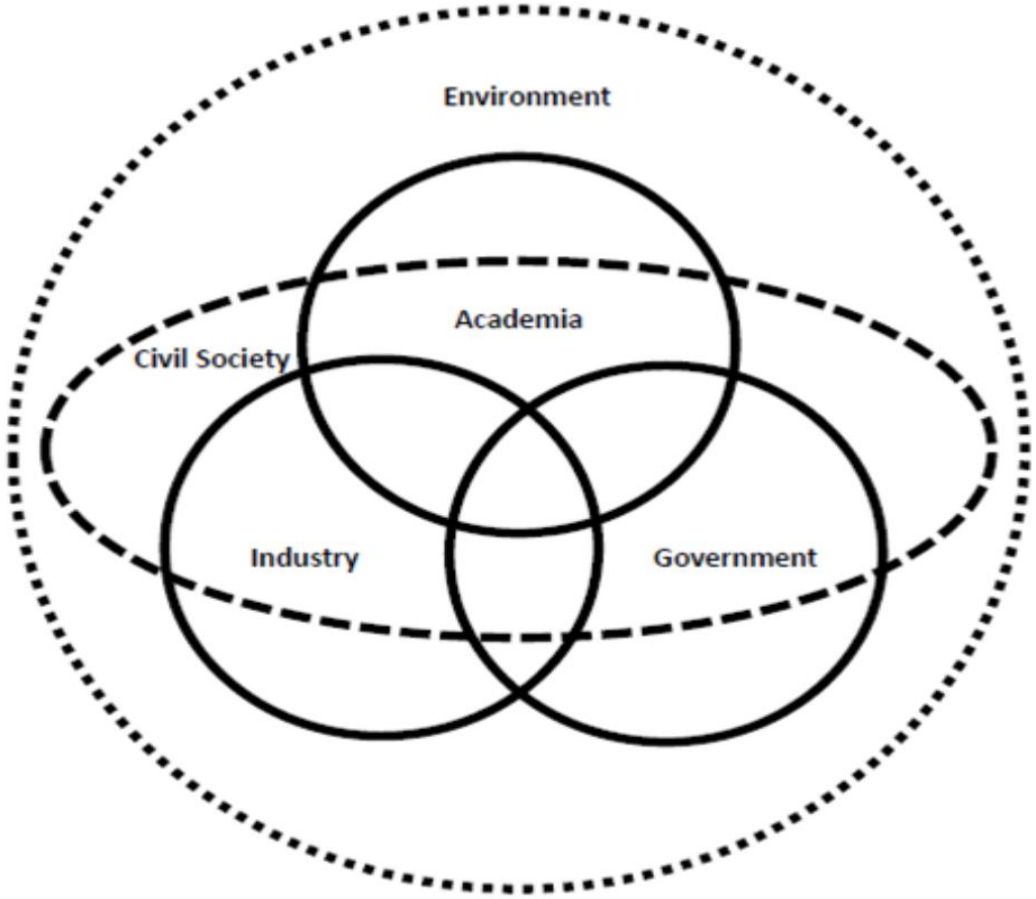
- QH requires a simultaneous inclusion of an "**inter-sectoral and intra-sectoral**, as well as **inter-regional and intra-regional knowledge and learning interfaces**"

- QH requires a functioning **multilevel governance structure**

Elias Carayannis & Ruslan Rakhmatullin, 2014. "**The Quadruple/Quintuple Innovation Helixes and Smart Specialisation Strategies for Sustainable and Inclusive Growth in Europe and Beyond**," Journal of the Knowledge Economy, vol. 5(2), pp. 212-239.

The Quintuple Helix

- **Fifth Helix: the environment (global warming)**
- **Socio-ecological transition of society and economy** in the 21st century (EC 2009)
- **"***The Quintuple Helix supports here the formation of a* ***win-win situation between ecology, knowledge and innovation, creating synergies between economy, society, and democracy"*** (Carayannis et al. 2012)
- Highly relevant to the green transition (EC policies 2021-2027)



Carayannis, E.et al. (2012). "The Quintuple Helix innovation model: global warming as a challenge and driver for innovation". *Journal of Innovation and Entrepreneurship*. **1** (1): 2.

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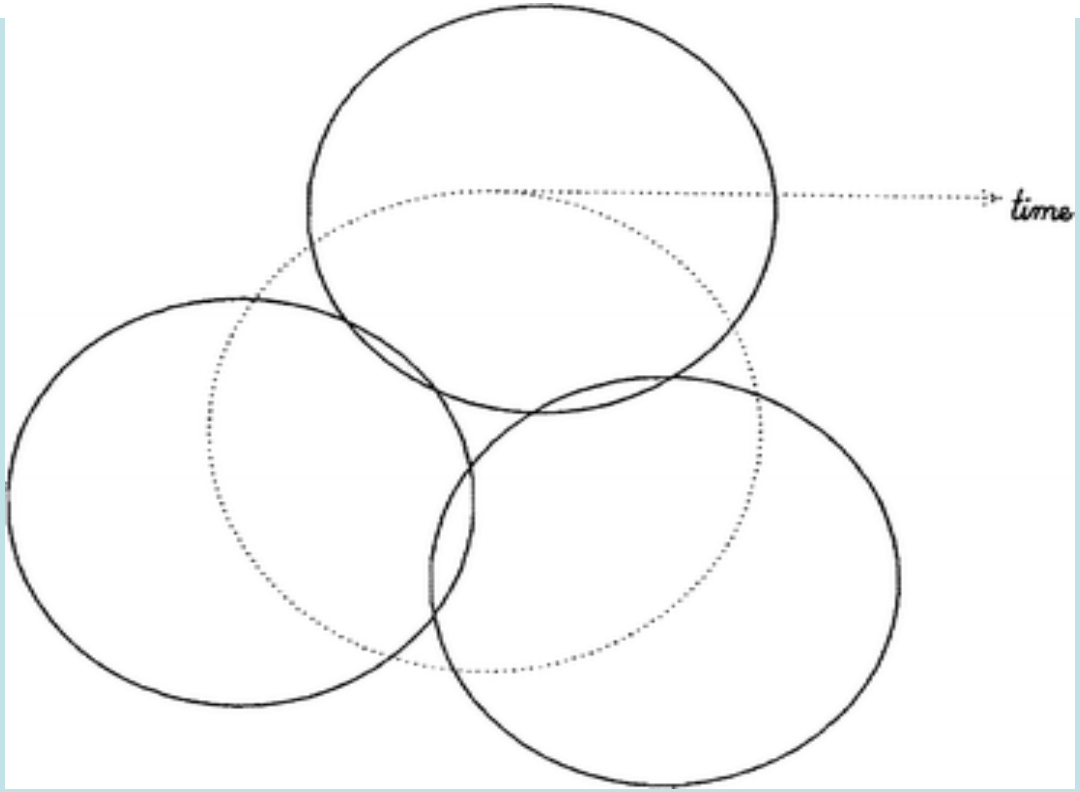
The N-tuple Helix

Leydesdorff, 2012

- The helices represent **specialization and codification in function systems** which evolve from and within civil society.
- When more than two helices are involved, various kinds of chaotic behaviour become possible through interaction:
  - stabilization along a trajectory (e.g. “lock in”)
  - destabilization
  - meta-stabilization
  - globalization
- **The helices operate as selection mechanisms asymmetrically on one another**, may shape a trajectory as in a co-evolution.
- Integration among the functions of wealth creation, knowledge production and normative control takes place at the interfaces in organizations
- Exchanges on the market, communication in knowledge production, and political discourse differentiate globally.



Loet Leydesdorff (2012), The Triple Helix, Quadruple Helix, …, and an *N*-tuple of Helices: Explanatory Models for Analyzing the Knowledge-based Economy? *Journal of the Knowledge Economy* 3, 25–35.

Thank you!

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