



# Gaps in Knowledge in the Science of Science and Innovation Policy: Suggested Fundamental Questions

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# *An Intellectual Call to Arms*

“Are we funding all the R&D we need to defend ourselves, improve and sustain our quality of life, and compete with other nations in a globalized high-technology economy?...”

EDITORIAL

Wanted: Better Benchmarks

How much should a nation spend on science? What kind of science? How much from private versus public sectors? Does demand for funding by potential science performers imply a shortage of funding or a surfeit of performers?...

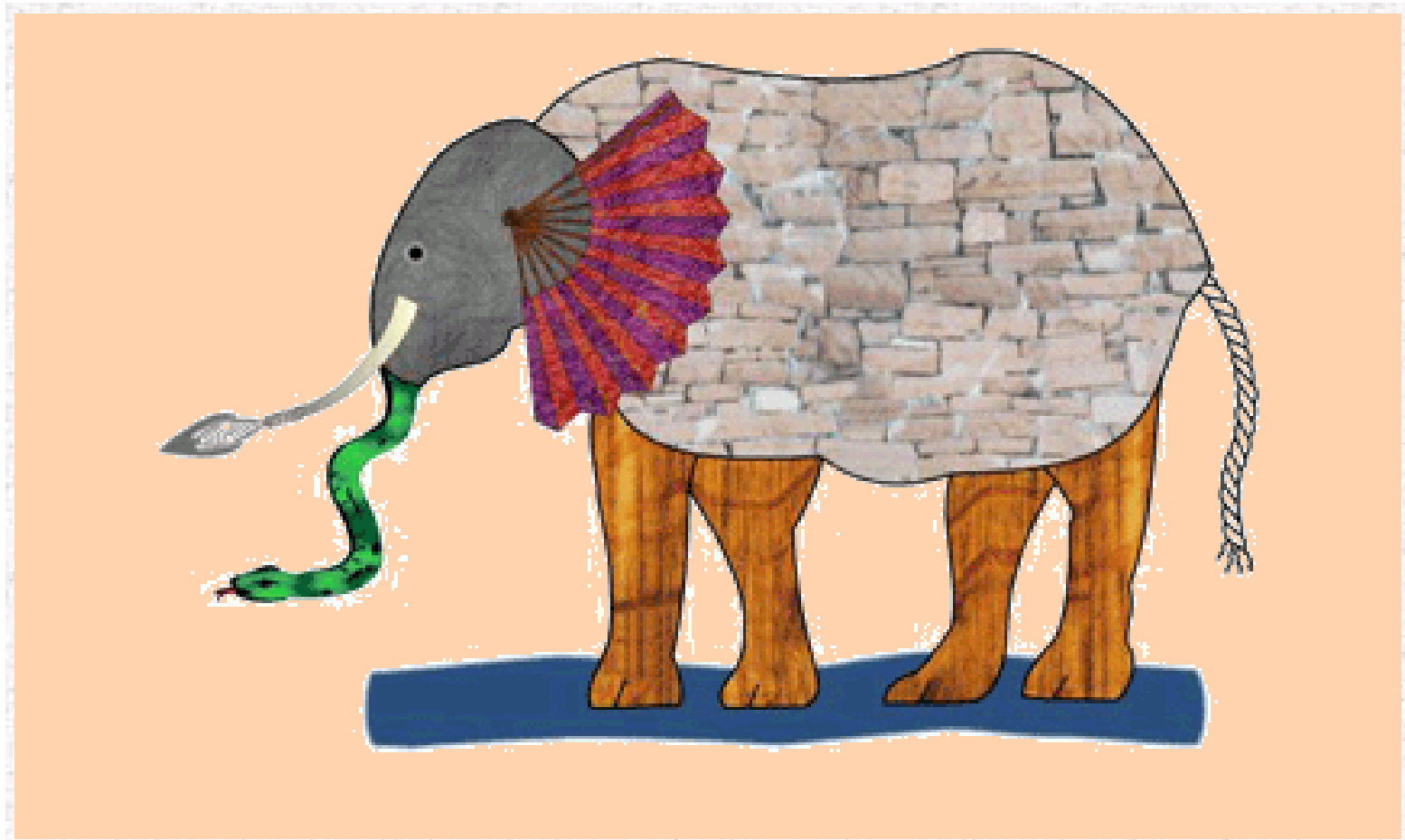
...We need econometric models that encompass enough variables in a sufficient number of countries to produce reasonable simulations of the effect of specific policy choices.”

John Marburger, Director  
Office of Science and Technology Policy  
Executive Office of the President  
April – May 2005



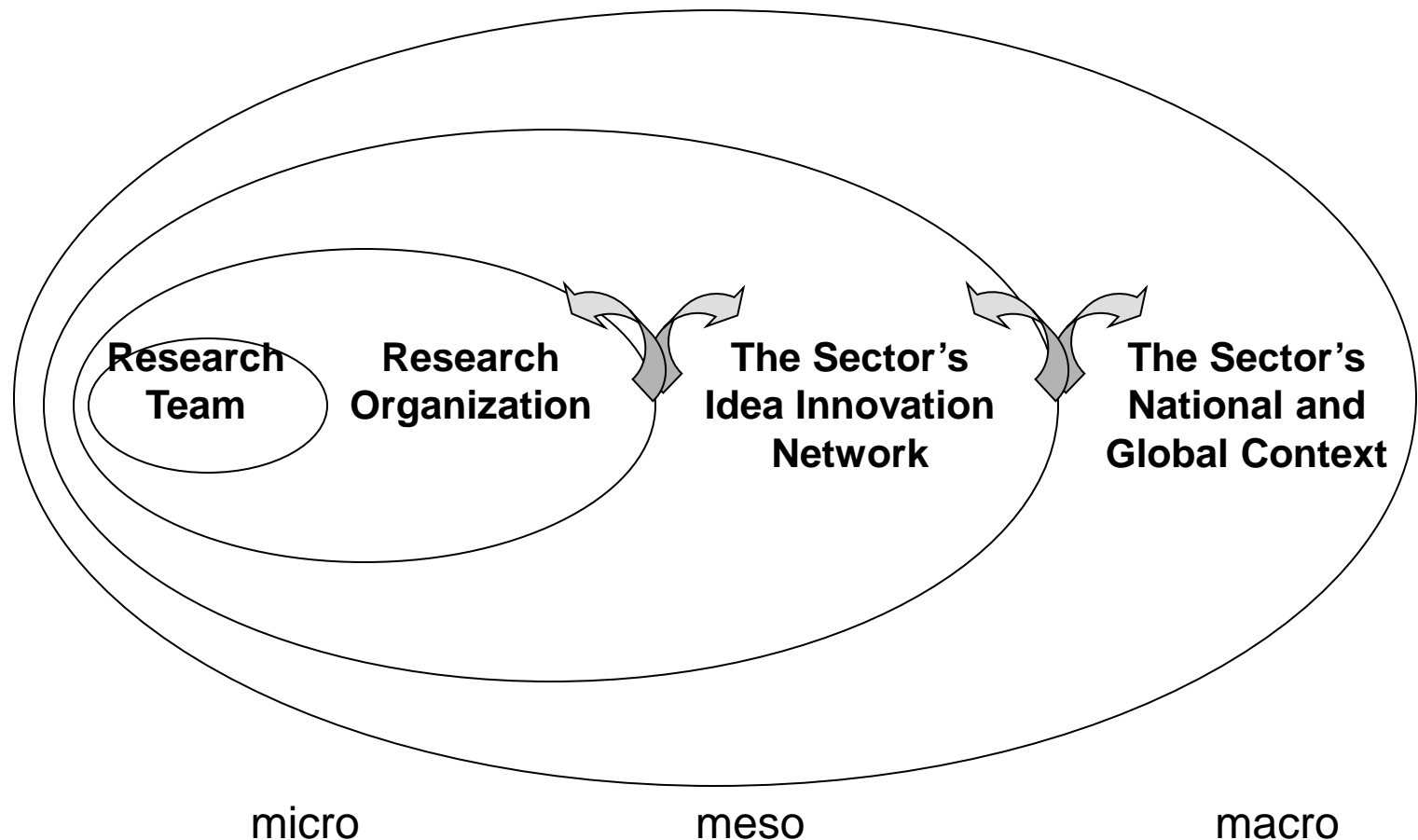
Source: Bhavya Lal, STPI, at AEA 2006

# Summary – What We Know



Parts are studied and understood better than the whole!

# A Science of Science and Innovation Policy must build a theory that connects levels



# Theories that guide our framework

## Research Team

- Management of innovation literature, learning theory

## Research Organization

- Organizational innovation theories
- Research Profiles theory

## Science/technological Sector

- Idea Innovation Network on RTD process
- Network theories
- Sector economic models

## National and global context

- Modes of coordination theories
- Institutional and institutional change theory

# Our aim –an evaluation framework that answers national policy makers' questions

A fruitful way to do this is to improve and connect existing theories to identify blockages and bottlenecks to innovation (new rationales for policy) at levels of

- Organizations
- Networks of organizations
- Macro institutional rules

To answer fundamental questions such as

- How much RTD funding goes to which technological and service sectors, RTD arenas and performers?
- Are we developing commercially/mission successful products and services, and how fast?
- How do we best contribute and coordinate at the national level?

# Micro level questions

## Allocation of RTD funds within a sector

### Possible blockages and bottlenecks

- Amount of funds (public vs. private) allocated to each arena
- Amount of funds allocated by how radical the RTD and how large the scope of focus within arena portfolios
- Presence of specific structure and management profiles in performing organizations

### Theory suggests (given mission and technical/market opportunities)

- Fill funding gaps
- Fund larger amounts where strategy is radical advance, or large scope is needed
- Match funding for organizational profile to strategy

### Evaluation implications

- Gather sector level comparative data and start to establish norms

# Blockages to Innovation at Research Team Level

## Attributes for Radicalness

### **Encourage Exploration, Risk Taking**

- Time to Think & Explore
- Pursuit of New Ideas
- Autonomy in Decision-Making

### **Integrate Ideas, Internally & Externally**

- Internal Cross-Fertilization of Ideas
- External Collaborations & Interactions
- Integrate Ideas & R&D Portfolio

### **Encourage Change & Critical Thinking**

- Sense of Challenge & Enthusiasm
- Commitment to Critical Thinking
- Identify New Projects and Opportunities

## Process Attributes for Large Scope

### **Clearly Define Goals & Strategies**

- Research Vision & Strategies
- Sufficient, Stable Funding
- Investing in Future Capabilities

### **Plan and Execute Well**

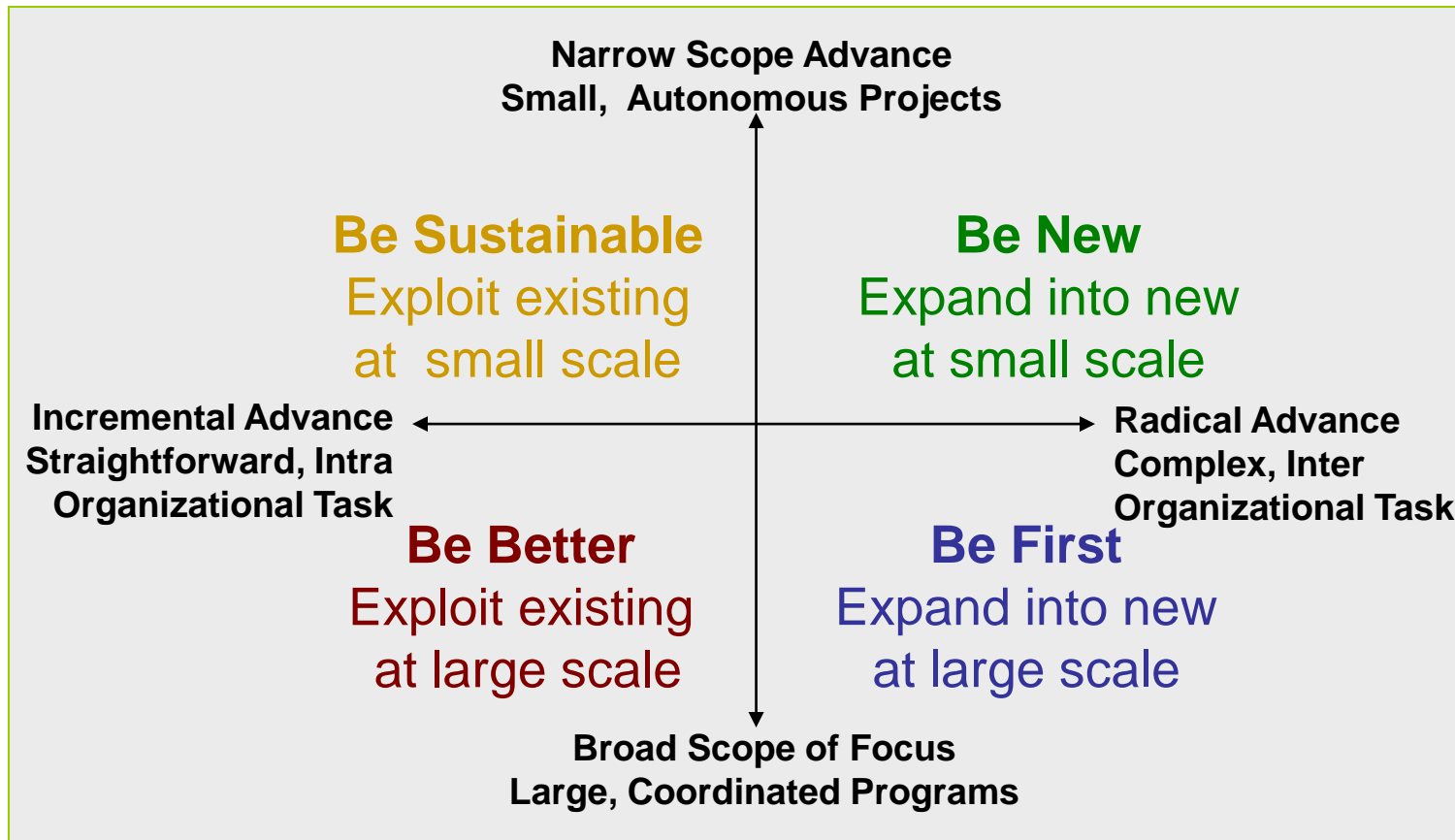
- Project Planning & Execution
- Project-Level Measures of Success
- Lab-Wide Measures of Success

### **Build Strategic Relationships**

- Relationship with Sponsors
- Champion Foundational Research
- Reputation for Excellence



A blockage could be the funding mix across four Research Profiles with different strategic outcomes.



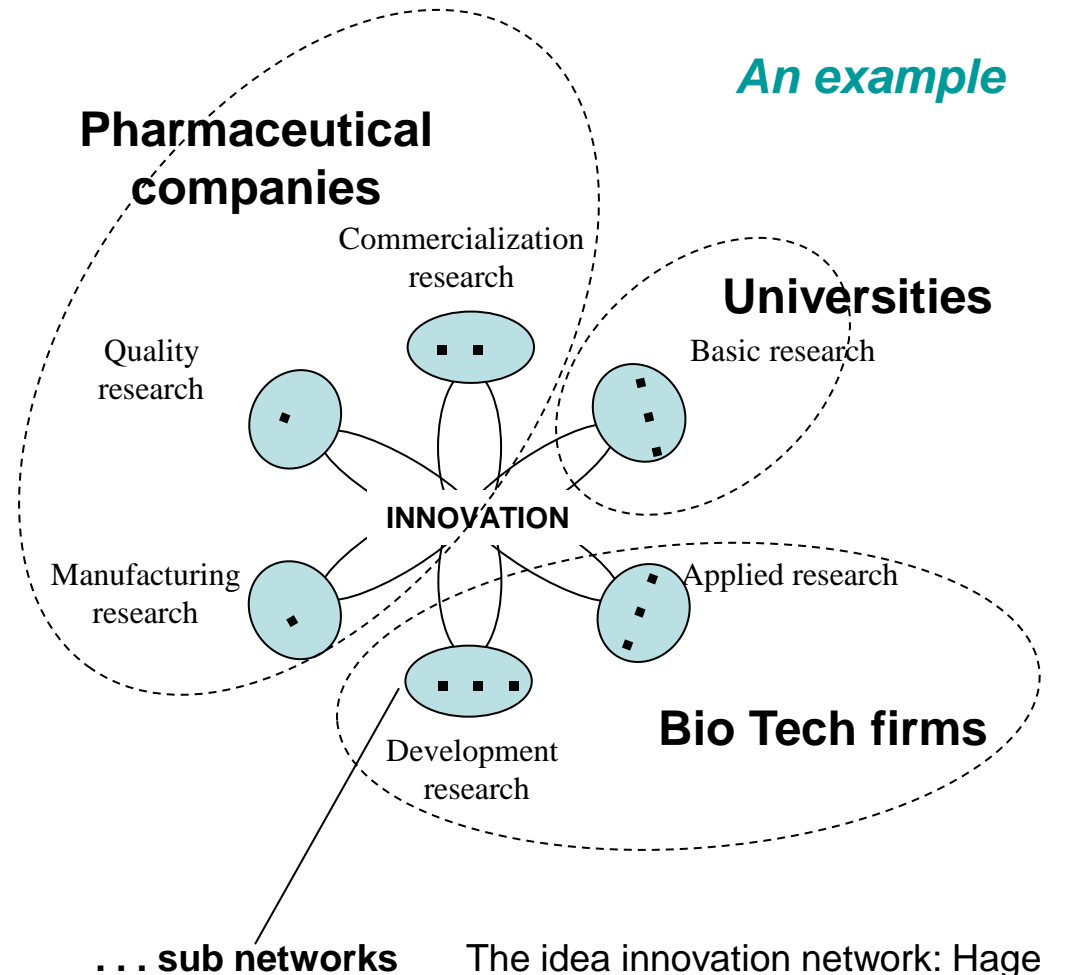
*An organization or program can have a mix of the four profiles and would manage them differently.*

# The Idea Innovation Network theory is key to describing the innovation process.

Increasing differentiation  
of arenas in the  
process

For successful  
introduction of new  
product/ mission

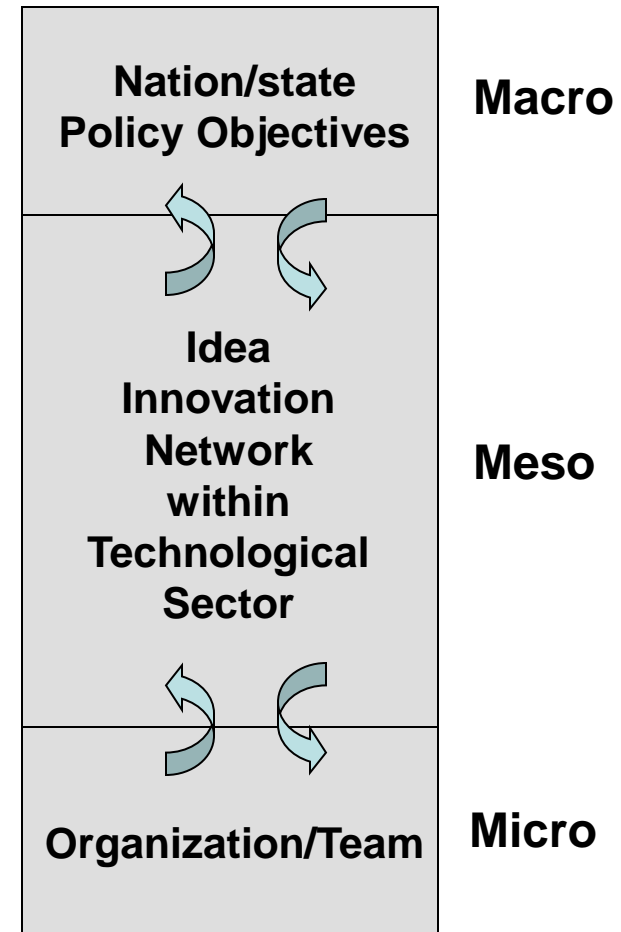
- RTD advance can occur in one or more arenas
- Ideas move between arenas
- Inter-organizational networks transfer tacit knowledge
- Manufacturing, quality research often ignored



The idea innovation network: Hage and Hollingsworth (2000), modifying Kline and Rosenberg (1986)

# Focus on the technology sector

- Bottlenecks can be spotted more easily here
- Meso level connects macro with micro
- Mission and policy decisions are often sector specific
- Policy impacts differ by sectors because sectors differ in
  - Amount of investment by RTD arena
  - Rates of technical change



# Meso level questions – Performance and connectedness

## Possible blockages and bottlenecks

- Technical achievement in real time in each arena (connected to sector performance)
- Overall sector socio-economic performance (new sales in product mix, speed to develop, how radical/broad)
- Strength of networks between differentiated arenas, among small organizations within arena

## Theory suggests (given mission and technical/market opportunities)

- Reasons for poor performance at 3 levels
- Where to increase transfer of tacit knowledge

## Evaluation implications

- Build on existing output measures and peer review
- Gather comparative sector data to establish knowledge transfer with forms of connectedness

# Macro level questions – Resources and modes of coordination

## Possible blockages and bottlenecks

- Extent to which dominant mode of coordination (market, state, association) facilitates innovation
- Extent to which high risk capital is available
- Extent to which resources (skills, facilities) are available by arena

## Theory suggests (given mission and technical/market opportunities)

- Arguments about market mechanisms and alternatives
- Location and speed of capabilities construction, destruction

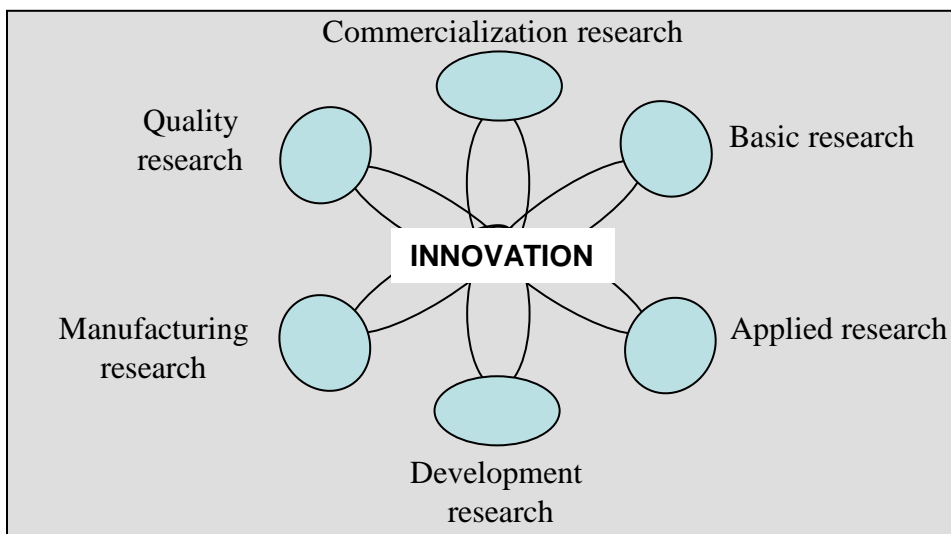
## Evaluation implications

- Examine what state interventions help form, strengthen networks

# All these work together...Key questions to identify innovation bottlenecks and policy objectives and effectiveness

High risk capital – available where      Capabilities – Level, mix, availability      Modes of coordination – effective?

**Macro- Institutional Rules as they affect the sector**



**Meso - Performance by sector and arena**  
Socio economic outcomes

Technical progress

Network connectedness

if not, check for bottlenecks

**Micro - funds allocation by arena and profile**

RTD arenas – are there sufficient funds

Portfolios - need more/ less radical, large scope?

Organizational profiles – do attributes match the profile?

# Summary and conclusions

## Strengths of our approach

- Theories-based, captures the process of innovation
- Useful for policy makers for reformulating policies
- Balances complexity and focus, using idea innovation network at meso level
- Able to connect micro with macro levels
- Indicators help identify organizational, network, and institutional bottlenecks and suggests how these occur
- Raises questions, will help build theory, including effectiveness of market mechanism for transfer of tacit knowledge and ways to break path dependency

Proposed framework indicates what might be done, and can guide further discussion and study.

# Contact Information

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*We welcome  
comments,  
suggestions*