Experimental economics

Lecture 1: Economics as an experimental science

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Economics as an experimental science

- When you hear the word economics, what comes to mind? Do you picture formulas and graphs on a chalkboard? Wall Street traders? Or maybe politicians arguing about taxes?

- Now another question: Do you think economics is more like physics—a hard science that discovers universal laws? Or more like history—a social science that interprets patterns but can't run experiments?

- This question matters, because today's lecture is about the idea that economics can actually be an experimental science. That may sound strange—after all, you can't put an economy in a test tube. But as we'll see, economists have found ways to bring people into labs, into classrooms, even into real-world settings, and design experiments that test economic theories just like scientists test theories in physics or biology.

Experimental economics

- Economics is a “behavioral science” since it focuses on people’s decisions on the use of scarce resources. Since about the beginning of the twentieth century economics has stood apart from other disciplines dealing with human behavior in its broadest sense due to the fact that it uses formal mathematical models and abstract theories based on clearly defined assumptions.

- Economic research based on models allows the assumptions on which a scientific statement is based to be precisely stated in a mathematical sense, thus enabling us to very precisely specify the situation to which the theory is to be applied. The decisive factor here is that the formal method allows the conclusions that economists draw to be derived and proven from the assumptions with exactly the same precision. Economists can therefore make “if-then” statements whose clarity and precision would be unimaginable without formal methods.

- At first sight, economists pay a high price for the clarity of these statements. A real-world test of the theory is scarcely possible because the assumptions used in the models economists construct have a high degree of abstraction from the real conditions of the everyday economic world and because they use ideal-typical behavioral models. And what good is a theory that makes unambiguous and mathematically elegant statements if it is not possible to know whether these statements have any significance for economic reality? This “empirical weakness” is transformed into a strength when the possibility of verifying the theory experimentally.

Early Economics: Philosophy, Not Experimentation

- In the 18th century, economics was known as political economy, and it was part of moral philosophy. Adam Smith's famous book, The Wealth of Nations (1776), didn't rely on experiments or mathematical models. Instead, Smith reasoned about human nature, self-interest, and markets. His famous idea of the 'invisible hand' was a conceptual metaphor, not something tested in a lab.

- In the 19th century, economists like David Ricardo, Thomas Malthus, and John Stuart Mill also worked largely from reasoning and observation. Ricardo's theory of comparative advantage, for example, was a logical deduction, not an empirical experiment.

- Even Malthus's gloomy prediction that population growth would outstrip food supply wasn't based on experimental data—it was a logical argument. So for much of its history, economics looked a lot like philosophy: reasoning about human behavior, but not systematically testing it under controlled conditions.

Economics Becomes Mathematical & Observational

- Things began to change in the late 19th century. The so-called marginal revolution—led by Jevons, Walras, and Marshall—introduced mathematical models of supply, demand, and equilibrium. Economics became more precise and quantitative.

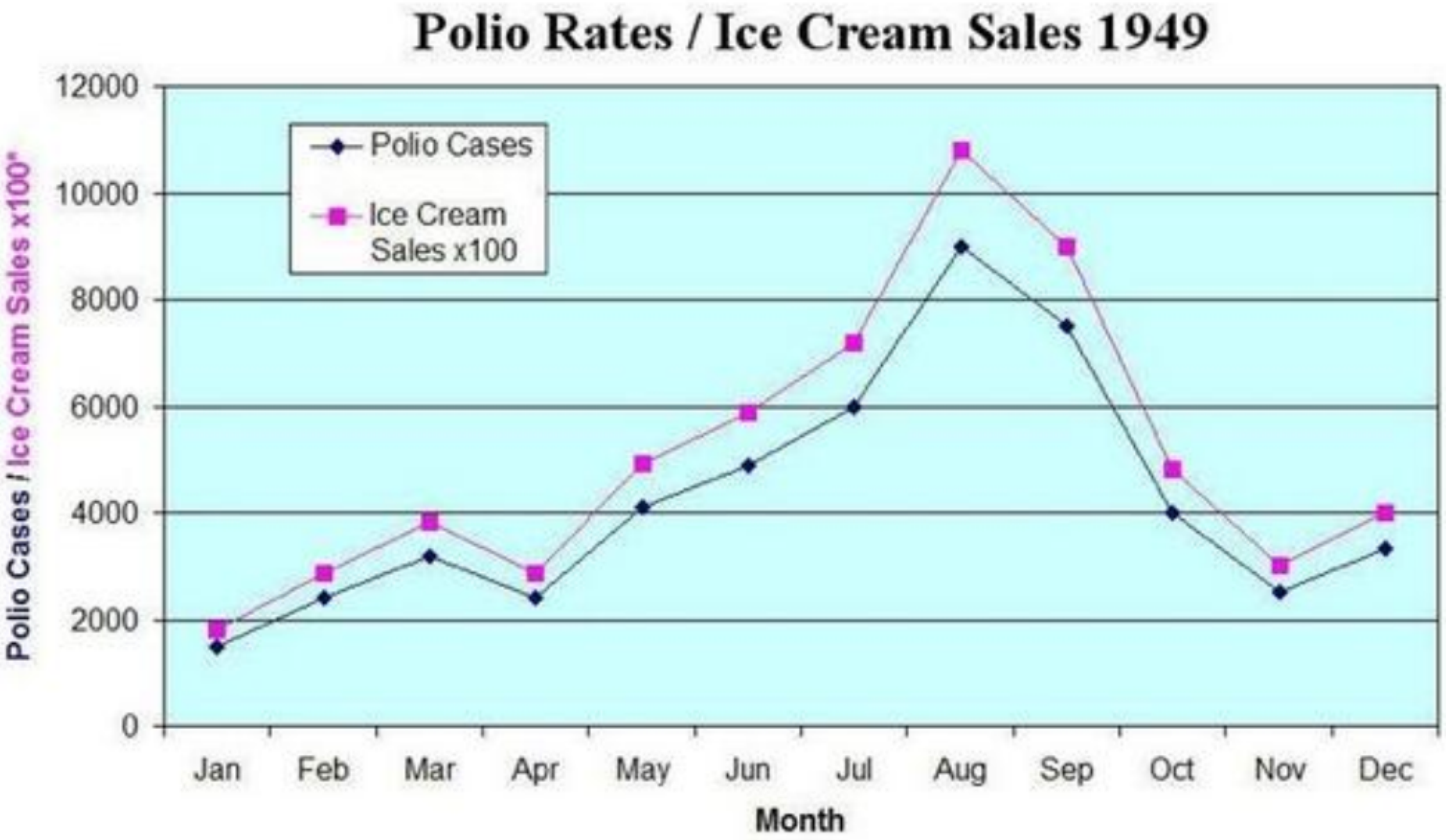
- By the early 20th century, economists started using statistics and data. Think of Simon Kuznets, who developed national income accounts, or Ragnar Frisch, who pioneered econometrics. Now, economics looked more scientific, but it was still mostly observational.

- Economists studied data the way astronomers study the stars: they could observe, measure, and model, but they couldn't intervene directly. This made it hard to prove causation. If two things moved together—say, wages and productivity—was one causing the other, or were both driven by something else?

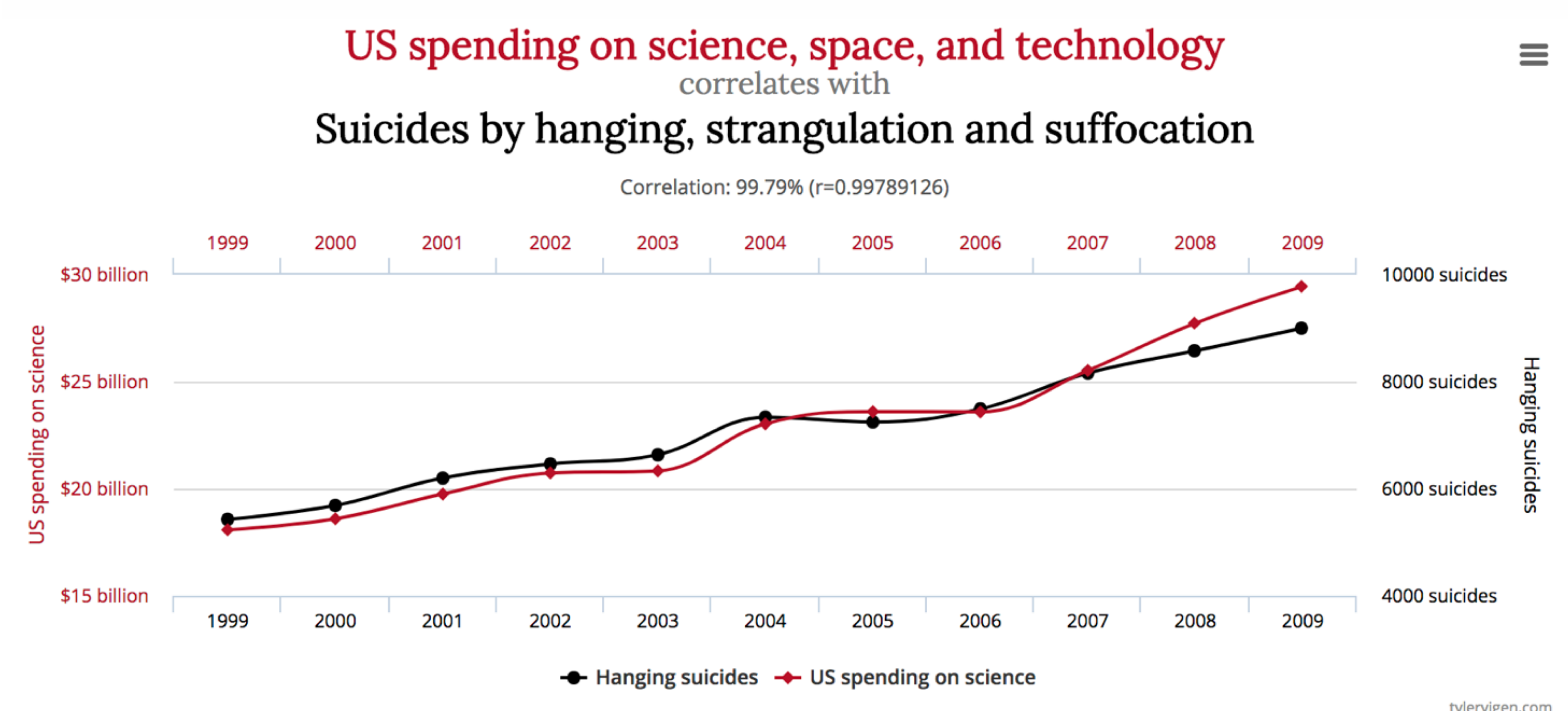
- "Economists (unfortunately) cannot perform the controlled experiments of chemists or biologists because they cannot easily control other important factors. Like astronomers or meteorologists, they generally must be content largely to observe." - Samuelson and Nordhaus (1985), Principles of Economics.

- "Experimental economics is an exciting new development." - (Samuelson and Nordhaus, 1992, p. 5)

The Real Cause of Polio!



Correlation vs. Causation



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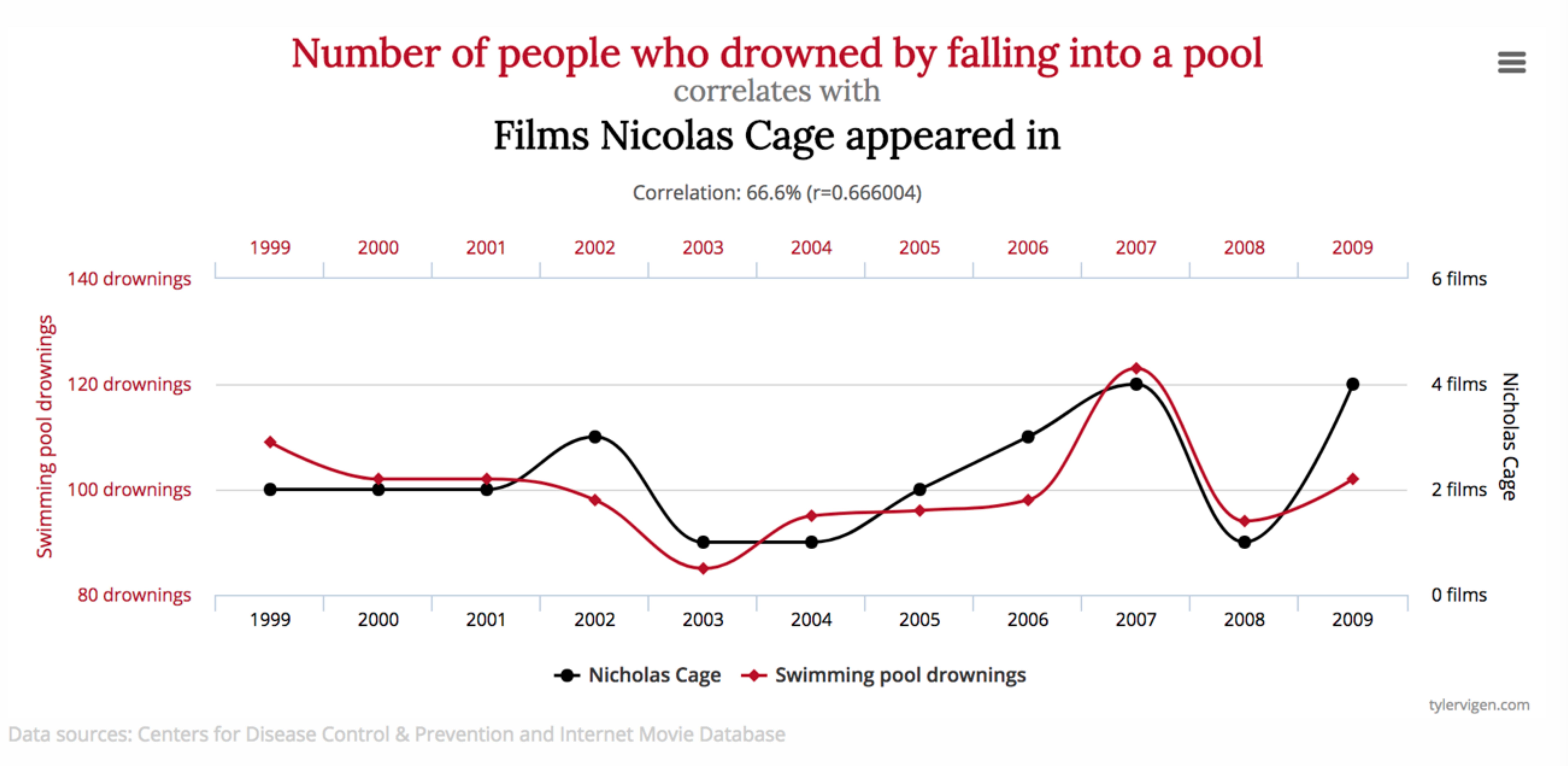


Correlation
Causality

Correlation Versus Causation

- The strength of association between two variables can be considered from a quantitative and qualitative point of view. In qualitative terms, the strongest relationship is a causal one. This means that the value of one variable causes a change in the value of another variable. For example, the force transmitted from one foot to a football is one of the reasons why the football flies so far.

- A correlation between variables is a qualitatively weaker form of relationship and exists when it can merely be observed that the increase of one variable is accompanied by an increase or decrease of the other variable. Even a perfect correlation does not necessarily mean that the variables are also causally related.

- For example, it may be observed that the amount of hair men have on their head and their respective income are inverse to each other, i.e. the less hair men have, the higher their income. If there were a causal relationship here, all men would probably shave off their hair in the hope of becoming richer. The actual causal relationship can be established easily if a third variable, age, is included.

- The older a man is, the more professional experience he has and, therefore, the higher the average income he earns. At the same time, it is in the nature of things that hair loss in men is also age-related. Age therefore has a causal effect on both the amount of hair and the average income of working men. Causation always means a correlation, but not every correlation means causation. To put it another way, if two variables are not correlated, there cannot be a causal relationship either. However, even if no causal relationship exists, there may well be a correlation.

- A simple statistical models merely measure the strength of a relationship and therefore provides purely quantitative information on the relationship between the variables. The relationship quantified by a statistical model is only ever causal to the extent that the experimental design, which was carried out in advance, has allowed it.

- Identification problem: given that two series are correlated, how do you identify whether one series is causing another?

    - Traditional Solution: Collect survey data on as many Z variables as thought might be relevant, and use econometric techniques to test for whether historical variation in X can predict variation in Y while controlling for variations in other Z variables.

Correlation vs. causation

- Research in labour economics shows that higher performance is usually observed in firms paying a piece rate rather than a fixed wage. But it is so because piece rates induce higher performance, or just the reverse: that firms with a piece rate compensation scheme attract higher-performance workers?
- Similarly, the likelihood of death and the time spent at hospital are strongly positively related in any population; do such data inform us about how dangerous hospitals are for health?
- The number of policemen in a geographic area is often positively correlated to crime rates; does it mean one should reduce police forces to contain crime?
- Unemployed people who receive more help from public placement agencies generally experience lower likelihood of finding a job; do placement agencies hurt the labour market potential of job-seekers?
- More examples:
  - Cholera in Russia
  - SAT preparation courses vs. test scores
  - Breast-feeding vs. malnutrition
  - U20 ice hockey rosters

Correlation vs. causation

- Historically, economics has relied on observation of naturally occurring processes for its data needs
  - Advantage: these processes are observed in their undisturbed form
  - Disadvantage: it is diffucult to establish causal relationships among observed variables since many of them are determined simultaneously
- Fundamental issue faced by those doing empirical work in economics: disentangling causality from correlation.We say that two economic variables are correlated if they move together. But this relationship is causal only if one of the variables is causing the movement in the other. The general problem that empirical economists face in trying to use existing data to assess the causal influence of one factor on another is that one cannot immediately go from correlation to causation. Knowing that two factors are correlated provides no predictive power; prediction requires understanding the causal links between the factors.
- Similar problems appear in public policies. For example:
  - Do lower welfare benefits cause higher labor supply among single mothers? Do larger benefits for unemployment insurance cause individuals to stay unemployed longer? How does minimum wage affect the employment?
  - Do education raise wages? Does class size affect learning?
  - Does access to information improve the market effectiveness?

Correlation vs. causation

- Analysis
    - Step 1: Document the correlation, that is whether data on two measures move together.
    - Step 2: Assess whether the movements in one measure are causing the movements in the other.
        - For any correlation between two variables A and B, there are three possible explanations, one or more of which could result in the correlation:
            - A is causing B.
            - B is causing A.
            - Some third factor is causing both.
    - Well designed research thus needs to make valid causal inferences. Ideally, such a design does three things:
        - 1. Covariation: demonstrates that the alleged cause (call it X) does in fact covary (corelate) with the supposed effect, Y.
        - 2. Time order: The research must show that the cause preceded the effect: X must come before Y in time. After all, can an effect appear before its cause?
        - 3. Elimination of possible alternative causes, sometimes termed "confounding factors”: The research must be conducted in such a way that all possible joint causes of X and Y have been eliminated.

Assessing causation

- SAT:
  - A -> B: SAT prep courses worsen preparation for SATs.
  - B -> A: Those who are of lower test-taking ability take preparation courses to try to catch up.
  - C -> A,B: Those who are generally nervous people like to take prep courses, and being nervous is associated with doing worse on standardized exams.
- Breast-feeding:
  - A -> B: Longer breast-feeding is bad for health.
  - B -> A: Those infants who are in the worst health get breast-fed the longest.
  - C -> A,B: The lowest-income mothers breast-feed longer, since this is the cheapest form of nutrition for children, and low income is associated with poor infant health.

The Turn Toward Experimentation

- In the mid-20th century, economists began to wonder: could we run actual experiments to test theories of markets and decision-making?
- Natural sciences had long done this. Physicists drop objects to test gravity. Biologists breed plants in different conditions. Could economists do the same with human behavior?
- Psychology provided inspiration. Pavlov's experiments with dogs and Skinner's studies of conditioning showed how controlled environments could reveal behavioral laws.
- In 1948, Edward Chamberlin, a Harvard economist, tried running classroom experiments with students playing buyers and sellers. He wanted to test whether markets reached equilibrium. His results were mixed, partly because his design wasn't strict enough.
- Enter Vernon Smith in the 1960s. He refined these experiments, added proper incentives—real money on the line—and carefully controlled the rules. What he found shocked many economists: even with small numbers of buyers and sellers, markets often converged toward the equilibrium predicted by theory.
- This was revolutionary. It showed that economic theory could actually be tested in a lab. Vernon Smith would later receive the Nobel Prize in 2002 for this work, helping establish experimental economics as a legitimate scientific field.

Experimental solution

- Naturally occurring processes often do not allow you to observe a key variable, separate the effects or infer causality. Only controlled variation allows for causal inferences.

- The solution? Create a decision environment that simulates the real world environment of interest, and randomly assign people between treatments in that environment where X is varied. Structure the design so that Z factors are either held constant across treatments, or else “average out” between treatments due to random assignment. See if Y varies across treatments as theory predicts.

- As researchers we can control the environment and the institutions and then observe behavior. The key idea of the theory is that the proper use of a reward will allow the research to induce specific characteristics in the subject, that he or she impersonates them and that his or her personal characteristics become irrelevant.

- Control: factors which influence behaviour are held constant and at most one factor of interest is varied at a time.

- We can implement truly exogenous ceteris paribus changes, discover clean causal links (causality), reproduce the structure of theoretical models - “two countries world” (counterfactuals), observe variables not observable in field data - e.g. subjective values, dishonest behavior, control and manipulate variables - e.g. double the number of competitors, or customers.

Golden standard for assessing causation: Randomized trials

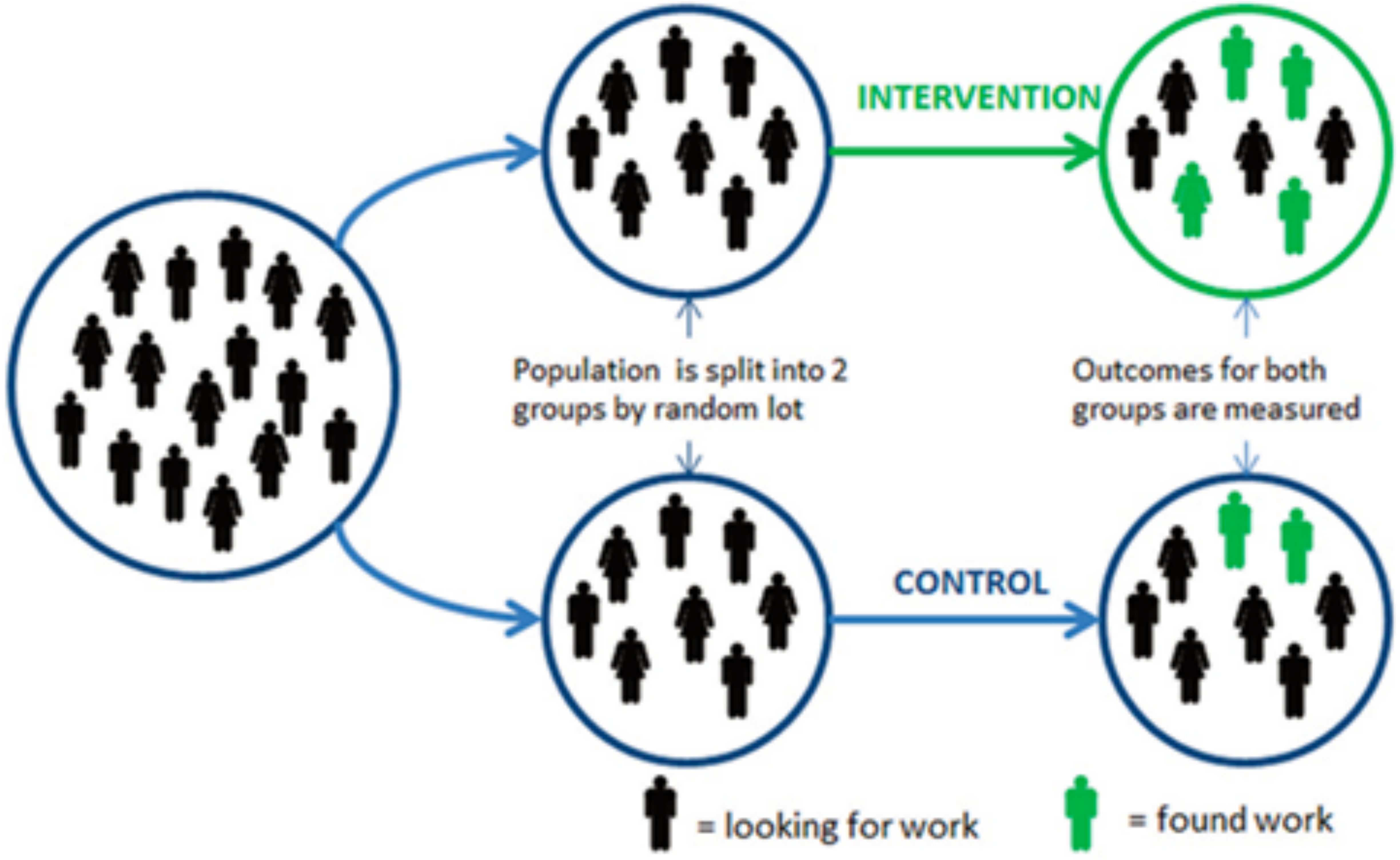

Figure 1. The basic design of a randomised controlled trial (RCT), illustrated with a test of a new 'back to work' programme.

The problem of bias

- We should always start our analysis of an empirical methodology with a simple question: Do the treatment and control groups differ for any reason other than the treatment?

- The non-treatment-related differences between treatment and control groups are the fundamental problem in assigning causal interpretations to correlations. We call these differences **bias**, a term that represents any source of difference between treatment and control groups that is correlated with the treatment but is not due to the treatment.

- By definition, such differences do not exist in a randomized trial, since the groups do not differ in any consistent fashion, but rather only by the flip of a coin.

- Thus, randomized treatment and control groups cannot have consistent differences that are correlated with treatment, since there are no consistent differences across the groups other than the treatment. As a result, randomized trials have no bias, and it is for this reason that randomized trials are the gold standard for empirically estimating causal effects.

- The description of randomized trials here relies on those trials having fairly large numbers of treatments and controls (large sample sizes). Having large sample sizes allows researchers to eliminate any consistent differences between the groups by relying on the statistical principle called the **law of large numbers**: the odds of getting the wrong answer approaches zero as the sample size grows.

Economics as an experimental science

- What exactly makes economics an experimental science?
- 1. Controlled conditions – Researchers design environments where key variables can be isolated.
- 2. Incentives – Unlike psychology experiments with points or tokens, economics experiments often use real money to ensure participants take choices seriously.
- 3. Randomization – Just as in medical trials, participants are often randomly assigned to roles or treatments.
- 4. Replicability – Experiments can be repeated in different labs, countries, or with different subject pools to test robustness.
- This is a major shift from observational economics. Observational data asks, “What do we see?” Experimental data asks, “What happens if we intervene?”
- Let’s take the Ultimatum Game as an example. Imagine you have $10. You must offer a share to another person. If they accept, you both get the money. If they reject, both get nothing.
- Standard economic theory predicts: you should offer as little as possible, and the other should accept—because something is better than nothing.
- But when this experiment is actually run, many people reject low offers out of a sense of fairness, even if it means getting nothing. This shows us that fairness norms matter, and that human behavior cannot always be reduced to pure rational self-interest. That’s the power of experimentation.

Philosophy of Science Perspective

- In 1950 Melvin Dresher and Merrill Flood devised a game based game-theoretical analysis on that has since then had a remarkable career in economics: the prisoner's dilemma. These two authors thought up this game with the intention of subjecting the concept of the Nash equilibrium to a particularly hard test (today this would be called a stress test).
- The closeness of the relationship between game theory and experimental research is also evident in the fact that a number of outstanding game theoreticians are among the early experimentalists. Expected utility theory and, as a consequence, also game theory use the notion of optimizing players who act strictly rationally as a basic premise. Beginning with the early experiments on the prisoner's dilemma of Dresher and Flood and the experiments that tested expected utility theory, the history of experimental research has also time and again been a history of findings that are at odds with the assumption of rationality. This does not mean that experiments always show non-rational behavior, but it occurs relatively frequently.
- From the perspective of philosophy of science, why does this matter?
- Karl Popper argued that a science must be falsifiable: it must make predictions that could be proven wrong. Experiments in economics make this possible. They allow us to test not only predictions, but also the assumptions underlying theories.
- Contrast this with Milton Friedman's view in 1953. He argued that it doesn't matter if assumptions are unrealistic—as long as predictions are accurate. For example, even if people aren't perfectly rational, models treating them as rational may still predict market outcomes well.
- Experimental economists disagree. They believe we should test assumptions directly, not just outcomes. If people care about fairness, or are influenced by framing, that changes the way we think about markets and policy.
- Do you think it matters if assumptions in economic models are realistic, or only if predictions are accurate?

Experimental economics vs. behavioral economics

- Behavioral economics: research programme aimed at improving economic analysis using realistic psychological assumptions about human behavior.

- Experimental economics is not a reseach programme. Reather, it is a research method based on experimental control, applied to the typical topics in economic analysis. However, it is particularly suited for the study of the phenomena of interest to the behavioral economics.

- Both behavioral and experimental economics owe a great deal to the accumulated knowledge in experimental psychology. Controlled experiments have been used for a long time in this field and most methodological discussions took place before they even appeared in economics.

Experiments in economics

- It is mainly thanks to two important characteristics that experiments are so well suited to testing formal theory. First, experiments make it possible to vary the conditions under which decisions are made in a targeted and controlled way. The experimenter is in control of what information he provides the subject, and can thus systematically investigate what influence the extent to which the decision-maker is informed has on the decision.

- This possibility to adjust the variables that are important for behavior in a controlled way represents a second very important feature of experiments. It allows the researcher to pose the question that specifically interests him and to gather the data that is specifically relevant to this question. He is not reliant on economic reality to provide the data he requires to investigate a particular issue. Rather, he is in a position to generate the data to virtually every question that can be asked.

- This means, though, that the opportunities offered by experimental research go beyond merely verifying theories. It can also be used to search for stylized facts, regularities in behavior that have not, at least not yet, been described by theories. By this means, explorative experiments yield observations that could provide valuable information as to how successful behavioral theories can be descriptively formulated.

Experiments in economics

- The range of application of the experimental method is therefore not limited to those areas determined by existing theories. Roth (1995) once aptly described this by attributing three main functions to experiments. They can:
  - “speak to theoreticians” by testing theories, helping to find new theories and establishing causal relationships
  - “search for facts” by uncovering stylized facts, for example investigating gender differences in attitudes toward risk and competition, or comparing efficiency of various market institutions
  - “whisper in the ear of princes”, i.e. they can be used to provide policy advice

Testing theories

- Theoretical models rely on behavioural assumptions to provide an understanding of the decisions of agents, and the resulting outcomes, induced by a given environment. They do so by restricting the economically relevant situation to a few key features.

- For example, auction models reduce the auction environment to marginal values for the good, prices and monetary benefits. Based on the assumptions of utility maximisation and the axiomatic underlying the game-theoretic analysis of strategic interactions, it yields clear-cut predictions of both bidding behaviour and the properties of the resulting allocation.

- Experiments exhibit two major advantages in that regard: the ability to both build an empirical situation that mimics the theoretical model, and measure or observe usually non-observable, or hardly measurable, dimensions (such as individual preferences towards the good, or individual prices posted). Experiments also get theory closer to reality by providing measures of individual preferences.

- Experiments not only allow us to assess whether the theoretical account of preferences actually makes empirical sense (e.g. to what extent is behaviour in risky environments actually described by the assumptions of expected utility), but also to assess whether predicted behaviour based on such preferences coincides with what theory predicts. In all these instances, experiments help in assessing the empirical relevance of theoretical results in terms of accuracy, precision and extent.

Searching for facts

- There are many economic situations that are worth understanding, but which are too complicated and/or too specific to be covered by theory.

- Auctions again provide a useful illustration of such experiments: as the allocation mechanism, or the amount of information available to bidders, becomes more specific, auction models quickly become intractable. This does not mean, of course, that such specific auction markets are of no economic interest (even when there is no obvious reason why a market works as it does, the mere fact that it is used in practice is sometimes enough to make it worth investigating).

- In such cases, experiments can be used as a substitute for theoretical analysis. They are used to ‘search for facts’ in the sense that they allow us to mimic well-defined situations and measure behaviour as well as the outcomes they generate.

- In the absence of prior expectations based on theory, such observations provide empirical knowledge about how the environment works, and what are its most sensitive features. To serve this purpose, such evidence must be robust and conclusive enough to actually serve as a stylised fact. In that regard, the replicability of experimental data, and the possibility to assess the robustness of the results through variations of the environment, are important advantages of experiments.

Whispering in the ears of princes

- This third purpose of experiments amounts to improving the decision-making process by informing regulators or decision-makers (Roth's 'princes') of the likely outcomes of new or existing public policies. The general principle is to use experiments to test-bed decision environments such as market mechanisms, policy changes or new organisational structures.

- Observed outcomes in the experiment provide insights into the likely changes in behaviour and economic outcomes raised by innovative decision environments. As such, this aim builds on the ability of experiments to both test theory and search for facts – depending on whether theoretical insights are available on the policy-relevant question under investigation.

- The specific contribution of experiments to policy design comes from the ability to answer the specific needs of decision-makers. Because all the parameters of the decision environment can be freely set in the laboratory, an experiment makes it possible to fully replicate the specific features of a given policy.

- This ability to fine-tune the experimental environment according to the requirement of the policy-relevant questions stands in sharp contrast with observational data. As compared to field experiments, laboratory experiments are cheap and easily implementable. An additional contribution of the use of experiments to policy design is their use in an instructive function. Laboratory experiments make economic reasoning more intuitive and appealing for non-academics. Even without producing any new knowledge, they can be used to make a convincing case of what the consequences will be of an intended change in the environment.

Conclusion

- To sum up: economics began as philosophy, transformed into a mathematical and observational science, and in the last half-century has embraced experimentation.

- This raises deep questions:

- Can experiments with students in labs really capture the complexity of global markets?

- Should governments use insights from behavioral experiments to design policies—what some call ‘nudges’?

- And is economics ultimately about universal laws, like physics, or about understanding human behavior, like psychology?

If you get this, you are ready for exam