

Scientific Realism-Based Probability for Probabilistic Economic Analysis

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ABSTRACT

In realist economics formed by Cairnes, Robbins and Keynes, statistical economic analysis is regarded as useless, although statistics looks intimate with realism. What made economics conflict with statistics? This paper focuses on this problem. We start from presenting traditional realist economists' views on uselessness of statistical economic analysis in the section 1. The section 2 is focused both on lack of homogeneousness condition of data and on changing from economic data into random variable, in order to investigate the validity of application of standard sampling statistics to the economic phenomenon composed of data having specific character different from data available in natural sciences. The latter half (i.e., the section 3, 4) of this paper discuss a new interpretation of probability based on scientific realism and the adaptation of the interpretation to the problem of confirming economic hypothesis regarded as a central economic analysis, from the point of view of realist economics, not of modern econometrics. This paper insists the methodological *substitutability* of probabilistic reasoning based on scientific realism for statistical inference in economics.

- 1 *Introduction*
- 2 *Fallacy in application of statistics to economic analysis*
- 3 *Scientific realism-based interpretation of probability*
- 4 *A probabilistic approach to confirmation of economic hypothesis*

1 Introduction

On the place of statistics in political economy, Cairnes, a representative among Irish economists in the latter half of nineteenth century included in the final period of classical school, states that statistics has only low predictive power in economic analysis. He thinks that economic reasoning is deductive, and that statistics serves only to supplementary analysis, apart from the fact that sampling (or inferential) statistics which aims to infer unknown truth from partial facts included in samples was not developed yet in his time. He presents a pessimistic view on statistical inference in relation to economics.

In connection with the processes just referred to of verification and the discovery of disturbing

causes, or . . . the discovery of the minor influences affecting economic phenomena, we find the proper place of statistics in economic reasoning. . . . In order to their detection, therefore, attention must be drawn to the effects which they [= capital economic doctrines] produce ; and this . . . can be best done by the use of statistics in constant connection with deductive ratiocination. (Cairnes [1888], p. 97)

On statistical quantitative investigation into economic events, Robbins,¹⁾ a deductivist and English-speaking critic of Cambridge new classical school, also refers to impossibility of statistical laws in economics in connection with difference between natural sciences and social sciences, although in his time the classical methods of sampling statistics was presented by Fisher [1921] who is an English theoretical statistician. Robbins emphasizes on impossibility of constructing statistical generalization (i.e., quantitative law) by use of economic data. His statement is as follows.

In the natural sciences the transition from the qualitative to the quantitative is easy and inevitable. In the social sciences, for reasons which have already been set forth, it is in some connection almost impossible, and it is always associated with peril and difficulty. (Robbins [1949], p. 111)

In the early years in the twentieth century, Keynes, who is contemporary with Robbins, brings up the *slippery problem*²⁾ on statistical induction regarded as a specific version of inductive probabilistic reasoning. He points out statistician's error in statistical generalization. What most statisticians fall into is the slipping in interpretation from data for description into value of random variable. It is caused by ignorance of difference in methods between descriptive statistics and sampling statistics. In this case, economic data turns into fictitiously stylized data.

The statistician, who is mainly interested in the technical methods of his science, is less concerned to discover the precise conditions in which a description can be legitimately extended by induction. He slips somewhat easily from one to the other, and having found a complete and satisfactory mode of

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- 1) Concerning pessimism related to the application of statistics into economics, such opinion in the turning point of the twentieth century is called 'the Cairnes-Robbins tradition' by Mäki. He states that '[one of the] economists who share the key tenets of the Cairns-Robbins tradition . . . may hold the view that economics is bound to be relatively weak in predictive power since its theories always at most capture a limited subset of all the factors that shape the phenomena: the uncontrollable complexity of economic systems and their surroundings makes the consistently accurate prediction of phenomena difficult if not impossible and thereby undermines technological success of the sort physical sciences are reported to exhibit.' (Mäki [2002], p. 98)
 - 2) Keynes has presented 'slippery problem' clearly. 'Thirty years ago I used to be occupied in examining the slippery problem of passing from statistical description to inductive generalization in the case of simple correlation ; and to-day in the era of multiple correlation I do not find that in this respect practice is much improved.' (Keynes [1939], p. 566)

description he may take less pains over the transitional argument, which is to permit him to use this description for the purposes of generalisation. One or two examples will show how easy it is to slip from description into generalisation. (Keynes [1921], pp. 327-8)

According to realist economics formed by Cairnes, Robbins and Keynes, statistical economic analysis is regarded as useless. However, statistics looks intimate with realism. What made economics conflict with statistical reasoning ?

The object of this paper is to give a further investigation into the uselessness of statistical economic analysis including econometrics, and to present new foundations of probabilistic economic reasoning, which is regarded as a new substitute for statistical economic reasoning. We also think that presenting the foundations serves as a contribution to unify economics, statistics and philosophical theory of probability.

2 Fallacy in application of statistics to economic analysis

We regard statistics as a mathematical theory of inductive argument, by use of which we are able to approach temporary law dominated in population with the aid of various informations included in samples. Temporary law implies hypothesis which has not been falsified inductively yet. Inductive argument means the mode by which we infer fictitious hypothesis or inductively-stylized generalization from factual evidence. Concerning investigation of applicability of statistics to economic analysis, we here discuss the structural nature of economic variable, apart from a philosophical problem³⁾ related to the impossibility of principle of induction proposed powerfully by Hume.

What we have to inquiry in relation to the validity of statistical economic analysis implies two issues. They are together focused on whether or not we can apply standard

3) On the ground of validity of inductive generalization like statistical inference, Keynes refers to the uniformity of nature from the point of view of inductive logic. 'The law of the uniformity of nature appears to me to amount to an assertion that an analogy which is perfect, except that mere differences of position in time and space are treated as irrelevant, is a valid basis for a generalization, two total causes being regarded as the *same* if they only differ in their positions in time or space. This, I think, is the whole of the importance which this law has for the theory of inductive argument.' (Keynes [1921], p. 226) And he also states that 'the main *prima facie* objection to the application of the method of multiple correlation to complex economic problems lies in the apparent lack of any adequate degree of uniformity in the environment.' (Keynes [1939], pp. 567)

Robbins also has a negative view on the uniformity of nature in the case of application of statistics to economic analysis. 'Ought we not to wish to be in a position to give numerical values to the scales of valuation, to establish quantitative laws of demand and supply? ... No doubt such knowledge would be useful. But a moment's reflection should make it plain that we are here entering upon a field of investigation *where there is no reason to suppose that uniformities are to be discovered.*' (Robbins [1949], p. 107)

sampling statistics to the economic phenomenon composed of the data having specific character different from the data available in natural sciences. The first concerns the lack⁴⁾ of homogeneousness condition of data in describing economic phenomenon. As the second issue, we deal with changing from the nature peculiar to economic variable regarded as unqualified data variable into those which is peculiar to random variable. Most economists unconsciously lead to the changing when they statistically generalize about economic events.

2.1 Lack of homogeneousness condition of data

Set of data is relative to the category of *data variable*. Data variable is fundamentally formed as effects resulted from causes in connection with a specific deterministic process, which is presumed that it is unchangeable over time and space. The process is very available for sciences in which various experiments are practicable repetitively with fixed conditions for observations.

The process produces homogeneous data if and only if it is unchangeable over time and space. This condition is regarded as *homogeneousness condition* of data. The condition underlies homogeneous effects and causes. If data is not subject to the condition, then we think that it is produced by *unqualified data variable*, not by data variable. In this case, unqualified data variable lacks strict property of data variable.

Economic process which produces economic data is not based on homogeneous causes because it depends on its historical and structural conditions, which give rise to unexpected economic fluctuations such as oil shock in Japan. In economics there does not exist stable

4) On the lack of homogeneousness condition of data, Keynes has already presented a specific view. '[T]he most important condition is that the environment in all relevant respects . . . should be uniform and homogeneous over a period of time. We cannot be sure that such conditions will persist in the future, even if we find them in the past. But if we find them in the past, we have at any rate some basis for an inductive argument.' (Keynes [1939], pp. 566-7)

Robbins proposes as follows. 'Rough ideas relating to the elasticity of demand in particular markets are indeed essential if we are to make full use of the more refined tools of economic analysis. But they have no claim to be regarded as immutable laws. However accurately they describe the past, there is no presumption that they must continue to describe the future. Things have just happened to be so in the past. They may continue to be so for a short time in the future. But there is no reason to suppose that their having been so in the past is the result of the operation of homogeneous causes, nor that their changes in the future will be due to the causes which have operated in the past.' (Robbins [1949], p. 109)

At the same time, Robbins rejects the application of theory of probability to economics because of absence of homogeneousness condition of economic data. 'The theory of probability on which modern mathematical statistics is based affords no justification for averaging where conditions are obviously not such as to warrant the belief that homogeneous causes of different kinds are operating.' (Robbins [1949], p. 112)

process producing homogeneous effects. Economic process is changeable over time and space.

Keynes refers to nonhomogeneous economic material (i.e., economic data) in connection with *the central question of methodology*.

There is first of all the central question of methodology,—the logic of applying the method of multiple correlation to unanalysed economic material, which we know to be nonhomogeneous through time. If we were dealing with the action of numerically measurable, independent forces, adequately analysed so that we knew we were dealing with independent atomic factors and between them completely comprehensive, acting with fluctuating relative strength on material constant and homogeneous through time, we might be able to use the method of multiple correlation with some confidence for disentangling the laws of their action. (Keynes [1973], pp. 285-6)

Keynes also regards economics as a science of thinking related to choosing of the model of contemporary world composed of nonhomogeneous data.

Economics is a science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world. It is compelled to be this, because, unlike the typical natural science, the material to which it is applied is, in too many respects, not homogeneous through time. The object of a model is to segregate the semi-permanent or relatively constant factors from those which are transitory or fluctuating so as to develop a logical way of thinking about the latter, and of understanding the time sequences to which they give rise in particular cases.' (Keynes [1973], pp. 296-7)

Keynes's epistemological view on economics focuses on choosing model for contemporary phenomenon composed of nonhomogeneous data. He criticizes econometrical methods for economic analysis because we take pains to extract essential character of the object from phenomenon based on nonhomogeneous economic data, while Tinbergen who is a Netherlander and contemporary with Keynes engages himself in statistical investigation into business cycles in the United States between 1919 and 1932.

2.2 Changing from unqualified data variable into random variable

Economic data used for economic analysis are included in the branch of unqualified data variable, not of data variable based on homogeneous data as mentioned above. The unqualified data variable such as economic data never accompany distribution of probability corresponding to each value. Therefore, economic data is also clearly irrelevant to *random variable*.

However, most of the economists who are well grounded in statistics or econometrics have a tendency to infer economic hypothesis from economic data by only reason of

quantitativeness of economic data, though the reason is too groundless. Essentially we can never infer generalization or stylized hypothesis from evidential economic data without property of random variable.

For instance, in an inquiry into the investigation of unknown cause related to a specific economic behavior (e.g., macro-consumption behavior), we use regression analysis based on the statistical model in which consumption is recurred to a regressor regarded as temporary cause (e.g., National Disposal Income). However, in the case, we fall into fallacy that macro-consumption variable as a regressand turns itself into random variable, not into unqualified data variable, under the influence of the property of random variable included in residual term in the regression model.

Such changing from unqualified data variable into random variable in economic analysis gives rise to a kind of slippery problem mentioned above, which is proposed by Keynes. That is, economic data used for descriptive statistics which aims to describe for itself is unconsciously slipped into the data used for sampling statistics which has an object to infer generalization over itself. The changing is illogical in economics because of ignorance of the slipping.

The two sections which follow discuss a new interpretation of probability and the adaptation of the interpretation to the problem of confirming economic hypothesis regarded as main economic analysis from the point of view of unification of economics and statistics, apart from standard methods of econometrics. These sections involve two tasks. First we have to deal with the new concept of probability necessary to realist economics. Secondly we try to adapt probabilistic reasoning based on scientific realism to the mode of confirmation of economic hypothesis.

3 Scientific realism-based interpretation of probability

Scientific realism means an epistemological view that hypothetical (or theoretical) entities characterized by a true hypothesis (or theory) actually exist even though they cannot be directly observed, and that really existing entity depending on evidence capable of confirming a hypothesis (or theory) also serves to confirm the existence of any hypothetical (or theoretical) realities. For instance, *economic man*⁵⁾ presented by Robbins

5) What a realist 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 such a universal bogey.' (Robbins [1949], p. 97)

is an economic hypothetical (or theoretical) entity, and existing economic entity corresponding to it is *me*.

A realist and anti-mainstream economist Lawson makes a great point of our digging into the structure existing underneath the surface of economic phenomenon. The structure means hypothetical entity. According to him, assuming that there exists a relation between real economic reality and hypothetical economic reality, actual event is governed by the structure.

[T]he world is composed not only of events and states of affairs and our experiences or impressions, but also of underlying structures, powers, mechanisms and tendencies that exist, whether or not detected, and govern or facilitate actual events. (Lawson [1997], p. 21)

From the point of view of scientific realism, we are able to realize that 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 specific scientific realism-based inductive inquiry⁶⁾, 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, on the assumption that we think the ladder or the link exists independently⁷⁾ of its user (i.e., economic subject). The notion such as the ladder or the link depends on a unique interpretation of probability corresponding to the circumstance of the inquiry. Such an inductive reasoning needs to construct a logical bridge from a real entity to a hypothetical (or theoretical) entity corresponding to it. The logical bridge is taken as a hypothetical device characterized by specific theory of probability.

We present the following notations in order to interpret epistemologically the scientific realism-based probability. *He* stands for a hypothetical entity in a theory in fictitious world. *Re(e)* means a real entity regarded as a counterpart of *He* and relates to empirical evidence *e* at

6) Carnap refers to an inductive inquiry as follows. 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) I agree with Carnap on the point that sampling statistics is regarded as an 'indirect probability inference'. I think that sampling statistics is a mathematical theory of inductive inference.

7) In the application of scientific realism to economic phenomenon, there exists an objection against scientific realism. An anti-realist and positivist Keuzenkamp states that 'in economics, the object is not independent of the subject. In other words, behaviour (like option pricing) is affected by economics. 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) He thinks that 'stylized facts are all mis-specifications of economic reality.' (Keuzenkamp [2000], p. 221) However, if so, is the value of any statistic estimated by statistics 'mis-specification'?

the same time. $Re(e)$ is an epistemological entity in factual world. The symbol of $\langle Re(e), He \rangle$ shows the one-way entailment⁸⁾ of $Re(e)$ upon fixed entity He . Here we think of the entailment, not of mutual relation between $Re(e)$ and He . The object to analyze is limited to the world⁹⁾ composed of conceptions independent of subject. Therefore the relation described as $\langle He, Re(e) \rangle$ is not defined. We here write $P(\langle Re(e), He \rangle)$ for the scientific realism-based probability given He .

Now we interpret the scientific realism-based probability $P(\langle Re(e), He \rangle)$. $P(\langle Re(e), He \rangle)$ measures the strength of the one-way entailment (or “entailability”) in $\langle Re(e), He \rangle$. We assume that $P(\langle *, ** \rangle)$ fulfills probability measures. $P(\langle Re(e), He \rangle)$ has the following properties.

- (P1) $0 \leq P(\langle Re(e), He \rangle) \leq 1$ for any evidence e .
- (P2) $P(\langle \Phi, He \rangle) = 0$, where Φ stands for the *empty* real entity when we still cannot create the counterpart of He , namely it stands for the unidentified real entity relative to the counterpart of He . Φ stands for $Re(\phi)$, where ϕ is empty evidence corresponding to He .
- (P3) $P(\langle \Omega, He \rangle) = 1$, if we could observe Ω which stands for the *universal* real entity composed of all real entities presumed theoretically. In this case Ω stands for $Re(\omega)$, where ω is universal evidence corresponding to He .

4 A probabilistic approach to confirmation of economic hypothesis

Fictitious hypothesis (or theory) is destined to be confirmed scientifically by factual evidence, although the hypothesis is nothing more than temporarily-justified hypothesis even if we verified the hypothesis. Keynes points out that there are few theories taken examination by statistics or general consideration. He insists superiority of verification of theory over prediction of it.

If a theory is first proposed and is then confirmed by the examination of statistics, we are inclined to

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- 8) On entailment, we regard Robbins's idea of ‘immediate acquaintance’ as one of the forms of entailment. ‘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 only inferentially. There is much less reason to doubt the counterpart [i.e., $Re(e)$] in reality of the assumption of individual preferences [e.g., He] than that of the assumption of the electron.’ (Robbins [1949], p. 105)
 - 9) Concerning the world characterized by one-way entailment in scientific reasoning, although it may be more likely in natural science rather than in social science, specification of the world leads to a problem whether or not we can actually realize the *reflexivity* between the object and economists in the object concerned.

attach more weight to it than to a theory which is constructed in order to suit the statistics. But the fact that the theory which precedes the statistics is more likely than the other to be supported by general considerations — for it has not, presumably, been adopted for no reason at all — constitutes the only valid ground for this preference. If it does *not* receive more support than the other from general considerations, then the circumstances of its origin are no argument in its favour.’ (Keynes [1921], p. 306)

Investigations developed in sections which are preceding result in the uselessness in applying sampling statistics to economic analysis, namely, the uselessness in the approximate and insensitive applying without consideration to *fallacy* in statistical economic analysis. That is, we cannot make a practice of inferring economic phenomenon by use of sampling statistics, if we overlook the fallacy.

In the preceding section, we have already presented *substitutability* of scientific realism-based interpretation of probability founded on unqualified data variable for probability used in standard statistical inference dependent on random variable. We here apply the probability interpreted newly to theory of confirmation of economic hypothesis. In this case, we have no intention of paying attention to statistical inference included in standard sampling statistics.

Concerning the realistic structure of economic hypothesis, we think that hypothesis h given evidence e is characterized by the real entity $Re(e)$, which is based on the entailment relation, on the assumption of existence of hypothetical (or theoretical) entity He which is the subject involved in the hypothesis. Hypotheses constructed by hypothetical entity He , according to Robbins, ‘are not postulates the existence of whose counterpart in reality admits of extensive dispute once their nature is fully realized.’ (Robbins [1949], p. 79) In fact, it takes very long time to realize fully postulates.

The theory of confirmation¹⁰⁾ is for measuring to what degree given evidence e supports economic hypothesis h . We here write $C(h, e)$ for confirmation of h given e .

Therefore, from the point of view of scientific realism, we confirm economic hypothesis h in terms of the entailment of $\langle Re(e), He \rangle$ given He . That is,

10) In this paper, confirmation of hypothesis is related to scientific realism-based interpretation of probability, while Carnap’s view on confirmation is entered into a relationship with logical interpretation of inductive probability. ‘I believe . . . that there can be an inductive machine with a much more modest aim. Given certain observations e and a hypothesis h (in the form, say, of a prediction or even of a set of laws), then I believe it is in many cases possible to determine, by mechanical procedures, the logical probability, or degree of confirmation, of h on the basis of e . For this concept of probability, I also use the term “inductive probability”, because I am convinced that this is the basic concept involved in all inductive reasoning and that the chief task of inductive reasoning is the evaluation of this probability.’ (Carnap [1966], p. 34) An inquiry into the relation between scientific realism and induction is a matter of great importance to us.

$$C(h, e) = P(\langle Re(e), He \rangle).$$

This equation means a probabilistic method for confirmation of economic hypothesis. Under specific conditions, the equation can be adapted to statistical¹¹⁾ confirmation of economic hypothesis.

Finally, this transformation form, which relates to Popper's view on *a priori* hypothesis which corresponds to zero probability, is a probabilistic approach to Popper's problem of confirmation (Popper [1988], p. 240). That is, the form also means an alternative solution for the Popper's problem, which is different both from the presentation based on Bayesianism by Howson [1973] and from the presentation based on subjective interpretation of probability by Gillies [1995]. The reason is resulted from the fact that initial probability¹²⁾ of hypothesis stands for $P(\langle Re(e), He \rangle) = 0$, when $Re(\phi) = \emptyset$. This case fits the property (P2) which scientific

- 11) Especially, in the specific case, namely in statistical inquiry in which $Re(e)$ is regarded as random variable, if we can assume that $Re(e)$ is a statistic (i.e., random variable) with normal distribution of probability given standard deviation σ , then we can realize that the linearly-transformed random variable Z which is defined as $(Re(e) - He) / \sigma$ is subject to the standard normal distribution $N(0, 1^2)$. When we get the mean of $Re(e)$, the probability density at $Z=0$ is the most probable value.

Moreover, concerning statistical confirmation of economic hypothesis, if we encounter the fact such as :

$$C(h, e) = P(\langle \text{the mean of } Re(e), He \rangle),$$

then we can get $C(h, e) = 1$ because the entailment from the mean of $Re(e)$ into He is attempted with maximum strength. Therefore, we judge that h is supported.

Concerning an example of He in economics, we can immediately image the marginal propensity to consume (MPC), and as an example of $Re(e)$ depending on statistical evidence e which is a counterpart of He , we can refer value of the statistical estimator (β^*_1), the second regression coefficient, which is 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 which means $MPC=0$. In this case,

$$C(h, e) = P(\langle \beta^*_1(e), MPC \rangle).$$

Moreover, if we encounter $\beta^*_1(e) / \sigma(\beta_1(e)) \geq 1.96$, then we judge that h is to be rejected because the strength of entailment from $\beta^*_1(e)$ into MPC is too low in comparison with critical value in the testing of hypothesis, in which significant level is 5%, in terms of standard normal random variable.

- 12) Keynes, who uses scientific entity with a synonym of hypothetical entity, proposes that existence of such scientific entity included in significant hypothesis is irrelevant to the problem of inquiring *a priori* probability of the hypothesis. 'A scientific entity, such as the ether or the electron, whose qualities have *never* been observed but whose existence we postulate for purposes of explanation, stands in it also. If the analysis of Part III is correct, we can never attribute a finite probability to the truth of such axioms or to the existence of such scientific entities, however many of their consequences we find to be true. They may be *convenient* hypothesis, because, if we confine ourselves to *certain classes* of their consequences, we are not likely to be led into error; but they stand, nevertheless, in a position altogether different from that of such generalizations as we have reason to invest with an initial probability.' (Keynes [1921], pp. 299-300) Apart from Popper's problem of confirmation of *a priori* hypothesis, such Keynes's view on an inquiry about *a priori* probability relating to significant hypothesis based on good scientific entity has a great suggestion on how we connect the entailment of $Re(e)$ into He with initial probability, not with *a priori* hypothesis.

realism-based probability possesses.

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