

CRP 501: Quantitative Methods for Planning Data Analysis

Introduction to Scientific Research

Key Questions

- What is science? What is social Science?
- How do we “know” anything in the social sciences?
- What are hypotheses and theories? How are they used in planning?
- What is the social science research process? How is it carried out?
- How do statistics fit into the social science research process?
- What ethical rules guides social science research? What about planning?

Foundations of Social Science

- Science – (Latin scire) “to know”
 - A method or process, as well as the knowledge gathered by that process
 - To be “scientific” = to correctly follow the scientific method
- Social Science
 - is the scientific study of organized human groups.
- Is planning a science?
- Epistemology – the study of the foundations of knowledge
 - In order to acquire knowledge, we must make certain assumptions
 - Those assumptions are untestable and unprovable
 - Different methods of acquiring knowledge are based on different assumptions

Foundations of Social Science: Epistemology

- Approaches to Knowledge – How do we “know” anything?
 - **Authoritarian Mode** – certain individuals (kings, clergy, scientists, etc.) are designated “producers” of knowledge
 - The source of their knowledge is rarely questioned
 - Assumption: those who claim to have knowledge are credible
 - **Mystical Mode** – knowledge is obtained from the supernatural (prophets, astrologists, diviners, etc.)
 - Assumption: nature is not orderly
 - Knowledge only exists in the spiritual, supernatural world
 - **Rationalistic Mode** – scientific thought is synonymous with logic and pure reason
 - Developed by Aristotle, later by Kant
 - Typically expressed in abstract, pure mathematics
 - Very prominent throughout planning (e.g. migration models, land use models, transportation models, etc)

The Scientific Approach/Method

- The Scientific Approach – product of 16th century Scientific Revolution based on the following premises:
 - The entire universe is fully intelligible and governed by natural rather than supernatural forces.
 - Rigorous application of the scientific method can answer fundamental questions in all areas of inquiry.
 - The human race can be "educated" to achieve nearly infinite improvement.

Scientific Approach/Method (cont)

- Scientific knowledge is acquired through falsification
 - We cannot “prove” anything, but we can “disprove” alternative explanations
 - Scientific assertions are supported by disproving alternative explanations
 - “Null Hypothesis Testing”
 - E.g.: “There are no significant differences in between travel modes of African-Americans in Chicago and the rest of the residents”
 - How might we disprove this hypothesis?

Methodology and its Goals

- **Methodology**
 - a system of rules and procedures upon which research is based and against which claims for knowledge are evaluated;
 - the “rules of the game”
- **Goals of social science methodology (why “the rules of the game”?)**
 - *Replication* – can an investigation be repeated by a different researcher(s)?
 - *Inference* – a claim for knowledge that is derived from methodological assumptions
 - A research methodology should allow a researcher to make “valid” inferences about their research population, a series of events, or any other broader phenomenon
 - E.g. Housing needs of low income people.
 - E.g. Urban sprawl in US cities

Methodology and its Goals (cont.)

- *Objectivity* – findings produced by research should be free of bias
 - E.g. A sidewalk poll
- *Intersubjectivity* – knowledge must be shared and understandable among other scientists
 - Proper methodology ensures scientists are “speaking the same language”
- *Validity* – correspondence between the measure and the concept it is thought to measure; “Are you measuring what you think you’re measuring?” (more to come under “Measurement”)
- *Reliability* – does a measure yield the same values for a particular case again and again?

Concepts

- What is Concept?
 - “an abstraction, a representation of an object, or one of that object’s properties, or a behavioral phenomenon.” (p. 24)
 - “shorthand descriptions of empirical world” (p. 24)
 - Vocabulary & terminology used in a particular area of study
 - E.g. urbanization, housing quality, social status, population density, household income, education level
- Functions of Concepts
 - Tools for communication
 - Perspective—A way of looking at empirical phenomena
 - Classification and generalization
 - Components of theories

Definitions

- Conceptual definitions
 - “Definitions that describe concepts by using other concepts” (p. 26)
 - Primitive & derived terms
- Operational definitions
 - “describes a set of procedures a research can follow in order to establish the existence of the phenomenon described by a concept.” (p. 29)
 - Observation & measurement
- Problems to avoid
 - Congruence Problem: agreement between conceptual and operational definitions
 - Theoretical Import: needed when concepts cannot be defined operationally

Theories, Models, and Research

- Levels of Theories (see p. 37)
 - Ad-Hoc classification systems
 - Taxonomies
 - Conceptual frameworks
 - Theoretical systems
- Good theories must be:
 - Testable
 - Logically sound
 - Communicable
 - General
 - Parsimonious
- Models
 - a likeness, representation, or simplification of reality that describes concepts in terms of other concepts

Two ways to build a theory

- Induction – observation proceeds theory
- Deduction – theory precedes observation
- Theory building involves both deduction and induction

How do Statistics Fit In?

- Statistics are an extraordinarily important tool for making and supporting social scientific assertions
 - They help to make inferences about a population from a sample
 - E.g.: A sample of few cities can be very representative of the entire country
 - They help to predict social and economic outcomes
 - E.g.: Statistical models for predicting land use and transportation patterns
 - They help identify patterns in social science observations
 - E.g.: Empowerment zones and economic development

Research Problem

- “A research problem is a question or an issue that stimulates a response in the form of a structured scientific inquiry.” (p. 46)
- Quantitative Research
 - Observable or measurable
 - Testable or verifiable
- Different flavors of research
 - Empirical (e.g., longitudinal and cross-sectional)
 - Case studies (empirical vs. documentary)
 - Review, critique, argument, debate
 - Application-based
 - Exploratory, descriptive, explanatory

Research Hypotheses

- Hypothesis – is a statement of the relationship between two variables; a tentative answer to a research problems
 - What you believe to be the case
 - Null vs. research hypotheses
 - Your job: Whether the null Hypotheses can be rejected and its implication
- Good hypotheses are:
 - Clear – operational definitions are understandable and precise
 - Specific – identify an expected direction (positive or negative) and level of analysis (individual, group, country, etc.)
 - Testable with available methods – can we test a value such as “trust” without putting people at risk?
 - Value-free – free of bias or intended results
 - As social scientists, can we really be value free?

Units of Analysis

- The most elementary part to be studied
- a.k.a
 - Level of analysis
 - Cases (as in a sample)
 - Subjects (as in an experiment)
 - Respondents (as in a survey)
- Fallacies (drawing inferences from inappropriate level of analysis)
 - Ecological fallacy - Drawing inferences about individuals directly from evidence gathered about groups, societies, or nations
 - Individualistic fallacy - Drawing inferences about groups, societies, or nations directly from evidence gathered about the behavior of individuals

Variables

- Variable – “Any trait that can change from case to case;” the language through which theories are expressed
 - Often stated in terms of causes and effects
 - Help us to make the transition from theories/concepts to empirical observation
- Dependent & independent variables
 - Dependent variable: Criterion, Outcome (the variable you wish to explain)
 - Independent variable: Explanatory, Predictor (variables that explain changes in the dependent variable)
 - As in $Y = f(X)$, e.g., $Y = a + bX$
 - Determined by research objective
 - Usually more independent variables than dependent variables

Variables

- Continuous & discrete variables
 - Continuous variables – variables that do not have a fixed minimum unit (e.g. length, time)
 - Discrete variables – variables that have a fixed minimum; cannot be subdivided beyond a certain point (e.g. \$, people, cars)
- Control variable
 - Test spurious relation between dependent & independent variables (see Fig. 3.1 on p. 51)

Relations

- Connection or association between & among variables
- Direction of relation
 - Positive (e.g., land value and accessibility)
 - Negative (e.g., lot size and housing density)
- Magnitude of relation
 - How much are the variables related to one other
 - Strength of the relation (e.g., correlation coefficient)
- $Y = a + bX + \text{error}$
 - Watch out for “outliers” or “noises” (see Fig 3.2 on p.55)

The hypothesis: A Template

- The “Template Hypothesis:”
 - “In comparing (*units of analysis*), those having (*one value of the independent variable*) will be more likely to have (*one value of the dependent variable*) than will those having (*a different value of the independent variable*).
 - e.g.: “In comparing *U.S. cities*, those having *urban sprawl* will be more likely to have *traffic congestion* than those having *no urban sprawl*.”
- Hypotheses specify the direction of the causal relationships between variables
 - Positive – as the independent variable increases, the dependent variable increases
 - Negative – as the independent variable increases, the dependent variable decreases
 - Curvilinear – the relationship is both positive and negative, depending on the level of the independent variable

Linking Theory and Hypotheses

- Idea 1: Viability of public transportation system
 - Research Problem
 - The Theory
 - Hypotheses?
 - Units of Analysis?
 - Variables
 - Relations?
- Idea 2: Impacts of Urban sprawl
 - Research Problem
 - The Theory
 - Hypotheses?
 - Units of Analysis?
 - Variables
 - Relations?

Online Resources

- ISU Library
 - Indexes and Abstracts (e.g., Expanded Academics ASAP)
 - e-Journals and e-Books (e.g., Urban Studies)
- U.S. Census Bureau
 - American FactFinder
 - Publications (pdf)
- Government Information
 - FirstGov