Introduction to Empirical Social Research

Summer Term 2020

Thomas Plümper
Professor of Quantitative Social Research
thomas.pluemper@wu.ac.at

Q&A to Chapter 1
Theories and Evidence
Chapter 1: Theories and Evidence

Participant Questions

How are predictions a logical consequence of assumptions?

If theories are formalized, the answer is simple: predictions can be shown to follow from assumptions by a chain of mathematical transformations. If theories are not formalized, we cannot check whether the predictions follow logically, in a consistent way from the assumptions. Unfortunately, not all theories are consistent and not all scholars clearly state their assumptions. In these cases, hypotheses (prediction) appear out of thin air. There is also another issue, in many cases, predictions are logically indistinguishable from assumptions. This is called a tautology, but it is not always easy to detect. Finally, consistency does not make a theory right, inconsistency merely makes it wrong.

Regarding the testing of theories: could you elaborate a bit on why we often cannot test the existence/relevance of the causal mechanism, but can only test the predictions? In these cases, are both the “cause” and the event it potentially causes being observable, but we do not have more information available? (and since correlation does not ensure causality, we cannot test the causality?)

Good question. Take a simple political science theory that explains the (effective) number of parties in parliament to the electoral system: the effective number of parties is larger in proportional electoral systems than in majoritarian electoral systems (in a probabilistic sense, it is possible to find proportional systems with few parties and majoritarian systems with many parties). The prediction is clear and testing the prediction is also clear. However, there are numerous causal mechanisms for this theory, including aversion to waste a vote on a party that does not make into parliament, the choice of platforms by the party itself, abstention if not party is sufficiently close to an individual’s ideal point, and so on. It is certainly possible to ask a few voters why they voted how they voted, but it is not clear (a) whether they fully understand their motives, (b) how they aggregate multiple motives, and (c) how heterogeneous voters actually are. Hence, it is simple to test the prediction, not simple and perhaps not possible to test the causal mechanism(s).

Simplification is an important “tool” in scientific work. Should simplification be limited to the assumptive elements of theories or is it also allowed/practical to use simplification in the elements of causal mechanisms and predictions?

Theories simplify reality. There is no exception. Theories simplify by (i) singling out a phenomenon which in reality depends on, and has repercussions to, other phenomena, (ii) making simplifying assumptions
that reduce the dimensionality of phenomena, (iii) reducing causality to a single or a few causal mechanisms. Simplification is necessary, but varied, as there are always better and worse simplifications.

According rational choice theories: Aren’t these theories the "best" in order to make neutral assumptions or am I getting something wrong here?

The term rational choice theory is used in two different ways. First, it is used for a set of behavioral assumptions on how individuals make decisions. By maximizing expected utility. This assumption is the best assumption about individual behavior if we do not allow heterogeneity in a population. If we assume that ‘all’ agents behave identically, rational choice assumptions have the best fit to experimental observations. However, we can improve on rational choice assumptions by allowing for different maximization strategies in a population. Social scientists hardly do this because it largely complicates models, makes predictions less clear, and does not contribute much. Second, the term rational choice theory is also used for genuine theories which use rational choice assumptions. It is of course possible and easy to combine behavioral assumptions with a causal mechanism, and as a result you get a parsimonious theory that has predictive power.

In the slides it says that "if something cannot be expressed by an arrow diagram, it is not a theory". What is the reasoning behind this? Is it because of the prerequisite that theories always have to describe some kind of relation (which can be expressed by an arrow)?

Causal diagrams visualize causal relations between variables. Here is an example from Pearl’s Causality:

Each node represents a variable, each arrow a causal direction. Thus, x1 causally influences x3 and x4 and it influences xi through these two factors and only through these two factors. Note that these are theories, and could be wrong. In any case, the diagram would tell us how we have to estimate the determinants of xi: In a simple model we would only have to use x3 and x4 as regressors, in a structural equation setting we would also control for x1 and x2 on a higher level than x3 and x4. Thus, arrow diagrams can be used to visualize any causal notion of a relation between factors which are causally related. Thus, if there is something that cannot be arrow diagrammed, it is not a causal relation.

**Why do many theories in the social sciences only one prediction?**

Great question. I do not know, really. I believe it is partly, because social scientist start with what they want to explain and do not think about the consequences of their model/theory. It is also because broader theories have frequently failed in the social sciences.

**How should we handle theories where the ability to scientifically prove or disprove them is technologically still far removed from today. An example for this would be Einstein’s Gravitational waves, where it took 100 Years to find definitive proof. How would we have to act, if a theory is produced, where we know that finding proof will take thousands of years.**

Scientists cannot ‘prove theories’ right – maybe they can disprove theories (read Popper about the logic of falsification). Even in the case of gravitational waves: relativity predicts the existence of gravitational waves. Eventually, we could demonstrate their existence. But this does not prove relativity as right, as many more theories, even very different ones, could predict the existence of gravitational waves. Empirical results at best provide evidence in favor of a theory. From a Bayesian perspective, this evidence should change scientist beliefs that the theory is correct, but neither the evidence nor the belief is a proof. Einstein is a good example here, because the theory of relativity was pretty much untestable on the day it was formulated. At least, nobody knew how. Meet Arthur Eddington, then the arguably best empirical researcher at Cambridge University, who came up with a great idea to test Einstein’s model against Newton’s. All that was needed was an eclipse of the sun. [https://en.wikipedia.org/wiki/Arthur_Eddington](https://en.wikipedia.org/wiki/Arthur_Eddington)

What this should tell you is that a theory is a theory if it can be tested, not if it has been tested. Falsifiability is the criterion that separates science from pseudoscience, or as Wolfgang Pauli said: if a scientific statement cannot be tested, it is not even wrong. [https://www.theguardian.com/science/2005/sep/19/ideas.g2](https://www.theguardian.com/science/2005/sep/19/ideas.g2)
**Are there no theories that cannot be falsified?**

Not if you define theory scientifically. A theory has three components: assumptions, a causal mechanism, and predictions. If a theory makes predictions, it can be tested. If a ‘theory’ does not make predictions, it cannot be tested. But then it is also not a theory, because a theory is defined by assumptions, mechanism, prediction. Unless you prefer Babylonian confusion over clarity, it makes sense to stick to this definition.

So what about prescriptive theories? These are, contrary to the beliefs of many, not really a problem, because normative theories have a causal core: *if you want to achieve y, you have to do x*, makes two positive and testable statements: first, x leads to y. And second, there is no z that also leads to y. Of course, you can use the term ‘theory’ differently, i.e. for idea or ideology or beliefs. But broad definitions usually lead to confusion and should be avoided.

**What is a normative (prescriptive) theory?**

This clearly should be known (at least that is what I thought…).

In the social sciences:
- Prescriptive theories (also called normative theories) are concerned with guidelines that describe what to do in order to achieve specific outcomes.
- In contrast, descriptive theories (also called positive theories) are concerned with characterizing and explaining regularities in the choices that people make.

**How exactly is the term falsification to be understood?**

Falsification means providing evidence that a theoretical claim is wrong. That is easy for deterministic relations: in order to show that if x then y is wrong, we need to find just one x that did not lead to y. Bullet in the head causes death. Find one survivor. Done. It is way more difficult with probabilistic theories, but not impossible and we return to this question.

**Regarding the criteria for ‘predictions are correct’ (slide 34): What is meant by “identification” and “replicability”?**

An estimated effect is identified if it is impossible (or perhaps extremely unlikely) that it has been caused by some other factor.

An empirical result is replicable, if another identical study finds substantively the same result. It is easy to think about this in terms of an experiment. We can conduct an experiment with 100 participants in many different labs in different countries with different participants. Do we get results which are statistically different? If so, the results are not replicable.
If a theory leads to a prediction which later is proven wrong by observation, is there a specific method of going forward, especially if there are contradicting results?

These are two partly independent questions. If a theory is in fact proven wrong, just bury and forget it. The world is not flat. Contradicting results pose more problems. Bayesians (like me) argue that you should not be very confident that a theory that is associated with some supportive and some contradictory evidence is correct. But it is also not necessarily wrong. Perhaps it oversimplifies. Then you can make it more complex (though that is not usually a good idea). Perhaps you can limit it to certain set of cases? A good example is Newton’s theory of gravity. It makes wrong predictions for high speeds. Thus, you would not be able to land a spaceship on an asteroid based on Newton. But you can build a bridge based on Newton even though it is wrong. No problem. But being useful for some identifiable cases does not make it right.

This is not a question but more of an observation, didn’t Rudi Dutschke eventually die from the Brain damage that was inflicted by the Gunshot wound?

Depends on your concept of cause and effect. Dutschke drowned in a bathtub, because he had an epileptic seizure, which has been associated with the gun wound. But he did not die of the shot and wound, and the shock. He died 1 years after the attack because he drowned. If you allow long range cause and effect constructions, then of course you would be willing to argue that Dutschke died because of the big bang. At the very least, he would not have died without the big bang. Thus, many scientists prefer to avoid infinite regresses when identifying causal relations. If you do this, then Dutschke died of drowning. But as I said, it is a matter of taste.

How is the Bayesian philosophy of science useful for practical research? A researcher would analyse existing literature for a topic and then decide which theories to base his research on and which to disregard. I have not seen a paper that would assign percentages of belief to theories.

Good question. Bayesian philosophy of science should perhaps not be taken too literally. But the logic holds: assume you have a theory and very little empirical evidence. The theory is consistent and plausible. But does it make correct predictions and does it identify a relevant causal mechanism? You do not know, because you have no evidence. But you still may have a belief, let’s assume you believe that with 80 percent certainty, the theory is correct. Take the question whether the corona infections decline in number as the outside temperatures increase. Plausible? Yes. Correct? We do not know. So if you are a scientist, you may believe it, but you put a lot of uncertainty on your belief. Now somebody published evidence. This should have two effect on your priors: the uncertainty declines, because you have a little evidence, but the uncertainty does not go away entirely. And you should potentially change the level with which you think the theory is correct (in predictions and mechanism). If the
evidence supports the theory, you move it closer to a 100 percent, but not to 100 percent because you have very little evidence. If the evidence runs counter to the theory, you reduce your prior and settle on a posterior that is lower. But not 0 percent, unless the evidence kills the theory.
If you think like this, you are a Bayesian. If you believe a theory is either right or wrong, you are at best a Popperian, but a true Popperian would only believe that a theory supported by evidence has not yet been rejected. Hence, supportive evidence means a lot for Bayesians but not for Popperians.

*How can the possibility be avoided that useful theory is rejected when using the Ockham’s razor?*

We do reject theories because of Ockham’s razor. We simply use less complex theories if the explanatory power of different theories does not vary much. This even includes wrong but simple theories such as Newton’s theory of gravity. It is simple, it is elegant, it makes wrong predictions for particles, waves and bodies that move at high speed. But that does not mean we cannot use it for slow particles and bodies.

*Popper believed that a single deviant case falsifies a theory. So accordingly, did he not distinguish between deterministic and probabilistic theories?*

Popper was not really a determinist. However, where he discusses falsification, he clearly uses deterministic claims as examples. For example, the claim ‘all swans are white’ is obviously deterministic – the probabilistic variant would be most swans are white. He used this to argue that a single deviant observation falsifies a theory.
However, a single deviant observation only falsifies deterministic theories, if theories are probabilistic single observations imply nothing.

*Could it be argued that only deterministic theories are "complete"? In other words that probabilistic theories just aren't sophisticated enough to account for all relevant variables.*

Another great question. Very clever. Could be, absolutely yes, but we do not know. Perhaps everything is deterministic and probabilistic theories are merely simplifications of a deterministic theory. But I would say that theories ought to simplify. A theory which is as complex as reality is pretty useless. Hence, we want theories to be probabilistic.

*If economics is a social science and thereby theories are probabilistic, how can neoclassical Theories claim universality?*

One should not confuse universalistic theories (all theories are universalistic given the population is specified) with probabilistic theories. A probabilistic theory can be valid
for all cases in the specified population and yet can be probabilistic. Clearly, Dutschke belongs into the population: he can die from a gunshot to his head. Yet, he did not, at least not for the next years to come.

*Can the scientific method really be free of all personal priorities? How can a scientist really get rid of all his personal views?*

Yes, of course. You just need a theory, an empirical model to test the theory, data, an appropriate method, and a belief in the results. I have dropped many of my ideas, and I did not drop others. If one cannot separate scientific results and ideological priors, one is not a scientist. Take the example of Paolo Macchiarini. [https://en.wikipedia.org/wiki/Paolo_Macchiarini](https://en.wikipedia.org/wiki/Paolo_Macchiarini)

He presumably killed quite a few people, because he strongly and against all evidence believed in his own theory. Clearly, when it comes to life and death, you want to place your life in the hands of a true scientist, not somebody who does against all evidence belief in his or her priors. Luckily, people that throw away their own ideas, if evidence suggest that this is a sensible idea, do exist. Whenever you talk to a scientist, ask what kind of evidence would be sufficient to falsify the theory. If the answer is none, then it is not science.

**Participant Answers**

*How are positive (predictive) and normative (prescriptive) theories related to each other?*

I think there are two ways in which positive and normative theories are related: Firstly, positive theories can serve as basis for a normative one. For example, if the positive theory predicts a desirable outcome for a certain measure there is a corresponding normative theory that states that this outcome actually is desirable and that therefore one should set the measure. Secondly a normative theory can account for a motive for humans to act in a certain way. Taking this motive into account can provide a positive theory predicting that people will act according to the normative claim (though the positive theory would probably have to show that the agents are going to recognize the normative claim and act upon it).

TP: The first argument (‘way’) is very convincing. However, I doubt that normative theories necessarily account for the ‘motives’ of human deciders.

*In the absence of any causal mechanism, that is: if everything is random, what do we expect to see?*
I think we can compare it to rolling a coin. We do not know which outcome will occur, we cannot predict it, but there will be a regular distribution over many repetitions. E.g. you have approx. 50% chance/probability to get a head on the coin. Probability of an outcome is the proportion of times the outcome occurs over a long series of repetitions. And we can gain the probability from e.g. observation, experiments.

TP: We definitely do not expect to see that everything is identical. We expect to see that variation is entirely random.

**Are causal effects stable over time and space?**

In social sciences – No. Society changes and so does our behavior. One thing that might have been true in the past is not necessarily true in the present or the future, even if it had been a significant part of the lives of people before us. On the other hand, say in natural sciences, causal effects might be stable. In this case, say in physics, a theory is more stable across time, as the theory itself also “includes” more time – possibly from the beginning of time until forever. This is not possible in social sciences. In social sciences we can only look at a relatively smaller time frame. So, to conclude the answer to the question: It depends at which causal effect we are looking, but they are not necessarily stable.

TP: In my opinion it's yes and no. I think it is the best case if you can find an ultimate causal mechanism which is stable over time and space, but I think it’s more realistic that different cultures in different spaces and in different times of history influence causal mechanisms (especially in social science, but also in other sciences as we are always biased from our surrounding and may have different methods and possibilities to do research over time and space). Another important point is that we cannot predict the future perfectly. We can do good analysis and have high probabilities of what is going to happen, but we can never be 100% sure and so there is always a part of uncertainty that causal effects are stable (even if they were 100% stable over time and space up to this point).

**Do causes have identical effects in all cases/circumstances?**

No because causes are dependable of its circumstances. For instance, when a bullet flies to the air into a tree nothing would happen to me, but if a bullet flies through my head, the effect would be most likely my dead.

TP: I agree effects depend on circumstance, but I am not sure what to make of the example. Perhaps the bullet is not the cause, but the cause of dead is bullet in the head. Still, most ‘causes’ in the social science have effects that depend on other factors, factors that we call conditioning factors.
Deterministic theory is universally valid for a set of cases. Probabilistic theory is not universally valid (all social science theories are probabilistic).

TP: There is an underlying issue here. Probabilistic theories can be valid, even universally valid. Let’s assume we have a theory that predicts that 80 percent of individuals respond to a certain stimulus. This is a clear testable probabilistic prediction. And it can be exactly correct. This at least does not allow us to reject the theory. It does not allow us to make a correct prediction about a single case with certainty. This is the nature of probabilistic theories. We need a sample to test them. If we agree that all social science theories are probabilistic, case studies are useless to test theories – a single case does not tell us anything about the ‘validity’ of a theory. This is why qualitative methodologists usually to not recommend qualitative methods as tool of deductive research.