National Centre for Research Methods

PEPA Programme Evaluation for Policy Analysis

Causal Inference in Economics

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PEPA is based at the IFS and CEMMAP

Institute for Fiscal Studies

cemmap centre for microdata methods and practice

Introduction

- The quest to establish causal relationships drives economic enquiry since its inception
- A causal effect is a *ceteris paribus* change that a certain action or factor induce on an outcome
- It differs from correlation, which measures the strength and direction of the relationship between two variables
- While conceptually simple, establishing causal relationships has remained a challenge
- This is mainly an empirical problem: within a theoretical model, causal relationships are well defined and can be completely understood

Introduction

- A seminal problem in economics, that may clarify the empirical difficulties, is that of understanding how demand and supply of a good change with its price
- Price and quantity traded in the market are simultaneously determined
- Thus, at each moment in time and each location, only one data point is observed
- Over time and locations, changes may be observed
- But these cannot, without further information, be attributed to changes in demand and/or supply

Introduction

- The classical solution to this problem requires two variables
  - One that shifts only the demand (say the temperature in the market for milk - to make ice-cream)
  - And the other that shifts only the supply (say the price of alfalfa)
- Within the demand-supply model, these variables induce exogenous variation (independent of market conditions) that can be used to separate how demand and supply vary with price
- The exogenous variables (temperature and price of alfalfa) were called *instruments*

Policy Evaluation

- Is at the core of economic research and public interest
- And at the heart of PEPA
- Aims to measure and understand the causal effect of some policy, investment or action on one or more outcomes of interest
- Endless list of examples:
  - The effect of direct taxes on labour supply
  - The effect of class size on test scores
  - The effect of education on wages
  - The effect of credit lines on investment
  - The effect of unionisation on earnings
  - The effect of foreign assistance on growth and poverty
  - …

The evaluation problem

- Suppose we want to assess the impact of a treatment, say university education, on an outcome of interest, say wages
- A direct measure of such impact on any one individual requires the observation of
  - Individual wage had she not completed university education
  - Individual wage had she completed university education
- The evaluation problem consists of the fact that we can never observe both pieces of information simultaneously for any individual
- This is a missing data problem, one that is inherently empirical

A simple solution

- To compare the wages of university graduates (treated) with those of high-school graduates (non-treated)

What would we obtain from such comparison?

- The correlation between university education and wages
- But the causal effect is more elusive:
  - Selection bias

    more academic individuals may be more prone to complete university *and* be capable of attracting higher wages irrespective of education
  - Heterogeneity

    individuals may benefit differently from university education
- As before, observational data on the two variables, treatment status and outcome, is consistent with *many* different causal interpretations

The randomised experiment solution

- Often labelled the “gold standard” in policy evaluation
- If well designed and implemented, eliminates selection bias and pins down a causal effect
- But rarely available in practice
  - Costs
  - Political and ethical constraints
  - Some impossible to implement
- Rigorous implementation is hard to ensure
  - Compliance
  - Adherence to randomisation protocols
- Identifies only average parameters

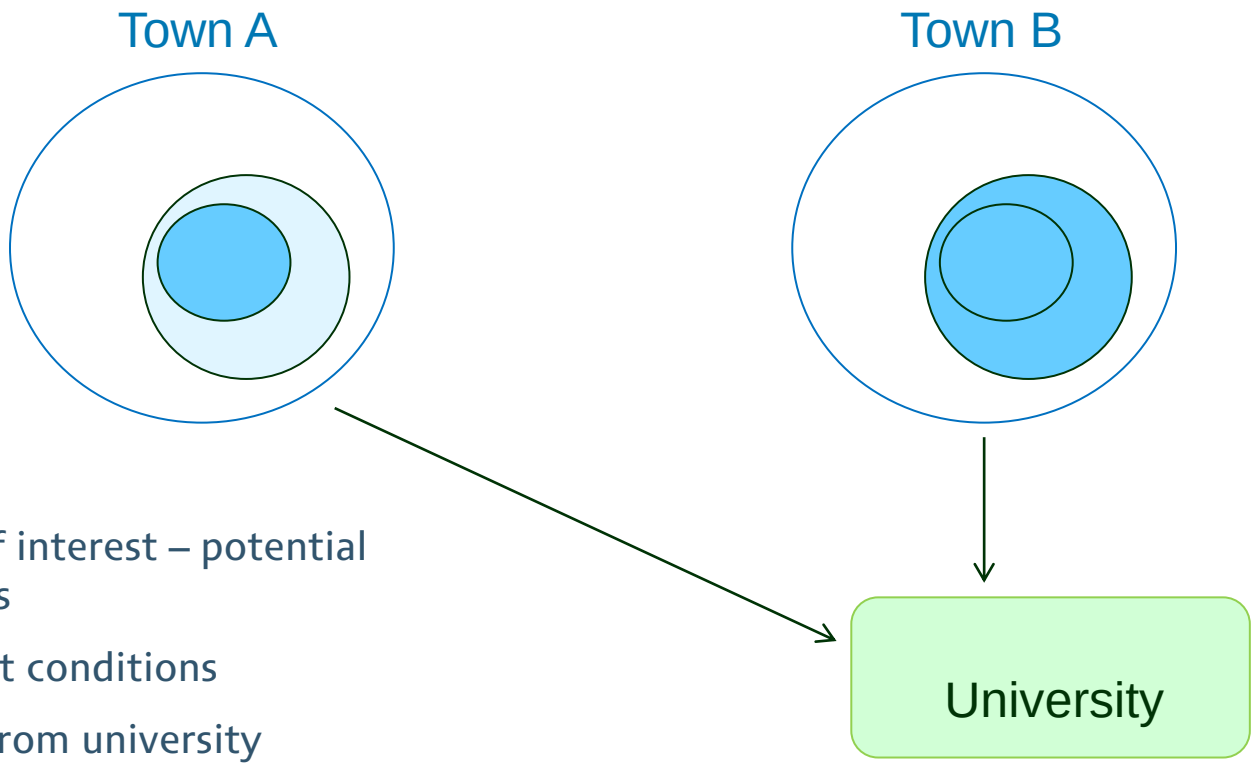
The (micro) econometric non-experimental approaches

- Several methods have been developed, depending on how particular data features are used, underlying assumptions and parameter of interest
  1. Matching
  2. Difference in differences (also known natural experiments)
  3. Instrumental variables
  4. Control functions
  5. Empirically-based structural economic models
- In most cases (except 5) the goal is to reproduce the conditions of randomised control trials to eliminate selection bias

Illustration: instrumental variables

- Information on a third variable - besides treatment status and outcome of interest - may help identify the causal effect of treatment
- In the education example, suppose such variable is distance to university: it is called the *instrument*
- If we accept that distance to university affects attendance but has no other impact on wages, we may use it to pin down some causal effect

Illustration: instrumental variables



Under the conditions

- similar population of interest – potential university candidates
- similar labour market conditions
- living further away from university induces some individuals to give up education (but not the reverse)

variation in distance to university can be used to estimate *an* average treatment effect parameter

Illustration: instrumental variables

- As with all empirical methods, IV has some drawbacks
  - Exogeneity: may be difficult to find instruments fulfilling the conditions
    - Perceived future cost of university education may change education decisions earlier in life
    - Relative abundance of highly educated individuals may change the local labour market
  - Interpretation of the estimated causal effect
    - If the effect is homogeneous, then IV successfully identifies it
    - But this is unlikely to be the case in a loosely specified model linking education and earnings
    - With heterogeneous treatment effects, the causal effect identified by IV depends on the instrument and specific variation used for estimation
    - Who the compliers are and how their gains from university education compare to those of other potential treated is usually unclear
    - But crucial for interpretation

Empirical structural economic models

- Although interpretation problems are more obvious under IV, they plague other evaluation methods - including randomised experiments – when used to measure the effects of causes but not to understand the causes of effects
- Heterogeneity in the causal treatment effect is not a technical problem
- It is a reflection of the absence of a model embodying a theory of *why* the treatment affects the outcome
  - Education may affect earnings through a number of processes, including learning, signalling, social skills, social networks, confidence building…
  - If different effects are found for different groups, time periods or regions, it is rarely clear what drives them

Empirical structural economic models

- Structural economic models describe the behaviour of economic agents (individuals, firms, government) or/and the functioning of markets, strongly grounded on economic theory
- They shift the focus of estimation from the causal effect to the structural, invariant parameters
- The whole distribution of the causal effect can then be indirectly recovered from the model and interpreted
- A major advantage of this method is that the findings are generalisable and cumulative
- But it relies heavily on underlying behavioural (economic) assumptions: sensitivity analysis

Some of PEPA aims

- To explore data on randomised trials to learn about the performance of other evaluation methods
- And to test theoretical models for policy evaluation
- To develop the use of optimality conditions in theoretical models to estimate structural (invariant) parameters relying on weaker conditions
- To understand how empirical evaluation methods map into a behavioural model and how this can be used to synthesize information from different studies
- To develop evaluation methods for duration data