# Research Design for Innovation Studies

## (Innovation System Engineering)

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University of Tokyo

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***Week 4***

# Today's Agenda

- Project Guidance
- Assignment for next week

# PROJECT GUIDANCE

# COURSE OBJECTIVE

# What is this course for?

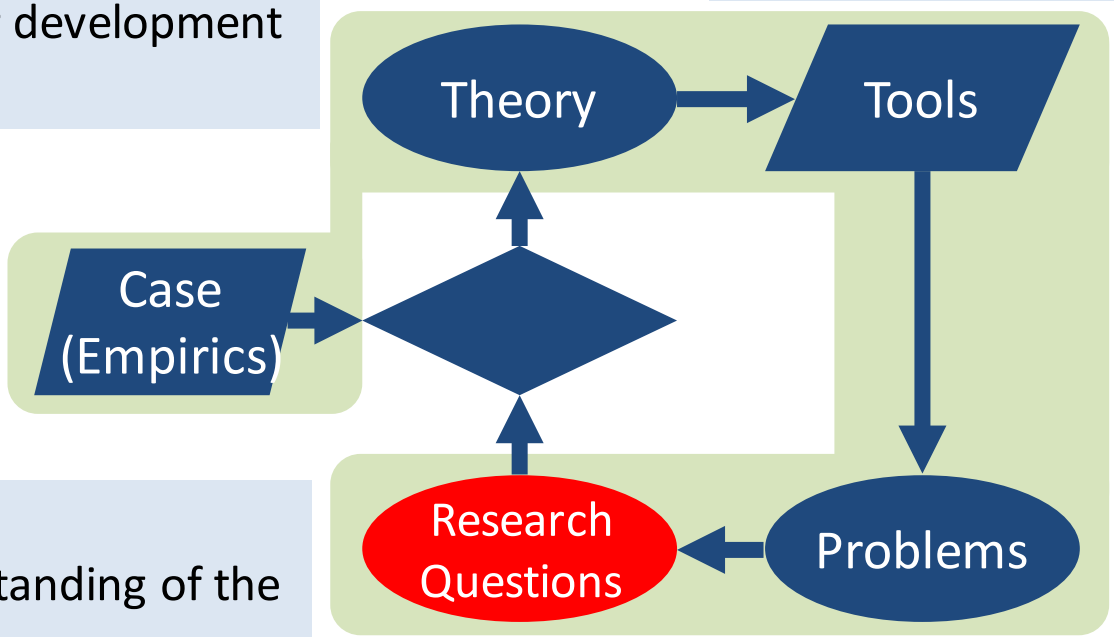
**OBJECTIVES**

- To provide with an understanding of key conceptual frameworks and analytical tools needed for innovation management
- To develop your ability to innovate
- To develop your skills for research design, or more generally, for problem finding

# How is the course delivered?

**Theory**
- To provide with general picture of innovation theories
- To present the frontier and limitation of theories
- To motivate further development of theories

**Tools**
- To understand efficacy and limitation of existing tools
- To motivate further development of tools/theories




**Case study**
- To facilitate understanding of the theories/tools

* I'll try to show a broad range of / up-to-date cases

**Research Question development [Project]**
- To develop research design/problem finding skills

# Why “problem finding”?

- Research questions are often GIVEN by supervisors - lack of opportunity to come up with your own problem
- Research questions often not elaborated – too broad, ambiguous, …
- Technically motivated but theoretically unjustified
  - Unless you intend technical progress, applying state-of-the-art techniques to damn questions isn’t a clever way of using your time.
- “Problem finding” is important in any profession (not only about academic research).

# Project

- Based on your own interest
  - Related to innovation studies
  - Different from your thesis topic
- Individual basis
- The goal is to FIND a research question but NOT to SOLVE the question.

  (Different set of skills needed, beyond the scope of this course)

# Examples of previous projects

- *The Role of Research in the Emerging Economies*
- *Bitcoin and remittances: potential for market disruption?*
- *The Effectiveness of Technology Transfer in a Culturally Different Partnership*
- *Industry 4.0 in relation to company's performance*
- *Novel approach to IP protection for research tools*
- *Impact of university policies in preventing conflicts of Interest in research/academia*
- *How does group size affect creativity of research in different fields*
- *University-industry collaboration as an incentive of academic innovation*
- *Impact Measurement and the Distribution of Scientific Capital*

# Project Output

1. Introduction
   - General problem to be discussed
   - Why the problem is worth studying
2. Theory & Hypothesis
   - What is known & what is unknown
   - Hypothesis to be tested
   - Justification for the hypothesis
3. Method & Data
   - Data & approach to test the hypothesis
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   - Summary of results
   - Implication: what the result means to policymakers
   - Limitation
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**Assignment 1**

- Find a hypothesis
- Explain rationale behind the hypothesis
- Explain why the hypothesis is relevant.
- Express the hypothesis in mathematical terms
- Identify key components that appear in the math, and explain measurements used in empirical research for each component
- Identify the sample and the justification

Assignment 1

# EXAMPLES

Laursen, K., Salter, A., 2006. Open for innovation: The role of openness in explaining innovation performance among UK manufacturing firms. Strategic Management Journal 27, 131-150.

- Question
  - What extent of search (depth and breadth) is optimal for OI?
- Study setting
  - UK innovation survey in 2001
  - 6,287 business units

# Hypothesis and Reasoning

- Hypothesis: External search breadth is curvilinearly related to innovative performance [H1].
- Reasoning: (+) Variety but (-) over-search
- Relevance: Firms make big investment in open innovation, external search for innovation sources, but empirical evidence as to OI is limited.

From Slides of Week 2

# Search Breadth and Depth

## 16 external sources of innovation

| | |
|---|---|
| Market | Suppliers of equipment, materials, components or software |
| | Clients or customers |
| | Competitors |
| | Consultants |
| | Commercial laboratories/ R&D enterprises |
| Institutional | Universities or other higher education institutes |
| | Government research organizations |
| | Other public sector e.g. Business links, Government Offices |
| | Private research institutes |
| Other | Professional conferences, meetings |
| | Trade associations |
| | Technical/trade press, computer databases |
| | Fairs, exhibitions |
| Specialized | Technical standards |
| | Health and safety standards and regulations |
| | Environmental standards and regulations |

**Breadth**

How many of the 16 are used?

# Excessive search is counter-productive

Innovative Performance

*%Contribution of new products in sales*


Breadth

He, Z.L., Wong, P.K., 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. Organization Science 15, 481-494.

- Literature repeated argues that both exploration and exploitation are necessary for sustainable innovation performance.
  - They may be simultaneously pursued (so-called "ambidexterity"), while they may be done sequentially in different points in time (so-called "temporal differentiation").
- Little empirical evidence had existed.

Should organizations simultaneously explore and exploit?

[Research setting] Survey of 563 manufacturing firms in Singapore/Malaysia in 1999/2000

# Hypothesis and Reasoning

- Hypothesis: There is a positive interaction effect between explorative and exploitative innovation strategies on firm performance. [H1]

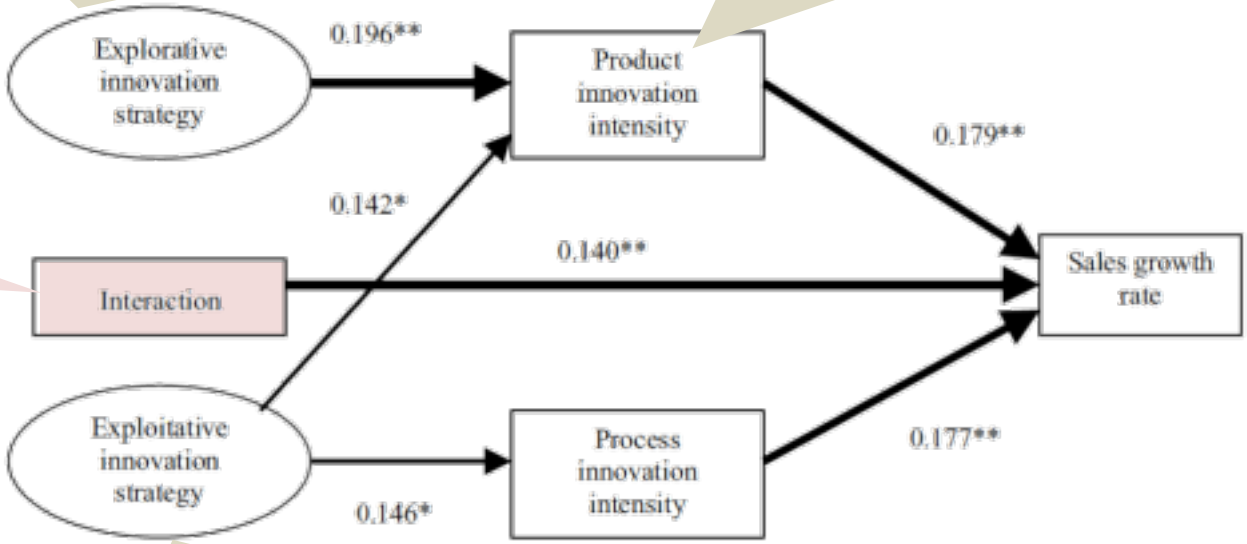
- Reasoning: "An organization needs to engage in sufficient exploitation to ensure its current viability and, at the same time, to devote enough energy to exploration to ensure its future viability."

- Relevance: Literature argues that both exploration and exploitation are necessary for innovation, but evidence is lacking.

# From Slides of Week 3

Objective of project (1) [5-point scale]
- Introduce new generation of products
- Extend product range
- Open up new markets
- Enter new technology fields

% Total annual sales that consist of new/improved products introduced over the last three years




Ambidexterity
Product of
(1) and (2)

Objective of project (2) [5-point scale]
- Improve existing product quality
- Improve production flexibility
- Reduce production cost
- Improve yield or reduce material consumption

% Annual production volume using new/improved processes introduced over the last three years

Source: He, Z.L., Wong, P.K., 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. Organization Science 15, 481-494.
Note: Notes. Chi-square=146887; d.f.=107; p =0006; Normed chi-square=1373; GFI=0933; CFI=0952; NFI=0861; RMSEA=0046. *p < 010; **p < 005; ***p < 001; two-tailed test. This simplified model does not show control variables, error terms, or the indicator variables of the latent constructs. Two latent constructs, explorative innovation strategy and exploitative innovation strategy, are represented by ovals. Observed variables are represented by rectangles.

# Project Output

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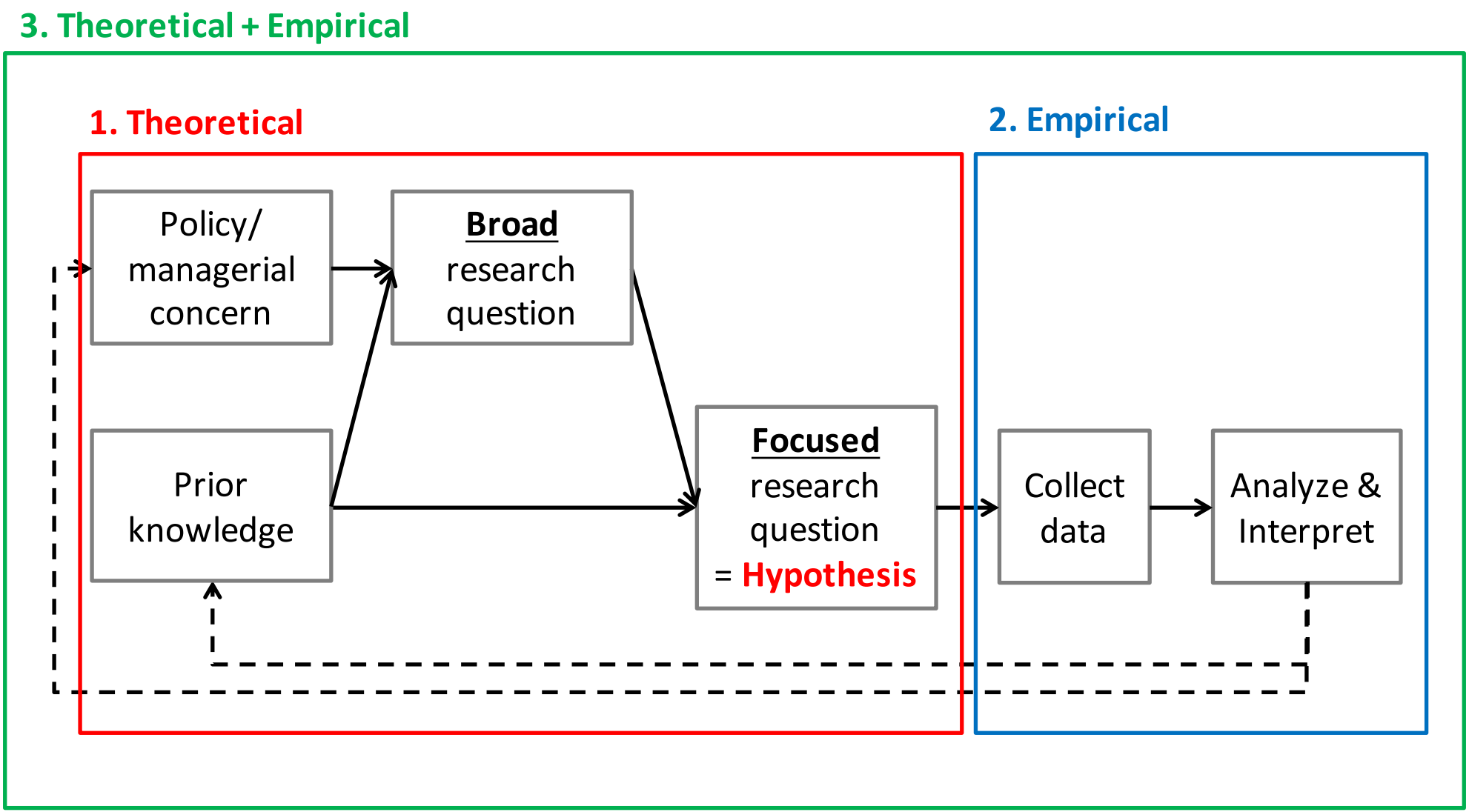
How do we get there?

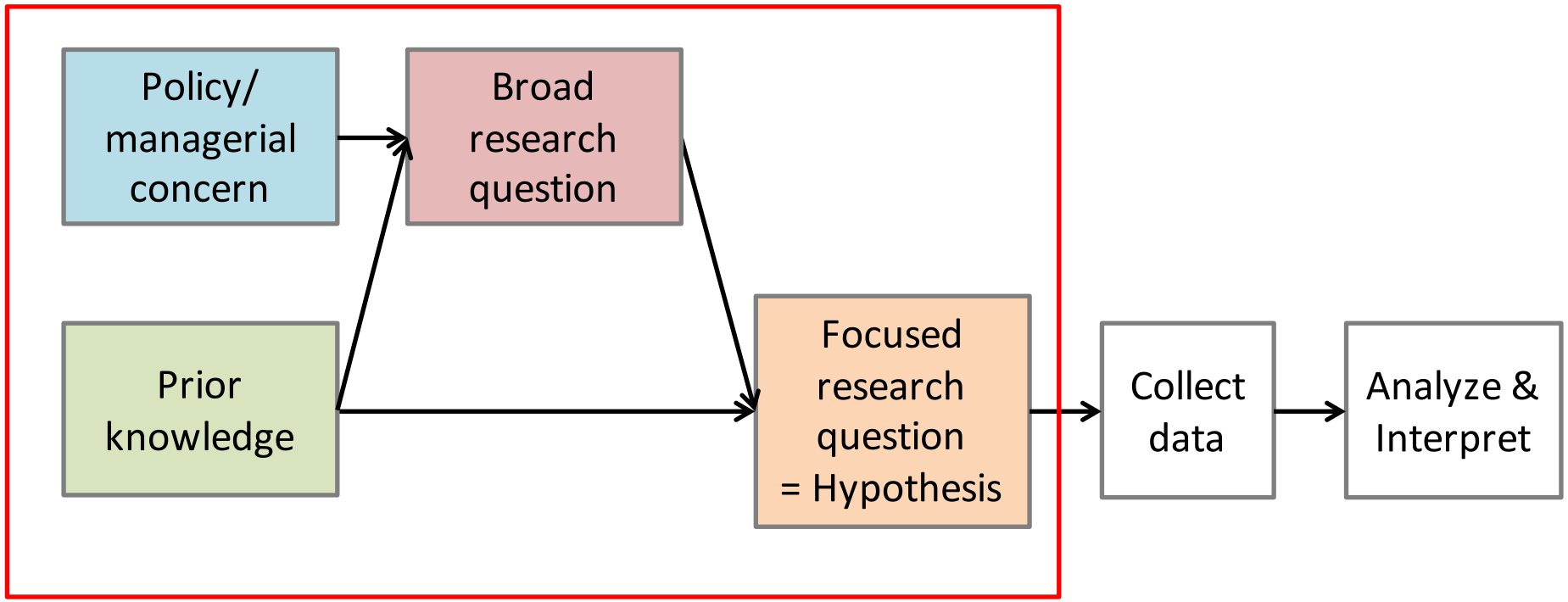
# DESIGN OF RESEARCH

# Process of Research



# Target of Project

"Theoretical + Empirical" with empirical part omitted.



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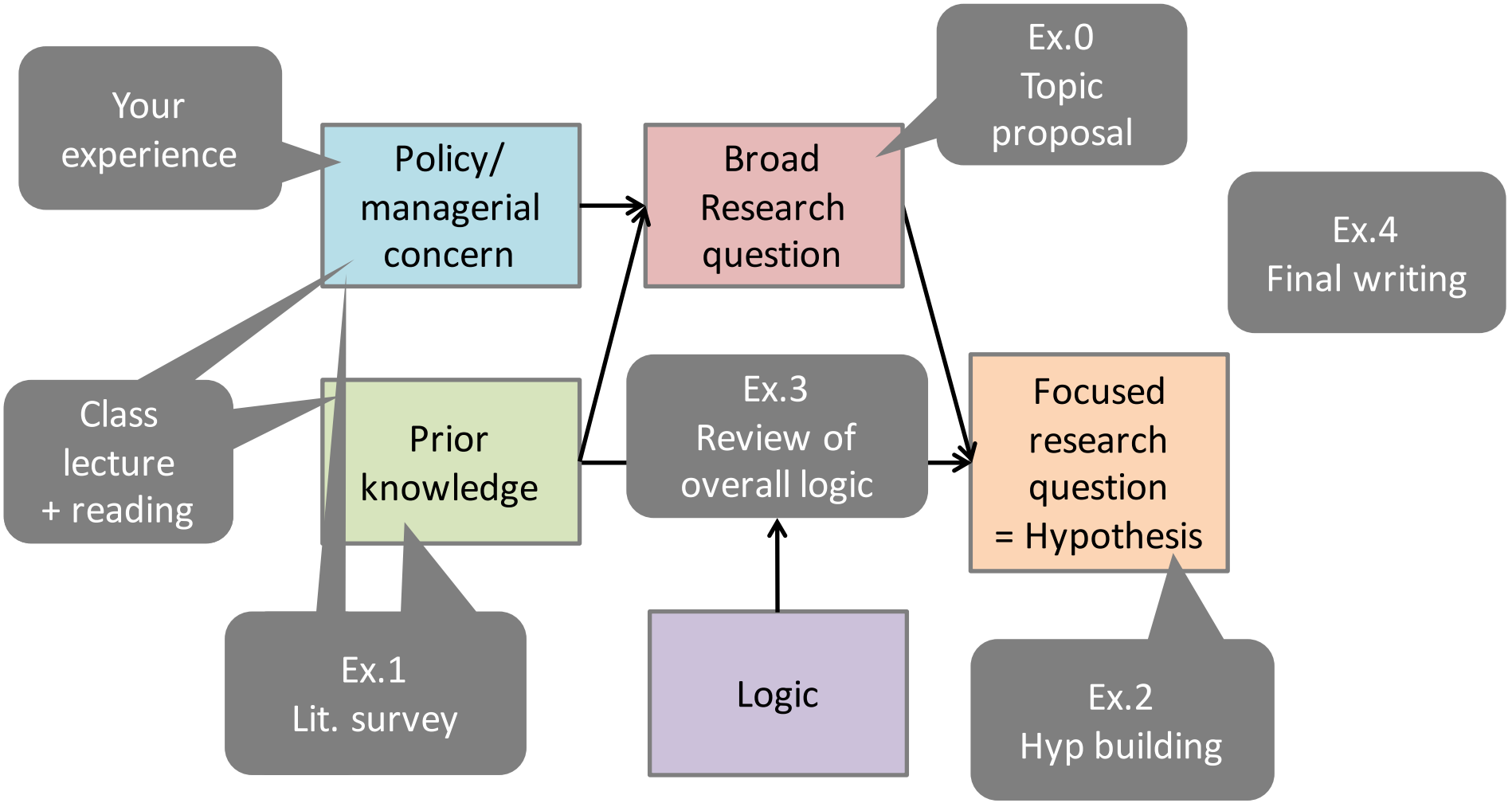
Mainly about this part

Supplementary

Not about this

# Exercises



# Final Output

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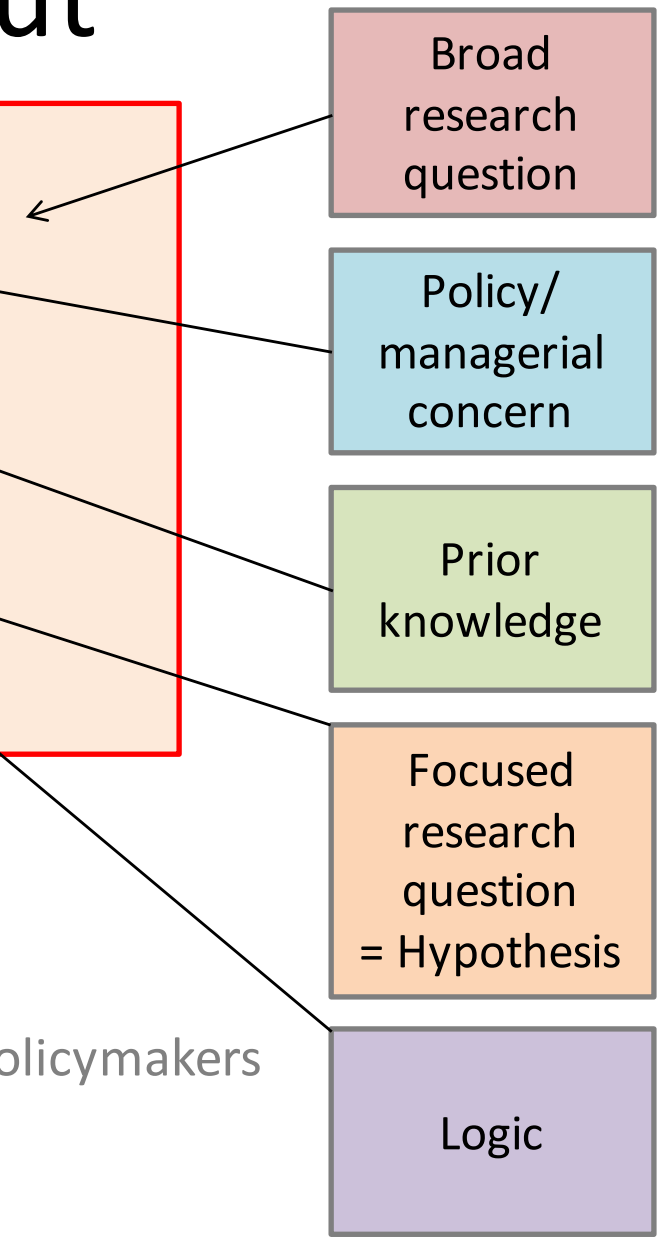


# BUILDING RESEARCH QUESTIONS

# Broad & Focused Question

| Broad Question | Focused Question (=Hypothesis) |
|---|---|
| Open-ended: What, How, Why – type questions | Closed-ended: Whether, How much - type questions |
| To identify the broad area of your interest | To propose explanation for phenomena (e.g., cause & effect) |

**Example**

Broad Question
How can we solve global warming?

Focused question
Does it solve global warming if gasoline cars are replaced by electric cars?

Testable statement (hypothesis)
Use/production/scraping of gasoline cars produce more CO2 than electric cars.

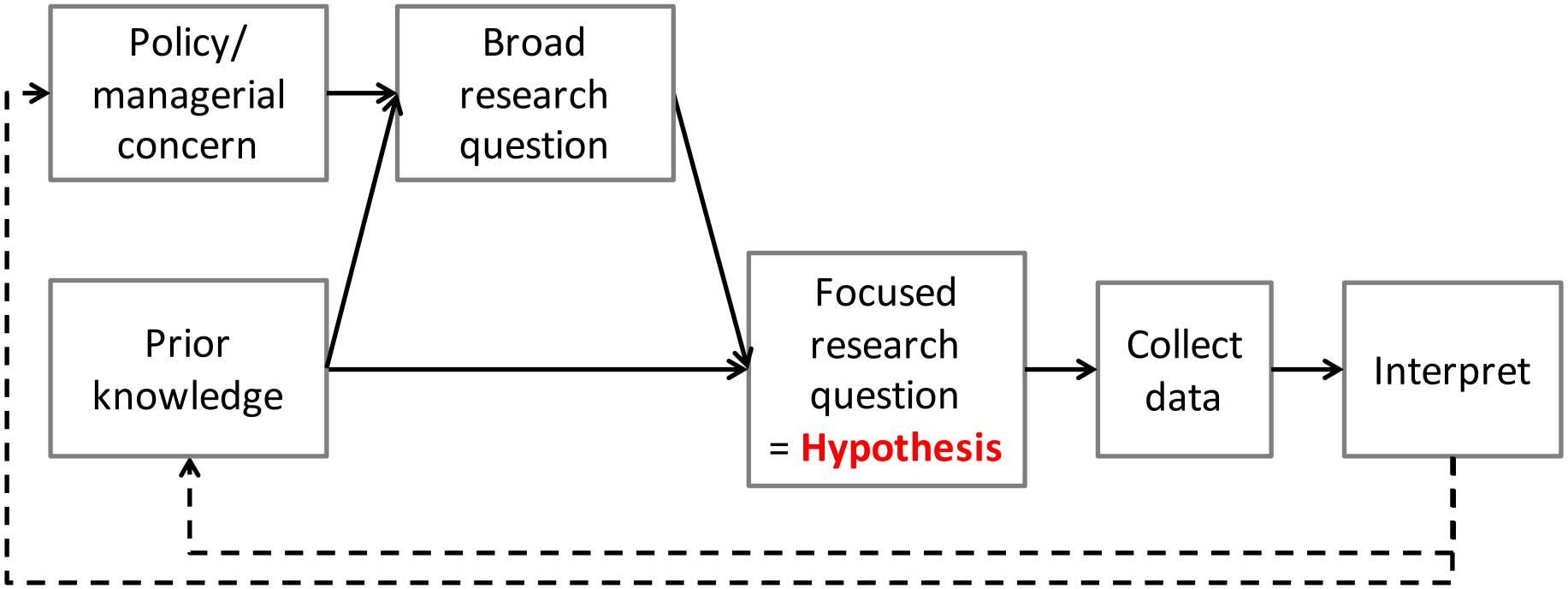
# More examples

| Broad question | Focused question (hypothesis) |
| --- | --- |
| [Ahuja 2001] How technological acquisition affect innovation post-acquisition performance? | H2: The greater the absolute size of the acquired knowledge base, the greater the subsequent innovation output of the acquiring firm. |
| [Laursen 2006] How is the openness of search strategy related to innovation performance? | H1: External search breadth is curvilinearly (taking an inverted U-shape) related to innovative performance. |
| [Gunther 2001] How is organizational learning affected by supervision? | H1: At high levels of exploration, increases in goal autonomy will be associated with increases in learning effectiveness. |
| [He 2004] Is the simultaneous pursuit of both exploration and exploitation beneficial? | H1: There is a positive interaction effect between explorative and exploitative innovation strategies on firm performance. |

Confirmation v. Exploration

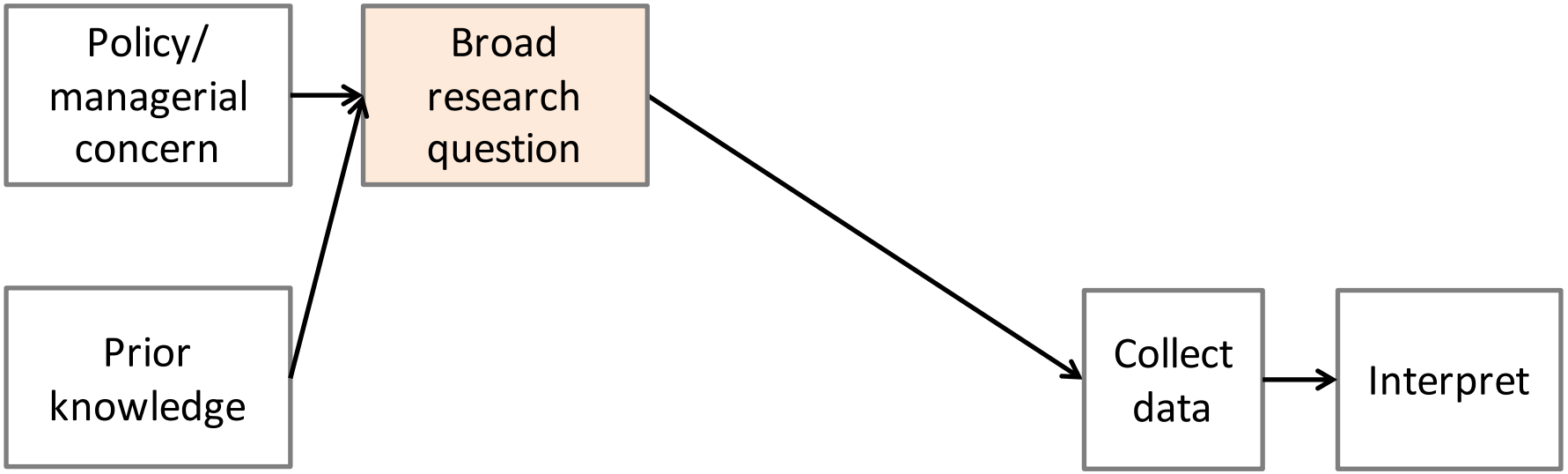
# WHY DO WE NEED HYPOTHESES?

# Process of Research



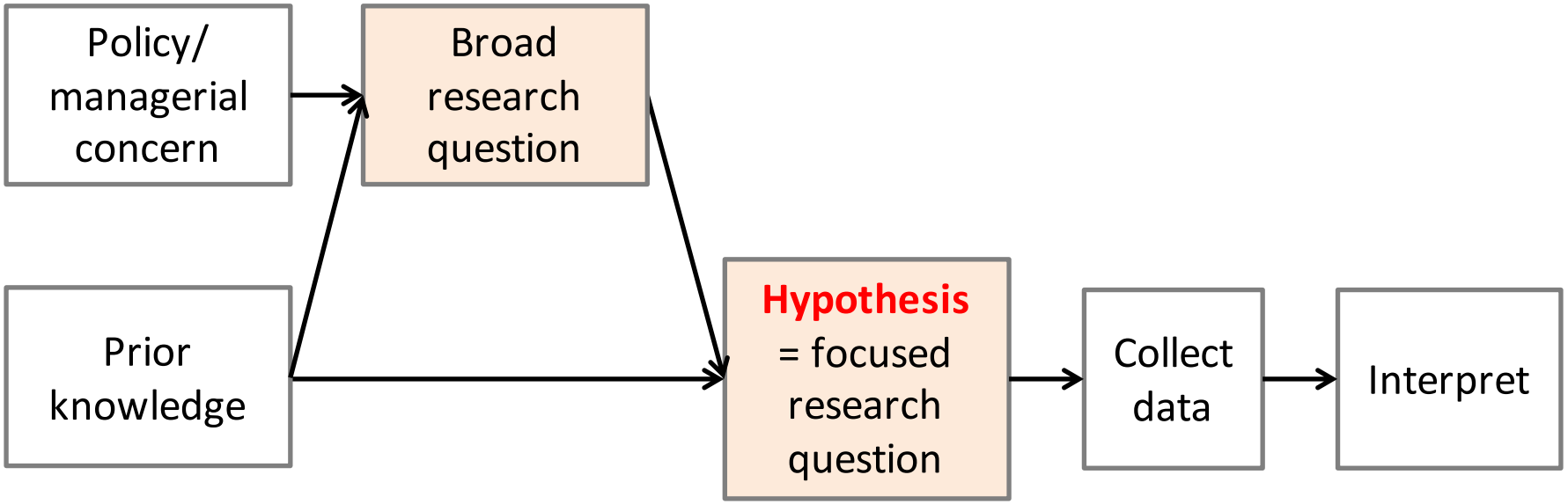
# Exploratory Research

No clear hypothesis is given. A broad question is asked, and data give a tentative answer to it.



# Confirmatory Research

A specific question (=hypothesis) is stated, justified by theory, and tested by data.



# Example

| | **Exploratory** | **Confirmatory** |
|---|---|---|
| Broad question | How can we solve global warming? | How can we solve global warming? |
| Data collection | Temperature and various potential causes are measured. | |
| Hypothesis | | CO2 emission increases temperature. |
| Data collection | | Temperature and CO2 (and many things related to CO2) are measured. |
| Analysis | Happen to find correlation b/w temperature and CO2. (Only if you measured CO2.) (Many other correlations are found.) | Test if there is a positive correlation b/w CO2 and temperature. |
| Interpretation | CO2 emission might increase temperature. (But, many other possibilities remain.) | CO2 emission increases temperature. |

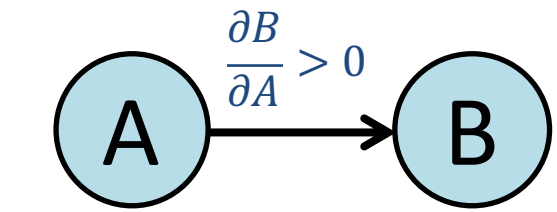
# Exploratory vs. Confirmatory

| | Exploratory | Confirmatory |
|---|---|---|
| Type of Question | What, How, Why – type questions; i.e., open-ended | If a statement (=hypothesis) is true or not |
| Hypothesis | Not clearly stated | Clearly stated |
| Goal of research | To have rough understanding about certain phenomena<br>To produce a posteriori hypothesis | To test a priori hypothesis |
| Stage of research | At the initial stage of a line of research | After a promising hypothesis is found (so after the exploratory stage) |
| Scope | Broad; various possibilities are explored. Possibly leading to unexpected explanation. | Focused; only pre-defined factors are examined. |
| Interpretation | Ambiguous | You can be more confident of your finding. |

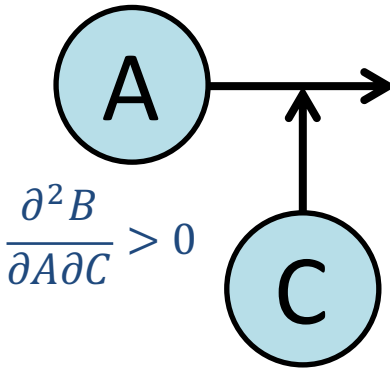
# Why do we need a hypothesis?

- Without hypotheses, you don't know what data are needed.
- You cannot explore all the possibilities.
  - E.g., you might forget to measure CO2.
- In exploration, you have to make efforts in irrelevant things, and you cannot go deep into relevant things.
  - E.g., In confirmation, you can investigate specifically about CO2-related factors (e.g., other gas, CO2 in different atmospheric layers).
- Without theoretical reasoning, you cannot explain empirical observations.
  - E.g., You wouldn't know if CO2 increases temperature or other way around.
- Without theoretical prediction (that existed before data collection), empirical finding is regarded as "hypothetical" (but not as a proof).
  - Your observation may be only accidental. It may be peculiar to your data.
- Without theoretical prediction (that existed before data collection), you are tempted to make a convenient interpretation for you.
- In social science studies, data preparation is often costly. You need to avoid spreading your resource over too many things. Even at the exploratory stage, you should prepare some hypotheses in your mind.

# Types of Hypothesis

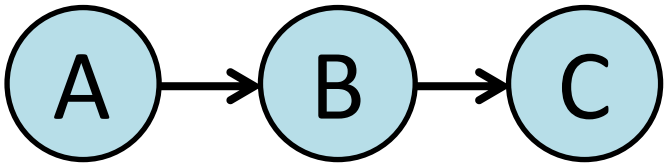



- B follows A.
- If there is A, then the likelihood of B increases.
- When A increases, B also increases.
- A is called independent (explanatory) variable.
- B is called dependent (criterion, explained) variable.



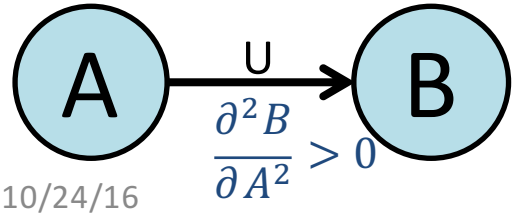

- The effect of A on B is increased by C.
- If C, it follows that A->B. If not C, it does not follow.

(This C is called "moderator".)




- If A, B follows, and then C follows.
- The effect of A on C is mediated by B.

(This B is called "mediator".)




- When A increases, B first decreases and then increases.

# Examples

## Hypothesis

## Math

[Ahuja 2001] The greater (A) the absolute size of the acquired knowledge base, the greater (B) the subsequent innovation output of the acquiring firm.

$$\frac{\partial B}{\partial A} > 0$$

[Laursen 2006] (A) External search breadth is curvilinearly (taking an inverted U-shape) related to (B) innovative performance.

$$\frac{\partial^2 B}{\partial A^2} < 0$$

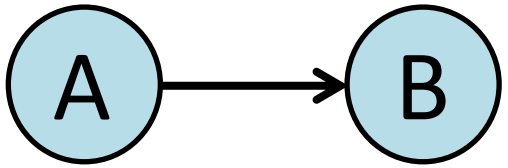
[He 2004] There is a positive interaction effect between (A) explorative and (C) exploitative innovation strategies on (B) firm performance.

$$\frac{\partial^2 B}{\partial A \partial C} > 0$$

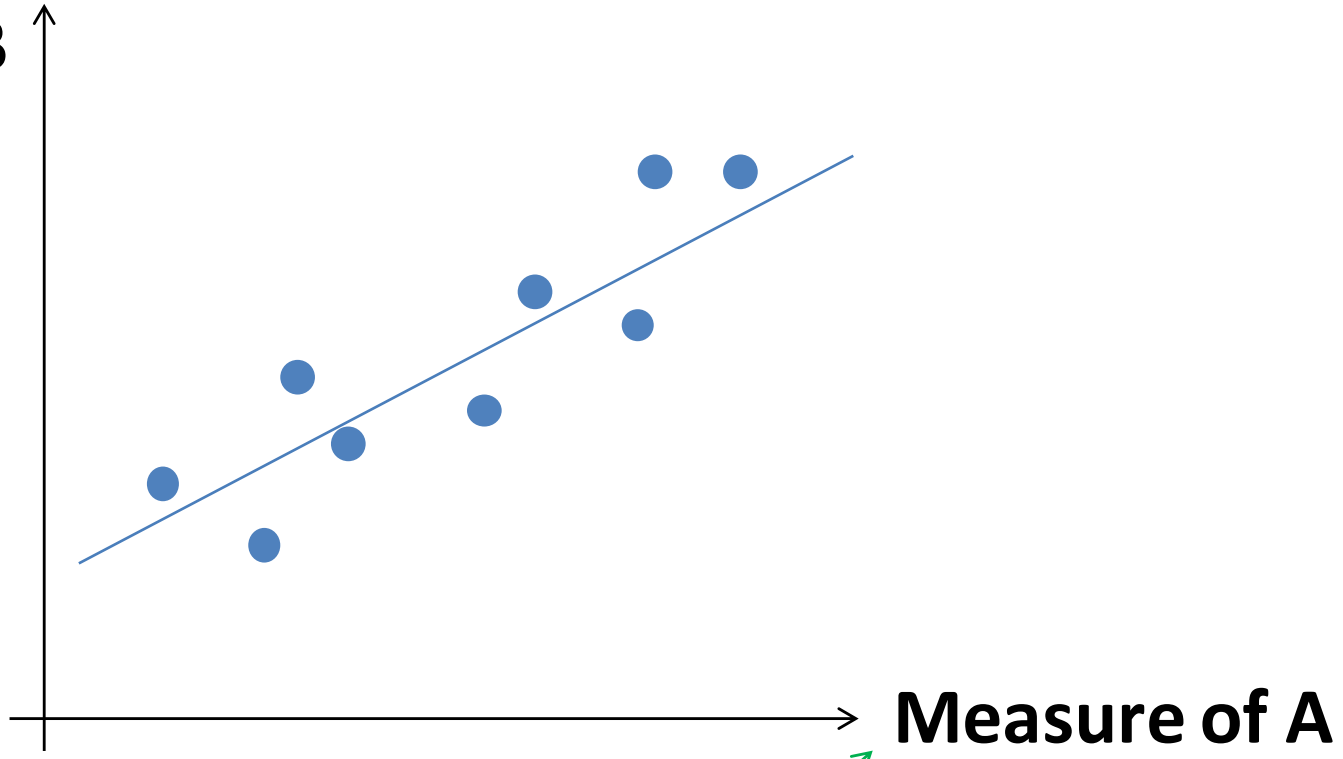
[Gunther 2001] At high levels of (C) exploration, increases in (A) goal autonomy will be associated with increases in (B) learning effectiveness.

$$\frac{\partial}{\partial C}\left(\frac{\partial B}{\partial A}\right) = \frac{\partial^2 B}{\partial A \partial C} > 0$$

# Design of Empirical Study

To test hypothesis: 


$$\frac{\partial B}{\partial A} > 0$$

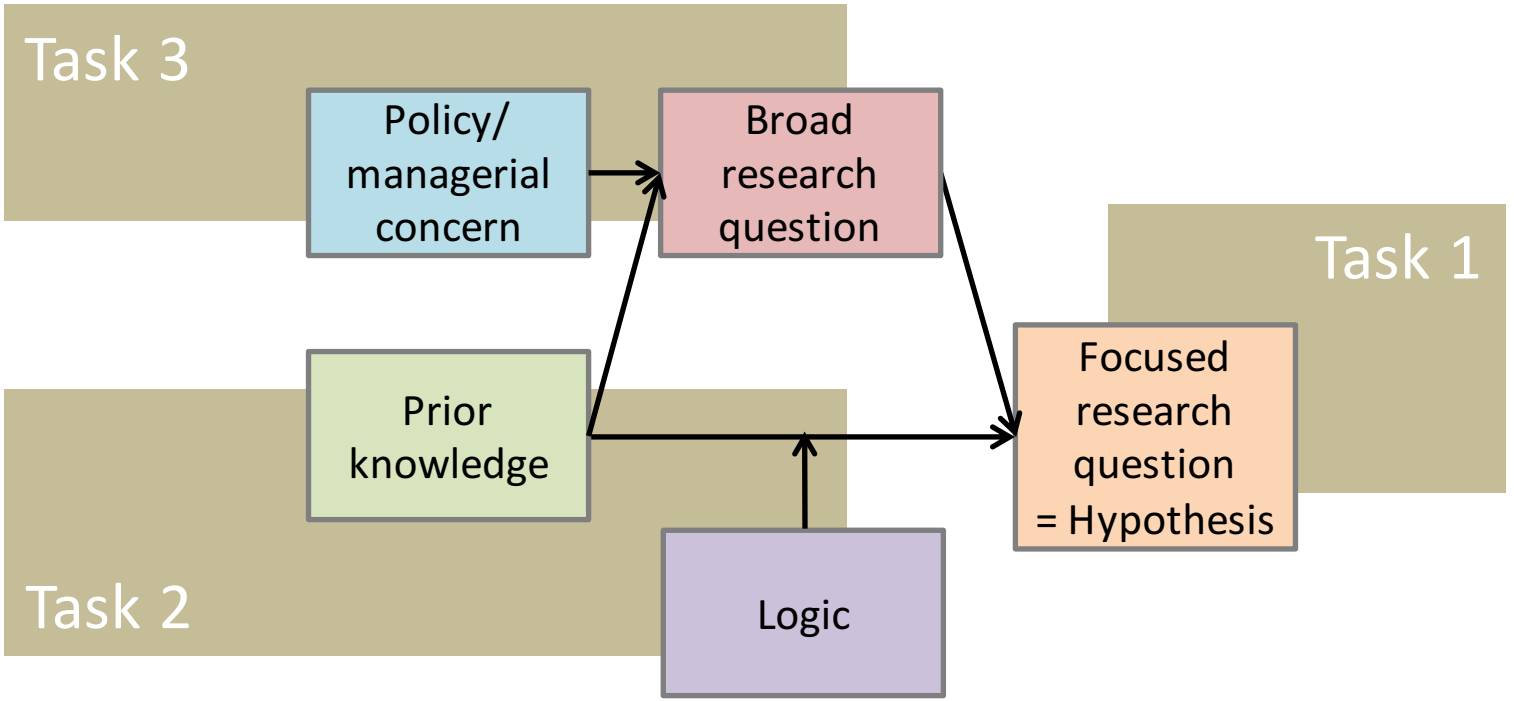



Define the measure, and decide how to measure it.

Define the measure, and decide how to measure it.

# To Sum Up

1. Propose your own focused question (=hypothesis).
2. Justify it by existing theories (i.e., literature) and logic.
3. Discuss its relevance.



# ASSIGNMENT

# Class Assignments

- Assignment of reading is given.
- Develop your interest for your project.
- Learn how theories are created (hypotheses are formulated).
- You don’t have to understand technical details.

# Assignment 2

- Read one of the listed papers.
- Come up with questions that you want to ask of me.
- Send it to sunkao1035@gmail.com
- Due at 1:00 pm on Oct 31