Ceteris paribus Clauses, Closure Clauses and Falsifiability

INGVAR JOHANSSON

Summary

The article argues that *ceteris paribus* clauses have to be separated from another type of clauses called closure clauses. The former are associated with laws and theories, the latter with test situations of a particular kind. It is also argued that closure clauses, but not *ceteris paribus* clauses, make Popper's falsifiability principle untenable. In that way, it also resolves the quarrel between Popper and Lakatos about *ceteris paribus* clauses and falsifiability by saying that both are partly wrong and partly right.

Much has been written about *ceteris paribus* clauses. I have myself earlier argued that *ceteris paribus* clauses have to be presupposed when a causal relation is tested, but not when a correlation is tested. In chapter IV: 4 of my book *A Critique of Karl Popper's Methodology* (Stockholm 1975), I also contended that when *ceteris paribus* clauses are necessary Popper's falsificationism is untenable. I still believe that I was on the right track in the book, but today my view is that there are two completely different kinds of clauses: One associated with laws and theories (whether regarded as correlations or causal relations), the other associated with test situations (where superposition principles are involved; which is always the case in connection with causal relations). The former kind of clause I shall call *ceteris paribus clause*, the latter one *closure clause*.

The two kinds of clauses just mentioned have, in my opinion, often been confused in discussions concerning *ceteris paribus* clauses and falsifiability. I am not thinking primarily of myself, but of Imre Lakatos. In his famous *Falsification and the Methodology of Scientific Research Programmes* he says that "even a most respected scientific theory, like Newtons's dynamics and theory of gravitation, may fail to forbid any observable state of affairs", and that this is due to a *ceteris paribus* clause. (p. 101.)

CETERIS PARIBUS CLAUSES AND FALSIFIABILITY

Universal correlations are obviously falsified by merely one counter-instance. If we assume a universal correlation for gases to the effect that the pressure (p), volume (v) and temperature (t) of gases always satisfy the equation '$(p \cdot v)/t$ = constant', then the existence of a gas with a p, v and t not satisfying this relation entails that the correlation, as a *universal* correlation, is falsified. I disregard for the moment all problems connected with the verification of singular statements. Singular statements will falsely be considered completely unproblematic.

Zeitschrift für allgemeine Wissenschaftstheorie XI/1 (1980)

When the universal correlation '$(p \cdot v)/t$ = constant' is falsified, there are two options. The equation can either be modified or completely rejected. If a *ceteris paribus* clause is attached to the correlation, it must mean two things: a) that the correlation is not regarded as a *universal* correlation, and b) that the correlation should not be completely rejected, i.e. it is valid within certain limits. A counter-instance only means that a relevant variable has a value which makes the correlation inapplicable. Everything else (*ceteris*) is not the same (*paribus*), as it should be if the correlation is to be applied. Popper has only once explicitly discussed *ceteris paribus* clauses, and then only in a footnote in his "Replies to my critics" in *The Philosophy of Karl Popper*. It reads as follows:

> No *ceteris paribus* clause is necessary. I do not wand to get involved in the morass of a discussion of these clauses; but I must say that I hold that most of the discussions of *ceteris paribus* clauses and all of the appeals to them are misleading. As a condition or antecedent, the clause "*ceteris paribus*" (all other things being the same) is, of course, never satisfied in this world. Such an antecedent would therefore empty a theory to which it was attached of any empirical content. Where use is made of such clauses in the social sciences, what is intended is to say that the *relevant* circumstances should not change. Yet what is relevant or irrelevant is a matter of risky *conjecture* (and such conjectures will be the more interesting the more specific they are, and the more testable they render the original theory). I therefore suggest that *ceteris paribus* clauses should be avoided and, more especially, that they should not be imported into the discussion of the methodology of the natural sciences. (pp. 1186–87)

In one sense Popper is right, in another he is wrong. If one is only interested in strictly universal statements, and whether these are falsified or not, then *ceteris paribus* clauses are superfluous and Popper is right. But if, in addition to this, one is also interested in the process which takes place between the refutation of a universal correlation and the formulation of a new conjecture, then *ceteris paribus* clauses cannot always be dispensed with. In this process a ceteris paribus clause means that the new conjecture should preserve or include the old correlation. The abuse of this kind of *ceteris paribus* clause consists in using them to preserve the old correlation without ever trying to formulate the limits within which it should hold, i.e. without trying to formulate a new strictly universal correlation. But the *possibility* of abuse of a thing is quite consistent with the notion that the thing itself may nonetheless be of great avail.

In today's science, the word 'ceteris paribus' is explicitly used in economics, usually meaning that a proposed regularity is meant to hold only under certain given assumptions. 'A rise in price causes a decrease in demand, *ceteris paribus*' means that the effect is to be expected only if, for instance, the income is distributed a certain way, the total income does not exceed a certain amount, and so on. This also applies when *ceteris paribus* clauses appear only implicitly, as, for example in theories which are said to be theories devised for 'the short run'. This means that there are unspecified variables which really affect the outcome, and that the proposed regularity is not a strictly universal one, but that these variables remain approximately constant in the short run.

CLOSURE CLAUSES AND FALSIFIABILITY

In the natural sciences there is, besides laws and theories, something called superposition principles (in the social sciences they are called aggregation rules), i.e. principles which tell how magnitudes like masses, velocities and forces are to be added. Superposition principles have to be regarded as empirical laws, not as a priori principles. This should be clear from Einstein's rejection of the ordinary superposition principle for velocities. (If a solar system moves away from us with a velocity v_1, and if, in relation to this system, a planet moves with a velocity v_2, then, according to classical mechanics, the planet's velocity in relation to us equals 'v_1+v_2', but, according to the theory of special relativity it equals '$(v_1+v_2)/(1+(v_1 \cdot v_2/c^2))$'.) In actual science, I think an isolated superposition principle is never tested; what is tested, rather, is a whole theoretical system which includes the principle in question. Let us, however, for the sake of the argument see what the situation would look like if one were to perform such a test.

Assume we are going to test the superposition principle for forces, i. e. the principle saying that the resultant force F = the vector sum of F_p, where F_p are the partial forces. If the law '$(p \cdot v)/t$ = constant' is to be tested, it is obvious that one has to ascertain the truth of exactly three singular statements: one about pressure, one about volume and one about temperature. This holds for every test independently of time and place. When the superposition principle is to be tested the situation is different. We know that there should be exactly one singular statement referring to the value of the resultant force, but we do not know how many singular statements we have to have about partial forces. Of course, the superposition principle entails that we should take all forces into account, *but it does not tell us how many there are.* The principle could be written $F = \sum_{p=1}^{n} F_p$, where n is a number which varies from on situation to another. There is no definite number of partial forces common to all situations. This means that a test of the principle encounters a problem which is totally absent from a test of the gas law mentioned above, viz. the problem of how many relevant singular statements there are in the test situation. We have to close the situation; we have to decide in some way how many partial forces there are. We have to introduce a *closure clause* saying that there are n_1 (n_1 is a definite number) partial forces, and that there are *no more* than n_1 partial forces.

Now suppose we have been able to test the superposition principle and stumbled on a counter-instance. We take it for granted that we have not made any mistakes when measuring the resultant force or any particular partial force. Do we then have to say that the superposition principle is falsified? No, we can make the conjecture that we have not taken *all* the partial forces into account. One counter-instance cannot be regarded as a falsification of the superposition principle, unless we have made up our minds as to how many partial forces there are. And this means deciding both how *many different kinds* of forces and how *many forces of each kind* there are. Well-known examples of such closure clauses having been contested abound in the history of science.

In classical physics, Newton's three laws of motion and the superposition principle were complemented by laws specifying different kinds of forces, best-known being the law of gravitation. When Newtonian theory, including the gravitational law, was applied to the planetary motions, the actual orbit of Uranus did not coincide with the predicted one. This counter-instance, as is now said in every text-book in the philosophy of science, was not and should not be regarded as a falsification of Newtonian theory. The theory was saved by the discovery of Neptune. This discovery meant that there existed a neglected partial force acting on Uranus. The prediction was not incorrect because *any* of the laws in Newton's theory were wrong. What was wrong was the supposition that all relevant initial conditions had been taken into account. The closure clause attached to the prediction was wrong.

The superposition principle can add any kind of forces, not only gravitational ones. This means that a counterinstance can also be questioned by investigating whether there are completely different kinds of forces at work. In this way, the so-called forces of weak and strong interaction were discovered. The gravitational and electromagnetic forces could not account for all phenomena in nuclear physics, and so new kinds of causal factors were introduced. The old laws were neither rejected nor modified. The closure clauses employed were declared false, and were modified.

According to Popper, a scientific law can in principle always be falsified by a conjunction of singular existential statements, i. e. statements of the form 'There is a so-and-so in the space-time region k'. To be able to maintain that the existence of closure clauses seriously affects Popper's falsifiability principle, one has to show that there are closure clauses which are not singular existential statements in Popper's sense. That some closure clauses can be regarded as such statements is obvious. Consider, for instance the superposition principle for masses. It says that the mass of a body $m = \sum_{p=1}^{n} m_p$, where m_p stands for the masses of the parts of the body. The closure clause in question specifies the number n, i. e. it says how many parts the body has. Evidently, a statement saying how many parts a particular body has at a specific time, is a singular existential statement. However, let us once again have a look at the superposition principle for forces.

Assume that we use the superposition principle to add Newtonian gravitational forces. Such forces have the peculiarity that they permeate everything. Nothing can stop them. This means that every body in the whole universe gives rise to a partial force on the body whose resultant force we are interested in. In actual fact, however, the number of relevant bodies is reduced by a conjecture saying that their masses and distances from us are such that most of them can be neglected. It should be noted that this conjecture, which is part of the closure clause, is a conjecture *about the whole of the universe*. That such a statement should be treated as a singular existential statement in Popper's sense is, to say the least, not self-evident.

However, the superposition principle for forces has another peculiarity which is even more damaging to Popper's falsifiability thesis. The principle may add *different kinds* of forces; the superposition principle for masses, on

the other hand, adds just masses, not different kinds of masses. With regard to the kinds of forces known (or conjectured) at the moment of the test, this means nothing new; *all* of them should be taken into account. What I want to stress is that the superposition principle is open-ended in the sense that it allows hitherto unknown forces to be added. If a theoretical system which includes the superposition principle for forces is tested, and a counter-instance is encountered, this does not in itself imply that *any* of the laws, nor *any* of the singular existential statements involved, are false. (Cf. the case of weak and strong interaction hinted at above.) It could mean that the part of the closure clause which says that *all kinds of relevant forces* have been taken into account is false; and this part is not a singular existential statement. It says that there are *no* more forces at work, i. e. we have a non-existential singular statement. Before we can say that the truth of the singular existential statements involved transmits falsity to at least one of the laws in the theoretical system, we have to make the assumption that the non-existential singular statement in the closure clause is true. Actually, this is often quite as bold a conjecture as the hypothesis that there exists an up to now unknown kind of force. We are faced with a dilemma which Popper has never noticed. Because of the open-endedness of the superposition principle for forces, *one is not, when confronted with a counter-instance, compelled by logic to reject or modify any of the laws or singular existential statements involved.*

As far as I can see, there is one argument a staunch Popperian may use to counter the remarks just made. He may say that in all the tests described, there is of course a singular existential statement which is false, even if the closure clause employed turns out to be false. Thus, that the closure clause is false normally means that the singular existential statement describing the resultant force is false, too. This, of course, is correct, but sidesteps the real point at issue. *In a test* or prediction there are *two kinds* of singular existential statements, viz. the necessary ones and the redundant ones. The statement describing the resultant force is in most cases in Newtonian mechanics of the latter kind. This can easily be seen. Newton's second law, '$F = m \cdot a$', and the superposition principle, 'F = the vector sum of F_p', can be combined into the formula 'the vector sum of $F_p = m \cdot a$', which makes the resultant force disappear from the scene. There is no need for a particular singular statement describing the resultant force if it is the partial forces, not the resultant one, which primarily are measured or estimated in the test situation.

Imre Lakatos has written the following:

> . . . even a most respected scientific theory, like Newton's dynamics and theory of gravitation, may fail to forbid any observable state of affairs. /---/ Another way of putting this is to say that some scientific theories are normally interpreted as containing a *ceteris paribus* clause: in such cases it is always a specific theory *together* with this clause which may be refuted. But such a refutation is inconsequential for the *specific* theory under test because by replacing the *ceteris paribus* clause by a different one the *specific* theory can always be retained whatever the tests say. (pp. 101–02.)

As should be clear, I agree with Lakatos if I may change his *ceteris paribus* clauses into my own closure clauses.

CAUSALITY AND CLOSURE CLAUSES

Newton's mechanics, which was used above to illustrate my thesis that some closure clauses make Popper's falsifiability principle untenable, contains an *explicit* superposition principle for forces. In many contexts, however, I think a corresponding superposition principle is used only *implicitly*. Consider, for instance, the statement 'A rise in temperature causes a solid rod to expand'. This statement is not falsified by the statement 'The temperature has risen but the length of the solid rod is the same'. There may have been a counteracting force at work. For instance, the rod could simultaneously have been exposed to a pressure which made it contract. This kind of reasoning has to presuppose the existence of a superposition principle for forces as well as certain associated closure clauses.

A causal statement like 'A causes B' differs from the corresponding correlation, 'A and B are universally correlated', in that A is regarded as in some way creating or giving rise to B; and I take it to be a defining characteristic of causal relations that they permit counteracting factors. This, in turn, means that causal contexts always contain a superposition principle which connects the different causal laws used. The relevant closure clauses have to be of the kind that makes Popper's falsifiability principle inapplicable, i. e. the criticism levelled against Popper is not restricted to the examples given; it applies to all causal contexts.

Once more I would like to quote and correct Imre Lakatos's criticism of Popper. Lakatos has said:

> A proposition might be said to be scientific only if it aims at expressing a causal connection: /–/ Similarly, 'all swans are white', if true, would be a mere curiosity unless it asserted that swanness *causes* whitness. But then a black swan would not refute this proposition, since it may only indicate *other causes* operating simultaneously. Thus 'all swans are white' is either an oddity and easily disprovable or a scientific proposition with a *ceteris paribus* clause and therefor undisprovable. *Tenacity of a theory against empirical evidence would then be an argument for rather, than against regarding it as 'scientific'. 'Irrefutability' would become a hallmark of science.* (p. 102.)

I regard this criticism of Popper as justified provided that the statement "Thus 'all swans are white' is either an oddity and easily disprovable or a scientific proposition with a *ceteris paribus* clause and therefore undisprovable" is replaced by the following: "Thus 'all swans are white' is either an oddity and easily disprovable, or a causal law which by means of a superposition principle can be connected with other causal factors. In the latter case, all tests of the law contain a *closure clause* which makes the law in a determinate sense undisprovable."

My distinction between *ceteris paribus* clauses and closure clauses also sheds new light on Popper's inability to understand Lakatos' criticism. Lakatos speaks of *ceteris paribus* clauses when he ought to speak of closure clauses. Popper takes Lakatos's phrase '*ceteris paribus* clause' too literally, thus missing the whole point of the criticism.

REFERENCES

Lakatos, I. and A. Musgrave (eds.): *Criticism and the Growth of Knowledge* (Cambridge 1970).
Schilpp, P. A. (ed.): *The Philosophy of Karl Popper* (La Salle, Illinois 1974).

Adresse des Autors:
Ingvar Johansson, Dept. for the Theory of Science, University of Umeå,
901 87 Umeå, Sweden