A Scientific Realism-Based Probabilistic Approach to Popper's Problem of Confirmation

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ABSTRACT

From the start of Popper's presentation of the problem about the way for confirmation of a hypothesis from the standpoint of anti-Bayesianism, there have been various controversies among philosophers of science. Especially Howson and Gillies have argued much honestly the problem from their own point of view. The problem is still one of the most important interests in philosophy of science. This paper focuses on the problem with reference to the preceding discussions, not from the standpoint both of Bayesianism and of subjectivism of probability. This paper founds a new interpretation of probability from the view of scientific realism. It aims at giving a proposition that it is possible to solve Popper's problem by connecting a function of degree of confirmation with a new kind of probability interpreted here, and that the interpretation of probability is consistent with what is called the zero *a priori* probability of hypothesis.

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1 Introduction

Confirmation theory of hypothesis [1] has been one of the most important interests in philosophy of science since Popper[l934] claimed that confirmation is not subject to the axioms of classical probability. With Popper's anti-Bayesian thesis on confirmation as a trigger, this is still a matter of controversy among philosophers of science. Do we accept the statement that the problem of confirmation posed by Popper can be solved by interpreting validity of theory or hypothesis as nothing but severity of the test (or temporary justification of theory or hypothesis)?

We will present a new interpretation of probability, based on scientific realism, after the nature of Popper's problem of confirmation is made clear. This paper aims for a new approach to the solution of Popper's problem in terms of scientific realism-based probability defined newly.

Finally we will claim that it is possible to connect a function of degree of confirmation with the new interpretation of probability, and that the interpretation of probability is consistent with what is called the zero *a priori* probability of hypothesis.

2 Popper on confirmation

Let us write C(*h,e*) for the degree of confirmation of a hypothesis *h* given evidence *e*, and P(*h,e*) for the probability of *h* given *e*. We call C(*h,e*) a function of degree of confirmation of the hypothesis . We assume that P(*h,e*) is a probability function.

It is a basic equation of equivalence based on the assumptions of Bayesianism that

$$C(h,e) = P(h,e).$$

However Popper denies the equivalence, and claims instead that

$$C(h,e) \neq P(h,e)$$

and that the function of degree of confirmation is not a probability function . The reason why Popper thought of the inequivalence is what is called the zero *a priori* logical probability of hypothesis or law. He claims that 'in an infinite universe, the logical probability of a universal law, even upon the most favorable empirical evidence, will always equal zero' (Popper[1983], p. 127). According to him, the inequivalence mentioned above is kept even though a hypothesis *h* is changed to a universal law. As anti-inductivist Popper rejects Bayesian form of inductive inference, C(*h,e*) is always zero and is meaningless because P(*h,e*) is ordinarily zero.

Although Popper thought that C(*h,e*) ≠ P(*h,e*) and 'no law [hypothesis] is confirmable' (Popper[1983], p. 127), he held hat C(*h,e*) can be defined in terms another form expressed as p(*e,hb*) - p(*e,b*) (Popper[1983], p.240). Here we have to pay attention to the fact that definition by Popper of the probability function p(*) is different from the P(*) in this paper. Popper presents 'the suggestion [2]...that we define C(*h,e,b*), that is the degree of corroboration of *h* by *e* in the presence of the background knowledge *b*, by the difference [3] p(*e,hb*) - p(*e,b*)', where P(*e,hb*) means 'a measure of the degree of support given by *e* to *h* in the presence of the background knowledge *b*' (Popper[1983], p.240).

We here call Popper's suggestion of C(*h,e,b*) mentioned above Popper's problem[4] of confirmation, while Popper calls it 'the problem of *degree* of support or *degree* of corroboration' (Popper[1983], p.240). We use the terms 'confirmation' and 'corroboration' as synonyms.

3 Scientific realism-based interpretation of probability

Scientific realism [5] means an epistemological view that hypothetica1 (or theoretical) entities characterized by a true hypothesis (or theory) actually exist even though they cannot be directly observed and that evidence confirming a hypothesis (or theory) also serves to confirm the

existence of any hypothetical (or theoretical) realities characterized by that hypothesis (or theory). For instance, Robbins's 'economic man' [6] is an economic hypothetical entity, and existing economic entity corresponding to it is me.

From the point of view of scientific realism, there does exist an epistemological distance between hypothetical truth, (i.e., 'economic man' as fiction) and the counterpart in reality (i.e., me as fact) of it. Therefore, concerning the distance, in a scientific realism-based inductive inquiry[7], we have to construct a ladder from the quantitative surface of an objective world to the qualitative underneath of the world, or a link between the inside of an analytical model and the outside of the model. Although the notion such as the ladder or the link depends on a unique interpretation of probability corresponding to the circumstance of the inquiry, scientific realism-based approach is not founded on the probability in classical statistics. Inductive reasoning needs to construct a logical bridge from a real entity to a hypothetical (or theoretical) entity corresponding to it. The bridge[8] is taken as a hypothetical device characterized by specific theory of probability.

Now we define the scientific realism-based interpretation of probability as $P^*(<He,Re(e)>)$ given hypothetical entity *He*, and the counterpart of *He*, namely real entity *Re(e)* depending on empirical evidence *e*. $P^*(<He,Re(e)>)$ is subject to the following conditions.

(P1) $<A,B>$ is defined as a logical relation between an epistemological entity A and another entity B, and $<A,B>=<B,A>$.

(P2) $P^*(<A,B>)$ stands for the probability based on scientific realism, which measures the strength of the logical relation $<A,B>$, and $0 \leqq P^*(<A,B>) \leqq 1$.

(P3) $P^*(<A,A>) = 1$.

(P4) $P^*(<A,A^c>)=0$, where A^c stands for an entity contradictory to A.

(P5) $P^*(<\Phi,A>)=0$, Φ stands for *a priori* empty entity in the case that we cannot create in the face of perceiving the counterpart of A, namely stands for *a priori* an unidentified entity relative to the counterpart of A

Finally, concerning whether the zero *a priori* probability of hypothesis presented by Popper holds for the scientific realism-based interpretation of probability, it is no problem because the zero *a priori* probability is just fit to the condition (P5) above mentioned.

4 A probabilistic approach to Popper's problem of confirmation

Let us write *h* for a hypothetical proposition described in terms both of a real entity *Re(e)* implying a conclusion (i.e., a counterpart, transformed from statistical evidence, in reality of hypothetically-given entity *He*) and of a hypothetical entity *He* implying a premise.

Then we can get the following equation:

$$C(h,e) = P^*(<He,Re(e)>).$$

This is a probabilistic approach to Popper's problem of confirmation from the point of view

of scientific realism, as an alternative solution different both from the presentation based on Bayesianism by Howson[1973] and from the presentation based on subjective interpretation of probability by Gillies[1995].

Concerning the realistic structure of hypothesis, we think that the hypothesis *h* given evidence *e* is characterized by the real entity *Re(e)*, which is based on the logical relation, on the assumption of hypothetical entity *He* which is the subject involved in the hypothesis. On emergence of *Re(e),* we have to rely on experience[9] .

For instance, as an example of *He* in economics, we can immediately image the marginal propensity to consume (MWC), and as an example of *Re(e)*, a counterpart of *He*, we can do the statistical estimator (β^*_1) relative to the regression coefficient of national disposable income (NDI) variable in the simple regression analysis of final consumption expenditure of households (FCEH) to NDI. Let us write *h* for a null hypothesis standing for MPC=0. In this case,

$$C(h,e) = P^*(<\text{MPC}, \ \beta^*_1>).$$

Especially, in a statistical inquiry, if we can assume that *Re(e)* is a statistic (or random variable) with nominal distribution of probability given standard deviation σ , then we can realize that the linearly-transformed random variable $Z = (Re(e) - He) / \sigma$ is subject to the standard normal distribution $N(0, 1^2)$.

Moreover, if there exist *h* and *e* such as:

$$C(h,e) = P^*(< He \text{ , the mean of } Re(e) >) ,$$

then we can get $C(h,e) = 1$.

Notes

[1] Gillies[1991] regards confirmation theory as 'a central area of philosophy of science' (Gillies [1991],p.518).

[2] About the original presentation of Popper's suggestion, see Popper[1934,p.400], where the relation between confirmation function and probability function is discussed tentatively.

[3] Gillies[1995] calls the difference ' [the] central to Popper's account of corroboration' (Gillies[1995Lp.115).

[4] Gillies[1988] discusses the Popper's problem as an examination of Popper's argument against Bayesianism due to him. He presents perfectly a substitute solution to Popper's problem from the point of view of subjective interpretation of probability (Gillies[1988] , pp. 192-195).

[5] A realist economist Lawson defines scientific realism as the following. 'In fact any position might be designated a *realism* (in the philosophical sense of the term) that asserts the existence of some disputed kind of entity (such as black holes, class relations, economic equilibria, gravitons, tanon-neutrinos, utilities). Clearly on this definition we are all realists of a kind, and there are very much conceivable realisms. In science, a realist position, i.e. a

scientific realism, asserts that the ultimate objects of scientific investigation exist for the most part quite independent of, or at least prior to, their investigation' (Lawson[1997], p. 15)

[6] What a realist English-speaking economist Robbins explains about 'economic man' as a hypothetical entity is as follows. 'Economic man is only an expository device—a first approximation used very cautiously at one stage in the development of arguments which, in their full development neither employ any such assumption nor demand it in any way for a justification of their procedure—it is improbable that he would be sure a universal bogey.' (Robbins[1949] , p. 97)

[7] For instance, scientific realism-based econometrics (or econometric inference) discusses the measuring of counterpart in facts of econometric (or social) entity in economic theory. Such econometrics assumes the superiority of existence of *a priori* theoretical entities in scientific reasoning, where the hypothetical (or theoretica1) entities can be inferred inductively from real entities as the counterpart by the logical relation between real entities in facts and socia1 (or hypothetical) entities in economic theory. Carnap refers to an inductive inference as following. That is,'[w]hen an inductive inference is made in this way, from a sample to the population, from one sample to an unknown future sample, or from one Sample to an unknown future instance, I speak of it as "indirect Probability inference" or "indirect inductive inference"'. (Carnap[1966], p. 39)

[8] Positivist and anti-realist Keuzenkamp[2000] objects to the scientific realism in economics: 'in economics, the object is not independent of the subject. In other wards, behavior (like option pricing) is affected by economics (the option pricing model). An independent truth does not exist.... The price elasticity of demand for doughnuts is not a real entity, existing outside the context of a specific economic model'. (Keuzenkamp [2000], p. 216) Keuzenkamp does not approve that the logical relation (or correspondence) between *He* and *Re(e)* does exist and that the evidence which confirm a true hypothesis (or theory) also serves to confirm the existence of a hypothetical (or theoretical) entity characterized by the hypothesis (or theory). However I think that the object in economics can be inferred from the bridge from a real entity to a hypothetical entity regardless of dependence or independence of the observer.

[9] On experience, Robbins considers it in relation to 'immediate acquaintance'. 'In economics, as we have seen, the ultimate constituents of our fundamental generalizations are known to us by immediate acquaintance. In the natural sciences they are known to only inferentially. There is much less reason to doubt the counterpart in reality [i.e., a *Re(e)*] of the assumption of individual preferences [i.e., a *He*] than that of the assumption of the electron.' (Robbins[1949], p. 105)

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