Working Paper

17

Philosophical Explorations of Causality and flagging its link to Behavioral Economics

Munish Alagh

December 2014

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Social Research
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Philosophical Explorations of Causality and flagging its link to Behavioral Economics

Munish Alagh*

Abstract

The Article aims to build in a motivation to examine Causality in the context of Behavioural Heuristics. Itbegins with an outline of contemporary approaches to causation. A more detailed discussion involving a historical evolution of the concept through time is done. Two decisive milestones are described, which mark the history of causality: the Aristotelian (scholastic) Conception (I), and the Scientific Conception (II). Further understanding of the term causation is undertaken: firstly causation as a relation, secondly causal relation as external to relata, thirdly causal relata as discrete entities, fourthly causation and time, fifthly David Hume's approach to causality. We then look into, probabilistic causation including the contribution of Salmon, Riechenbach and Suppes. The two types of Scientific Explanation are discussed. A research topic in Behavioral Economics through an existing published article on:'The Role of Causality in Judgment under uncertainty' is introduced.Using the conceptof this article as an overall framework, causality is linked to an interpretation of behavioural heuristics such as base rate neglect. Possible further study is suggested based on previous research to test the efficacy of causal Bayesian inference in accurate representation of these biases.

Key Words: Contemporary Approach to Causation,History of Causation,Causal Relata, Probabilistic Approach to Causation, Scientific Explanation, Judgement under Uncertainty, Bayes Theorem, Behavioral Economics, Heuristics.

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Philosophical Explorations of Causality and Flagging its link to Behavioral Economics

Causality has been researched in detail in contemporary literature. Below a brief examination of the literature is undertaken in order to throw light on the relevance of the concept of causality for our study of heuristics. A detailed examination of the concept is necessary before we go into the connections between the philosophical relevance of causality as a concept and illustrations of the impact of the relevance of the concept on behavioural economics and the significance of causality in a study of the subject.

I. Inadequacy of Received View of Cause[1]

We begin with an outline of contemporary approaches to causation. This is necessary in order to understand why a detailed further look at causality as a concept is required, before undertaking a review of applications of the concept:

The following approaches have been prominent in contemporary discussions of causation: (1) the approach which analyzes causation in terms of necessary and sufficient conditions, (2) the counterfactual approach, (3) the instrumental approach, (4) the probabilistic approach, and (5) the singularistapproach, which is a minority view.

a.) We explain the approach which analyzes causation in terms of necessary and sufficient conditions:
Cause as INUS-condition.: This definition involves two parts,a.) "a condition of this sort, that it occurred, that the other conditions which, conjoined with it, form a sufficient condition were also present, and that no other sufficient condition ……. was present on this occasion."[2]b.) "An insufficient but non-redundant part of a condition which is itself unnecessary but sufficient for the result."[3]

b.) We further define Causality as Counterfactual Dependence:To say that 'B is causally dependent upon A.' is to say that 'if A had not occurred, then B would not have occurred.' Moreover, to say that A is the cause of B is to say that there is a chain of causally dependent events linking A with B.[4]

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1 Hulswit, Menno. "Causality and causation: The inadequacy of the received view." *SEED* 2 (2004): 3-23.
2 Mackie, John L. 1965/1993. "Causes and Conditions." *American Philosophical Quarterly* 2/4 (1965): 245-64. Reprint in: Sosa and Tooley (eds.). *Causation* (Oxford 1993). 33-55.
3 ——— (1974). *The Cement of the Universe.A Study of Causation.* Oxford: The Clarendon Press.
4 Lewis, David. 1973/1993."Causation." *Journal of Philosophy* 70: 556-67. Reprint in: Sosa and Tooley (eds.). *Causation* (Oxford 1993). 193-204

c.) We also explain the Instrumental Approach to Causality.[5]: "[f]or a mere spectator there are no causes"[6]"a cause is an event or state of things which it is in our power to produce or prevent, and by producing or preventing which we can produce or prevent that whose cause it is said to be"[7].

d.) We explain Causality as Probable Occurrence: "An event A may be said to be a cause of an event B, if, given the occurrence of A, the probability of the occurrence of B is higher than the probability of the occurrence of B would have been if A had not occurred.

e.) An explanation of the Singularist Approach to Causality is given[8]:we are strongly inclined to confuse two questions: (1)"what did cause, i.e. what did then and there suffice to the occurrence of that concrete individual event?"[9] (2) "which part of what did suffice would be left if we subtracted from what did suffice such portions of it as were unnecessary to such an effect?"[10]

Most of these widely divergent approaches share some important common characteristics. The two main problems regarding causation concern (1) the criteria by virtue of which it can be determined that some item may be called a cause, and (2) the precise nature of the necessity that is presumed to be involved in causation[11].

The received view is inadequate both because it conceives causation as a relation instead of a process, and because it falsely assumes the causal relata to be discrete entities between which there is not even a hint of transitivity. The most troublesome aspect of the received view, however, is its basic ambiguity regarding the causal relata. Thus, though most contemporary philosophers hold that the causal relata are events, there are also some philosophers who hold that they are facts, and again some who hold that, next to event causality or fact causality, there is also agent causality in which the agents are conceived as substances[12].

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5 Collingwood, Robin G. (1938/1991). "On the So-called Idea of Causation."Proceedings of the Aristotelian Society 38. Reprint in: A.B. Schoedinger (ed.). Introduction to Metaphysics: The Fundamental Questions. Buffalo, New York: Prometheus Books. Pp.145-162.

6 ([1938] 1991: 151)

7 (Collingwood [1938] 1991: 148)

8 Ducasse, Curt J. (1926/1991). "On the Nature and the Observability of the Causal Relation. *Journal of Philosophy* 23: 57-68. Reprint in: A.B. Schoedinger (ed.). *Introduction to Metaphysics: The Fundamental Questions*. Buffalo, New York: Prometheus Books. Pp. 133-144.

9 (Ducasse [1926] 1991: 139)

10 (Ducasse [1926] 1991: 141)

11 Hulswit, Menno. "Causality and causation: The inadequacy of the received view." *SEED* 2 (2004): 3-23 SECTION I.

12 Ibid SECTION 3.2.

II. Historical Evolution of Cause[13]

A more detailed conceptualisation involving a historical evolution of the concept through time will give us a deeper understanding. Two decisive milestones mark the history of causality: the Aristotelian (scholastic) Conception (I), and the Scientific Conception (II). Moreover, these two conceptions of cause are mutually incompatible.

(I) The Aristotelian (scholastic) Conception: Aristotle stated that, in reference to any singular entity, the question 'What is this?' Could be answered in four different ways, each of which corresponded to what he called a 'Cause' in the sense of 'something without which the thing would not be'. The answers to four different questions, respectively: 'What is this made of?', 'Who is this made by?' 'What is this made for?' and 'What is it that makes this what it is and not something else?' The answers have come to be known as, again respectively, the Material cause, the Efficient cause, the Final cause and the Formal cause. Only the efficient cause has some features we associate with causation now.Aristotle conceived efficient causes as 'things responsible' in the sense that an efficient cause is a thing that by its activity brings about an effect in another thing. Thus, the efficient cause was defined by reference to some substance performing a change: it is the "primary source of the change." According to the Aristotelian conception, causes are conceived as the active originators of a change that is brought about for the sake of some end.

(II) Scientific Conception: Probably the most radical change in the meaning of cause happened during the seventeenth century, in which there emerged a strong tendency to understand causal relations as instances of deterministic laws. Causes were no longer seen as the active initiators of a change, but as inactive nodes in a law-like implication chain.

This change of perspective had its antecedents in Stoicism and medieval philosophy. Stoics were the first to associate causation with exceptionless regularity and necessity. But, contrary to the scientific conception of cause, the necessity involved in the causal relation pertained to particular events; it was thought to be necessary that the same particular effect would recur in the same particular circumstances, and that it was not possible that it would be otherwise[14].

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13 Hulswit, Menno2002. *From Cause to Causation.A Peircean Perspective.* Dordrecht: Kluwer Academic Publishers.

14 Sorabji, Richard. (1980). *Necessity, Cause and Blame. Perspectives on Aristotle's Theory*.Ithaca, New York: Cornell University Press.

An important characteristic of the modern conception of cause was that causation and determinism became virtually equivalent. The crux of the debate between the rationalists and the empiricists pertained to the nature of this determination.

II)i Rationalist Conception of Cause: In the rationalist conception of cause, the relationship between cause and effect is a logical relation. Necessitation involves implication. Thus, a complete knowledge of the causes is tantamount to knowing the premises from which by reasoning alone the effects can be deduced. Thus, it may be argued that the rationalist philosophers all held some hybrid conception of cause, involving a combination of cause (II)(the identification of causes with grounds, without which the thing would not be) and cause Aristotelian (scholastic) Conception (I), (the originators of a change).

II)ii. The Empiricist Approach: To David Humecommonly held to be the main representative of the empiricist approach to causation, our idea of causal necessity is due partly to our observation of the constant conjunction of certain objects, and partly to the feeling of their necessary connection in the mind. The habitual impression of conjunction feels like a necessitation, as if the mind were compelled to go from one to the other. The necessary connection is not discovered in the world but is projected onto the world by our minds.

Kant's concept of cause[15], by which he tried reconcile the rationalist and empiricist views, is a hybrid of (II)i and (II)ii. Because causal relations involve laws (II), Kant in effect says that an event A is the cause of an event B if, and only if, there is a universal law of the form: events of type A are necessarily followed by events of type B. But, while defending the rationalist idea that causality is an a priori conception, which involves strict universality and necessity (II)i, he also holds the empiricist view that causes precede their effects, which from the perspective of (II)i(according to which, causes are contemporaneous with their effects) is utterly impossible.

Mill too conceived causal relations in terms of law-like generalizations (II). His analysis is about kinds of causes and kinds of effects. The "real cause" of an event is that set of conditions which, when they are all met are invariably and unconditionally followed by the type described as the effect[16].

All in all, the complex evolution of the concept of cause from the seventeenth century on is marked by the interplay between, at least, two radically different conceptions of cause: the Aristotelian-scholastic conception, according to which causes are the

15 Hatfield, Gary. *Prolegomena to Any Future Metaphysics*, translated and edited by Gary Hatfield, revised edition (Cambridge: Cambridge University Press, 2004).
16 Mill, John Stuart. (1874). *A System of Logic.* Eighth edition. New York: Harper and Brothers.

active initiators of a change, and the scientific conception, according to which causes are the inactive nodes in a law-like implication chain.According to I, 'A is the cause of B' means 'A is the initiator of a change in B'; according to II, 'A is the cause of B' means 'Given the occurrence of B, A must necessarily have occurred.'This is probably the basis of Granger Causality[17]. Hicks in his book focuses on the time dimension of the cause and the temporal relationship between cause and effect. Hicks focuses on three perspectives on time: eternity, a period of time, and a point in time. But the reader of Hicks from the perspective of economic theory methodology will be disappointed if he is looking for some criteria by which to choose between, for example, the labor theory of value, subjective value theory, or some eclectic theory. Hicks is not really concerned with what constitutes causality. He only notes that there are some theories in which both cause and effect are eternal[18].

III. Further Understanding of the Term, Causation.[19]

a) Causation as a Relation

According to the scientific view, Causation means some sort of law-like relation between cause and effect, rather than the production of an effect by its cause. In Hulswits writings[20] the term 'causation' is used exclusively for the production of an effect by a cause, and the term 'Causality' for the relation between cause and effect. If correct, the distinction has far reaching consequences. For, since each of the modern theories concerns causality rather than causation. The contemporary discussions of the concept of 'cause' pertain to causality rather than to causation. By asking, "What are the necessary and sufficient conditions for something to be a cause?". They fail to address the more basic issue of Causation.

b) Causal Relation as External to Relata

Contemporary discussions of causation are inherently affected by Hume's views on the subject. One sign of this influence is the idea that the relationship between causes and effects is a purely external affair. Causes are not merely external conditions of an effect; there is an 'active immanence' of the causes in the effects[21].

c) Causal Relata as Discrete Entities

Whitehead makes clear that, without some continuity between a past event as a cause and a present event as its effect, we simply cannot have any recollection of something happening a quarter of a second ago. Though our experiences are in some sense

17 Granger, C.W.J. (1980)."Testing for causality: A personal viewpoint". *Journal of Economic Dynamics and Control* **2**: 329–352

18 Hicks, John.R, Causality in Economics, New York: Basic Books, Inc., 1979, pp. *xii*, 124

19 Hulswit, Menno. "Causality and causation: The inadequacy of the received view." *SEED* 2 (2004): 3-23

20 Ibid.

21 Whitehead, Alfred N. 1929/1978. *Process and Reality.An Essay in Cosmology.* New York: The Free Press

definite, individual events, they are continuous in respect of their subjective forms; there is, in Whitehead's words, an "identity of subjective form inherited conformally from one occasion to the other"[22]. Similarly, C.S. Peirce (1839-1914) concluded on the basis of a detailed analysis of the question, “How can a past idea be present?” that events are not discrete because they do not have a definite beginning and a definite end. According to Peirce, saying that a past idea can be vicariously present explains nothing because it raises once more the question how this vicarious representation is related to the past idea. After thus having rejected the idea of vicarious representation, Peirce presented the only possible alternative:

“How can a past idea be present? Not vicariously. Then, only by direct perception. In other words, to be present, it must be ipso facto present. That is, it cannot be wholly past; it can only be going, infinitesimally past, less past than any assignable past date. We are thus brought to the conclusion that the present is connected with the past by a series of real infinitesimal steps.”[23]. So a kind of continuity with the past was introduced by Pierce.

d) Causation and Time

Though it is said that causes precede their effects in time, it is not stipulated how this precedence affects the relationship. If there is indeed a temporal priority of causes to their effects, then causation must somehow involve the production of the effect by its cause such that the cause precedes its effect. And "if [causation] does involve 'production', then it is a process rather than a relation"[24]

The ambivalence regarding the status of causal relata is a symptom of the circumstance that our modern worldview is strangely caught between Aristotle's substance ontology and the modern scientific fact ontology. It would appear that the received view's apparent insistence on events is trapped between Aristotle's substance ontology and the modern scientific fact ontology. This tension may be a heritage of Hume's ambivalence when he described causation as a relation between types of events, thereby implicitly endorsing a fact ontology, while his examples were expressed in the terminology of a substance ontology. The confusion seems hopeless.

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22 (Whitehead [1933] 1933/1967. *Adventures of Ideas.* New York: The Free Press 1967, 186).

23 Peirce, C.S. (1992). *The Essential Peirce.Selected Philosophical Writings.* Vol. I (1867-1893). Eds. N. Houser and C. Kloesel. Bloomington: Indiana University Press. (EP I: 314; 1892)

24 Bennet, James 0.(1974). "Process and Causality." *Tulane Studies in Philosophy.* Vol. 23. Studies in Process Philosophy I. Den Haag: MartinusNijhoff. 1- 12.

One of the main reasons of the inadequacy of the received view of causation is the interpretation of events as changes in a substance. This view is inconsistent because it is based upon two incompatible categorical frameworks: a substance ontology and a fact ontology. The tendency to implicitly conceive the causal relata as substance-like entities is rooted in Aristotle's substance ontology, and contradicts the standard view that causation is some sort of relation. The latter view goes back to the fact approach to reality, which became predominant in the seventeenth century. Thus, the history of the concept of cause was seen to be intimately related to the historical evolution from the substance ontology to the fact ontology. This evolution was marked by two decisive milestones: (I) the Aristotelian-scholastic Conception, according to which causes are the active initiators of a change (substances), and (II) the (seventeenth century) Scientific Conception, according to which causes are inactive nodes in a law-like implication chain (facts). The inadequacy of the received view is (partly) due to the fact that it has failed to recognize this basic ambiguity, and that it has taken the Scientific Conception (II) as point of departure, which, from both an historical and an ontological point of view, is a derivative conception of cause.

Hulswit made a distinction between causation, or the production of an effect by a cause, and causality, or the relation between cause and effect, and concluded that the received view concerns only causality. I argued that causation is more fundamental than causality, because causes and effects are abstractly separated aspects from a continuous process of causation. Mistaking the nature of the relationship between these abstracted elements for the core of causation is due to confusion between conceptual abstractions and the concrete reality from which they are derived. We further need to study the approach of major philosophers to Causality

e) David Hume and Causality

The following aspects of David Humes writings are of interest[25]

From an Enquiry in Human Understanding- The fact that there are different species of philosophy-i) abstract reasoning and ii) clear simple logic. Secondly, Ideas are less vivid than sensations of impressions. Thirdly he discusses, how ideas can be contradicted not facts which can only be true or false. Further his study underlines, how if one wants to truly wants to understand cause and effect one must understand habit, custom and belief and that this belief of necessary connection between one event and its following event is something which is felt after uniform experience. Also he discusses that habit, custom and belief leads us to surmise about our feelings

25 (Beauchamp, Tom L. and Rosenberg, Alexander:Hume and the Problem of Causation, 1981;David Hume,EUH, edited by Tom L Beauchamp, 2000.)

regarding chance, cause or probability of an event based on experience. Further from general references on Hume and Causality we can surmise that there are no innate ideas and all knowledge comes from experience.

Hume rigorously applies this standard to causation and necessity. Also another concept discussed in Hume is that we have a very tenuous grasp on causal efficacy. Despite constant conjunction of events A and B we are left with a very weak notion of necessity. The above leads to the problem of Induction. We cannot go from Evidence to Hypothesis from effect to cause. We cannot establish a hypothesis by assuming a hypothesis. Further the copy principle shows that senses of impressions lead to ideas, which are less vivid and are product of intellect. So,causal reasoning is just due to experience, that's all. Causal Reductionism suggests that our only notion of causation is constant conjunction with certitude; the mental determination of the mind according to some is thus not emphasized and considered contrary to Humean emphasis on necessity which does not emphasise causal efficacy just causal conjunction.

f) Hume's Work Explored Further[26]

Hume intended to study human nature through a scientific method. Earlier on he complained that the ancient philosophers repeated the errors of ancient natural philosophers or philosophers of (what passed of as) science then, in that, they concentrated on consulting their imagination in constructing their views about virtue and happiness without consulting Human nature. Thus Hume's study was empirical. According to Hume the philosophers of his period (the early modern period) made the same mistakes as the ancients did, whereas natural philosophers (now called scientists) had progressed to using the empirical method, philosophers were instead too speculative and relying on a priori assumptions. The constructive phase which linked philosophy to human nature, explained causation through empirically describing perceptions as impressions and ideas, with impressions being responses to ideas and explaining the emphasis of the force or vivacity of an impression distinguishing it from an idea which precede it, this is the Copy principle, to support which he describes that a person having not experienced a particular shade of colour can move from his impression of other shades to the idea of this shade, thus a contradiction or an exception to the rule, thus proving it. Hume states that while ideas can be contradicted, facts are just true or false; this distinction is Hume's fork. Hume further explained Causal inference, he shows that if we assume future will be like past

26 Morris, William Edward and Brown, Charlotte R., "David Hume", *The Stanford Encyclopedia of Philosophy* (Summer 2014 Edition), Edward N. Zalta (ed.), URL=<http://plato.stanford.edu/archives/sum2014/entries/hume/>.

We can show a connection between past and future, but from past we cannot go to future using demonstrative reasoning because state of nature can change, we can of course go by using that future will be like past, but that will be trying to establish a probable argument like future will be like the past by assuming a probable argument (that future will be like past) which is circular reasoning. So he comes to a solution by explaining skeptical doubts of understanding by describing custom or habit which is the general names for the principles of association which make the future conformable to the past in our mind and this tendency to believe an association is thus explained. Further he explains necessary connection: this is Hume's description of causal necessity which expresses simply the succession of one event to another not the efficacy of determination or power leading to cause-effect relation, he finally defines external impression as one event following another in one definition and the internal impression of custom of one event following another as the second definition of causation.

A Study on Causation[27] which begins with an analysis of Hume states that Hume's conclusion about causation seems to be summed up in the two definitions[28] of a cause. These definitions, identify causation first with regular succession and then with succession together with a psychological association. How are the two definitions even to be reconciled with one another? There may well be regular successions such that ideas of the successive items provoke no associations, and again successions which are not regular but are such that the ideas of the successive items are suitably associated. Further, we need to introduce probabilistic causation, although this is strictly speaking not necessary for linking Causality to Heuristics, however a deeper understanding of causality requires us to understand probabilistic causation:

IV. Probabilistic Approaches to Causation

Philosophers have studied the role of probabilistic notions in the analysis of causal concepts. Probabilistic Causation uses probability theory to designate a group of theories that aim to characterize the relation between cause and effect. The central theme of Probabilistic Causation is the idea that causes change the probabilities of their effects.

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27 J.L.Mackie, The Cement of the Universe, A Study of Causation, Oxford, At the Clarendon Press, OUP, 1980, Reprinted, 2002.

28 David Hume, An Enquiry concerning Human Understanding,, Section Seven, Barnes and Noble New York, 2004.

Some preliminaries:

The Regularity Concept[29] involves the concept of causation and further defines that causation involves a regular association between cause and effect. This "regularity association" means that causes are contiguous with their immediate effects and precede them. This argument is made by David Hume. A further argument made by Hume quoted in the same reference above is that the human psychological propensity to pass from an "impression"(perception) of a cause to an idea of its effects or from a perception of an effect to an idea of its cause. (Causal Inference involves just that i.e., from effect to cause). This leads people to mistakenly believe that there is a "necessary" connection between cause and effect. Beauchamp and others argue that this notion of necessity is very weak. Sources on Philosophy quote that[30] there are Causal Realists as well as Causal Skeptics, Causal Skeptics are those who claim that Hume's problem involving inductive logic of Causal Inference is unsolved and Causal Realists who introduce additional interpretive tools to avoid these conclusions and maintain that Hume has some robust notion of Causation. These analysts including Hausman[31] claims that this kind of a Humean account takes the Mystery out of Causation and while retaining the all-important links between causation and regularities explains the mistaken belief that there is more to Causation than regularity, contiguity and time order. These skeptics say that there is not much to the notion of Causal efficacy(see Beauchamp for more on this).

Imperfect Regularities:Let us consider certain weaknesses of regularity theories. Imperfect'Regularities' can have some implications. We again recapitulate that Regularity means that causes are invariably followed by effects, so smoking causes cancer, but is smoking inevitably followed by cancer? Some smokers do not develop cancer, also there are heterogeneity of effects, cancer may be caused due to genetic reasons to a non-smoker, or a smoker can get cancer due to exposure to some other carcinogenic agent, also, determinism says that if an event occurs then its effect is bound to occur, or another event that is the logical effect of this is bound to occur, but probabilistic theories show that sufficiency for an effect may not be simply a certain

29 Daniel M. Hausman. (1998). Causation, Regularities, and Time: Hume's Theory. In: *Causal Asymmetries*. pp. 36-54. [Online].Cambridge Studies in Probability, Induction and Decision Theory. Cambridge: Cambridge University Press. Available from: Cambridge Books Online <**http://dx.doi.org/10.1017/CBO9780511663710.005**> [Accessed 08 August 2014].

30 Fieser, James (2011). Hume,David. In James Fieser & Bradley Dowden (eds.), *Internet Encyclopedia of Philosophy*.

31 Daniel M. Hausman. (1998). Causation, Regularities, and Time: Hume's Theory. In: *Causal Asymmetries*. pp. 36-54. [Online].Cambridge Studies in Probability,Induction and Decision Theory. Cambridge: Cambridge University Press. Available from: Cambridge Books Online <**http://dx.doi.org/10.1017/CBO9780511663710.005**> [Accessed 08 August 2014].

cause if the effect is not physically determined by the cause, so smoking may not be a sufficient cause to create cancer, a person may live hundred years after smoking 60 cigarettes his whole life.

The central concept behind probabilistic theories of causation involves the idea that causes change the probability of their effects. An effect may both, still occur in the absence of its cause or fail to occur in its presence, smokers is a cause of lung cancer, not because all smokers develop lung cancer, but because cancer is more likely in case of smokers than non-smokers. This is entirely consistent with the concept of imperfect regularity that some non-smokers get cancer and some smokers do not get it.

Irrelevance: Something may be followed by another or even lead another, but may make no difference to it. Probabilistic theories of causation involve making a difference for the probability of its effect.
Asymmetry: A causes B but B does not Cause A. So A must precede B, but what we need is not just a statement of the directionality of causation but an explanation of it.
Spurious Effect: Atmospheric pressure falls in a certain region, barometer reading falls and there is a storm. So drop in reading causes the storm if storm is preceded by a fall in reading, but this causation is spurious.

V. Critical Analysis of Probabilistic Causation

A. Susa and Tooley's Analysis

Susa and Tooley critically analyze philosophers' study of the role of probabilistic notions in the analysis of causal concepts[32]

a) Philosophers studying probabilistic causation have claimed that Causation is not restricted to deterministic process.
b) Probabilistic Causation states that Causes must in some way make their effects more likely.
c) Logic of Probabilistic Causation involves the notion of difference between conditional and unconditional probabilities of a given type of event. An event of type C is positively relevant to an event of type E if and only if the conditional probability of an event of type E conditional to C is greater than the unconditional probability of an event of type E. Another explanation involves the notion of subjective conditionals of the individual event in question, sufficient condition of C causing E would be conditional event E occurring if C occurs is greater than in case C does not.

32 Ernest Susa, Michael Tooley (ed.),Causation (Oxford Readings in Philosophy) Oxford, (1993), page 19-20

B. Salmon's Contribution[33]

Salmon says that probabilistic causal concepts are used in innumerable contexts of everyday life and science. For instance various substances are known to cause cancer in laboratory animals even though there is no presumption that every laboratory animal exposed to the substance developed any malignancy. Salmon writes that in philosophical literature, there arethree attempts to provide theories of probabilistic causality: Hans Riechenbach, I J Good and Patrick Suppes have offered reasonably systematic treatments.[34] His main conclusions include the following:

a. Event E may have greater unconditional probability than C causing E, because other causal factors incompatible and more efficacious than C may exist.
b. Whereas the logical probability of an event of type E, given only that events of type C causally necessitate events of type E, will be higher than the a priori logical probability of an event of type E.But this relation cannot be used as a part of a probabilistic analysis of causation since the relation itself involves that very concept.
c. Salmon suggests not to abandon relating causation to probability but to supplement probabilistic concepts with other ones, in particular with causal processes.

The most difficult problem involves the dictum that cause effect relations must always involve positive statistical relevance. Dictum cannot be accepted in an unqualified way yet a cause which can probabilistically bring about a certain effect may atleast raise the probability of that effect vis-à-vis some other state of affairs.

C. Riechenbach's Theory[35]

a) Screening Off
If A causes C which in turn causes E then C is causally between A and E and Screens off A and E, also if A and E are both caused by C as in the above example where the barometric pressure dropping(C) led to mercury reading falling(A) and Storm(E), the pressure falling screening off the storm from the mercury falling, mercury falling makes no difference to the storm.

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33 Ibid, page 19-22
34 Hans Riechenbach. *The Direction of Time*(Berkeley, Calif. and Los Angeles, 1956); I J Good, 'A Causal Calculus I', British Journal for the Philosophy of Science, 11/44 (1961), 305-18, Suppes, A Probabilistic Theory of Causality, Amsterdam, 1970
35 Salmon, W. C. (1980), "Probabilistic Causality", Pacific Philosophical Quarterly 61: 50-74. Reprinted in:Ernest Susa, Michael Tooley (ed.),Causation (Oxford Readings in Philosophy) Oxford, (1993).page 138-142

b) 'Common Cause Principle' (CCP): Reichenbach formulated a principle he dubbed the 'Common Cause Principle' (CCP). Suppose that events A and B are positively correlated, i.e., that

$$P(A\&B) > P(A)P(B).$$

But suppose that neither AnorB is a cause of the other. Then Reichenbach maintained that there will be a common cause, C, of A and B,this is used in dropping variables from a model that are correlated and is a pointer to missing variable. Reichenbach says that the common cause explains the correlation between A and B. Although Reichenbach is not always clear about this, the most sensible way of understanding this is as what Hempel (1965) calls a Deductive-Statistical explanation.The idea is that probabilistic correlations that are not the result of one event causing another are to be explained in terms of probabilistic correlations that do result from a causal relationship.

There is a relation that may be simply statistical that means there is a relation between two events but one does not lead to another. This means that there is no causal relation.If events A and B have more than one common cause, then there will be no one common cause that screens A off from B. CCP may fail if events A and B are not distinct. For example, it may fail if A andB are logically related, or involve spatiotemporal overlap. Suppose that events E, F, and G are completely unrelated, and that they are probabilistically independent. Define A to be E&F, and B to be E&G. Now A and B will be correlated, due to the logical overlap, and there may be no cause that screens them off. Or suppose that I am throwing darts at a target, and that my aim is sufficiently bad that I am equally likely to hit any point on the target. Suppose that a andb are regions of the target that almost completely overlap. Let A be the event of the dart's landing in region a, B the dart's landing in region b. Now A and B will be correlated, and there may well be no cause that screens them off.

c) Path Specific Causation
Consider a well-known example. Consumption of birth control pills (B) is a risk factor for thrombosis (T). On the other hand, birth control pills are an effective preventer of pregnancy (P), which is in turn a powerful risk factor for thrombosis. Overall, birth control pills lower the probability of thrombosis. Nonetheless, there seems to be a sense in which it is correct to say that birth control pills cause thrombosis. Here is what is going on: The use of birth control pills affects one's chances of suffering from thrombosis in two different ways, one 'direct', and one via the effect of pills on one's chances of becoming pregnant. Whether birth control pills

raise or lower the probability of thrombosis overall depend upon the relative strengths of these two routes. As it turns out, for many women, the indirect route is stronger than the direct route, so the overall effect is to prevent thrombosis.By holding fixed whether or not a woman becomes pregnant, we can isolate the component effect of pills on thrombosis via the other causal pathway. More generally, we can determine the component effect of C for E along a causal pathway by holding fixed (positively or negatively) all factors that are causal intermediates between C and E that do not lie along the given the path (together with the other factors required by the theory).

D. Suppes Theory[36]

Given the basic probability-raising idea, one would expect putative counterexamples to probabilistic theories of causation to be of two basic types: cases where causes fail to raise the probabilities of their effects, and cases where non-causes raise the probabilities of non-effects. The discussion in the literature has focused primarily on the first sort of example.

(a) Probability-lowering Causes. Consider the following example, due to Deborah Rosen (reported in Suppes (1970)). A golfer badly slices a golf ball, which heads toward the rough, but then bounces off a tree and into the cup for a hole-in-one. The golfer's slice lowered the probability that the ball would wind up in the cup, yet nonetheless caused this result.

Let S represent the golfer's slicing the ball, H her hitting a hole-in-one, and B be the appropriate background context. Now ~S is actually a disjunction of several alternatives: if the golfer hadn't sliced the ball, she might have hit the ball cleanly (S'), or missed it altogether (S?). Rather than saying that the golfer's slicing the ball caused the hole-in-one, and trying to analyze this claim by comparing P(H | S&B) and P(H | ~S&B), we can make two more precise contrastive claims. The golfer's slicing the ball, rather than missing entirely, caused the hole-in-one, as evidenced by the probabilities P(H | S&B) > P(H | S? &B), but her slicing the ball rather than hitting it squarely did not cause the ball to go in the hole: P(H | S&B) < P(H | S' &B)

b) Preemption: A different sort of counterexample involves causal preemption. Suppose that an assassin puts a weak poison in the king's drink, resulting in a 30% chance of death. The king drinks the poison and dies. If the assassin had not poisoned the drink, her associate would have spiked the drink with an even deadlier elixir

36 Ibid, page 143-151.

(70% chance of death). In the example, the assassin caused the king to die by poisoning his drink, even though she lowered his chance of death (from 70% to 30%). Here the cause lowered the probability of death, because it preempted an even stronger cause.

One approach to this problem would be to invoke a distinction between net and component effects. The assassin's action affects the king's chances of death in two distinct ways: first, it introduces the weak poison into the king's drink; second, it prevents the introduction of a stronger poison. The net effect is to reduce the king's chance of death. Nonetheless, we can isolate the first of these effects by holding fixed the inaction of the associate: given that the associate did not in fact poison the drink, the assassin's action increased the king's chance of death (from near zero to 0.3). We count the assassin's action as a cause of death because it increased the chance of death along one of the routes connecting the two events.

c) Probability-raising non-causes. For a counterexample of the second type, where a non-cause raises the probability of an outcome, suppose that two gunmen shoot at a target. Each has a certain probability of hitting, and a certain probability of missing. Assume that none of the probabilities are one or zero. As a matter of fact, the first gunman hits, and the second gunman misses. Nonetheless, the second gunman did fire, and by firing, increased the probability that the target would be hit, which it was. While it is obviously wrong to say that the second gunman's shot caused the target to be hit, it would seem that a probabilistic theory of causation is committed to this consequence. A natural approach to this problem would be to try to combine the probabilistic theory of causation with a requirement of spatiotemporal connection between cause and effect.

E. Two Types of Scientific Explanation

Inductive Reasoning helps us from a specific observation to form a hypothesis or theory. The premises should provide some degree of support for the conclusion.

Deductive Reasoning helps us in applying the General Theory or Hypothesis to reach a specific conclusion where the premises logically entail the conclusion, in a valid deductive argument thus truth of premises is a guarantee of the truth of the conclusion.

An inductive argument is one which goes from specific to general, a deductive argument is an argument which goes from general to specific, more elaborately an

inductive argument is one which goes from a specific observation to a general hypothesis or a theory. A deductive argument is one which goes from a general theory or hypothesis to a specific conclusion.

However Inductive reasoning merely helps use of logic in forming a hypothesis or theory that may not entail a conclusion which is true. Meanwhile, Deductive Reasoning is a form of valid reasoning that is it helps us in using logic to reach a true conclusion. On the other hand, Deductive Logic helps us in applying the scientific method created by inductionists to reach specific situations.

A description of Hempels two types of scientific explanation is elaborated by us.[37] The deductive nomological explanation explains the event to be explained ie the explanandum to be expected by reason of certain explanatory facts. These facts may be divided into two groups: 1) particular facts and 2) uniformities expressed by general laws. This amounts to a deductive subsumption of the explanandum under principles which have the character of general laws: it answers the question "Why did the explanandum event occur?" by showing that the event resulted from particular circumstances in accordance with laws. This conception of laws has been referred to as the Covering Law Model or the deductive model of explanation.

The explanatory laws can be the character of empirical generalisations connecting different observable aspects of the phenomena under scrutiny, or as science often involves, the answer to the question, Why? With respect to the uniformities expressed by such laws, which can be answered in basically the same manner, namely by subsuming the uniformities under more inclusive laws and eventually under comprehensive theories.

An explanation of a particular event is often conceived as specifying its cause or causes, in the context of explanation a cause must be allowed to consist in a more or less complex set of particular circumstances, the assertion that those circumstances jointly caused by a given event, implies that wherever and whenever circumstances of the kind in question occur, an event of the kind to be explained comes about. Hence, the given causal explanation implicitly claims that there are general laws, by virtue of which the causal antecedents mentioned by the circumstances, is a sufficient condition for the occurrence of the event to be explained.

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37 Hempel, C. (2002). Two models of scientific explanation. In Yuri Balashov& Alexander Rosenberg (eds.), Philosophy of Science: Contemporary Readings. Routledge.Pages 45-51.

The converse does not hold: there are deductive-nomological explanations which would not normally be counted as causal, we do not consider the subsumption of scientific laws under more comprehensive principles as causal, we speak of causes only in reference to particular facts or events and not in reference to universal facts as expressed by general laws. But not even all deductive nomological explanation of particular events will qualify as causal; for in a causal explanation some of the explanatory circumstances will temporally precede the effect to be explained: and there are explanations of the deductive nomological type which lack this characteristic. So in conclusion, laws are important in DN model, they connect the explanandum event with the particular conditions cited in the explanans, and this is what confers upon the latter the status of explanatory (and, in some cases causal) factors in regard to the phenomenon to be explained.

In Deductive-Nomological explanation, the laws and theoretical principles involved are of strictly universal form: they assert that in all cases in which certain specified conditions are realised an occurrence of such and such a kind will result. Hempel[38] distinguishes two varieties of statistical explanations, the Deductive Statistical explanation involves deduction of a narrower statistical uniformity from a more general set of premises. The Inductive Statistical explanation involves statistical laws subsuming individual events, the conclusion is not entailed by the premise but if the probability of the premise being true is high then the probability of the conclusion being true is also high. Probabilistic Statistic Explanation is also nomological, it accounts for a given phenomenon with reference to general laws or theoretical principles; but some or all of these are of probabilistic-statistical form, ie, they are, generally speaking assertions to the effect that if certain specified conditions are realised, then an occurrence of such and such a kind will come about with such and such a statistical probability.

In the case of Inductive Reasoning if we want to connect the antecedent event with the explanandum and thus to establish its explanatory significance for the latter, we cannot invoke a universal law to the effect of the explanan on the explanandum, what can be asserted is only a generalisation that the explanan will be followed by the explanandum with high statistical probability.

Thus our distinction of the two types of explanation are based on the fact that:

> Probabilistic explanations involve degrees, DN involve either/or.
>
> That DN asserts that all elements of a certain reference class have a specified property and IS asserts that in the long run a specified proportion of the members of the reference class have some specific property.

38 Hempel, Carl, 1965, *Aspects of Scientific Explanation*, New York, NY: Free Press.

VI. Research Topic in Behavioral Economics: The Role of Causality in Judgement under Uncertainty

Most so-called "errors" in probabilistic reasoning are in fact *not* violations of probability theory[39]. Examples of such "errors" include overconfidence bias, conjunction fallacy, and base-rate neglect.Statistical principles are not learned from everyday experience because the relevant instances are not coded appropriately. The lack of an appropriate code also explains why people usually do not detect the biases in their judgments of probability. Gigerzener proposes a more contemporary frequentist interpretation of probability rather than the subjectivist interpretation of Kahneman and Tversky. However more relevant for our study work done by Tevye R. Krynski and Joshua B. Tenenbaum from the Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology on Bayesian Causal Inference[40] shows that Bayesian inference over causal models can more accurately explain the variance of applying statistical principles versus everyday reasoning. Below we describe their article which shows that Causal Bayesianism will predict people's behaviour more accurately than Classical Bayesianism. (Hicks has a book which talks of interpreting effect preceding the cause[41]. Bernard Weiner while working on Social Psychology also talks of spontaneous causal thinking[42].)

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39 Gigerenzer, G. (1991a). How to make cognitive illusions disappear: beyond "heuristics and biases". In W.Stroebe, & M. Hewstone (Eds.), European review of social psychology (Vol. 2, pp. 83-115). Chichester, UK: Wiley

40 Krynski, T. R., &Tenenbaum, J. B. (2007).The role of causality in judgment under uncertainty. *Journal of Experimental Psychology: General*, *136*(3), 430.

41 Hicks, John.R, Causality in Economics, New York: Basic Books, Inc., 1979, pp. *xii*, 124

42 Weiner, B. (1985). "'Spontaneous' causal thinking". *Psychological Bulletin*, 97, 74–84.

BOX. 1

Bayes Theorem

The conditional probability of both events A and B happening given that B has happened is given by the proportion of Probability of AB to Probability of B

And, we obtain learning factor as:

The overall chance of B happening is a weighted combination of its probability given that A happens (times A's own probability), and its probability that not A happens (times not A's own probability). Casanovas chance of seducing the countess depends on how swayed she is by charm times the likelihood that he will be charming plus how repelled she is by boorishness times the chance he is a boor.

Also if we call A our hypothesis and B the evidence,

So, suppose we are half sure X did a murder (Previous Hypothesis) we multiply this with (new) hypothesis, i.e., he did do the murder given the evidence divided by the Learning Factor which is the product of reliability of evidence given by how firm is the evidence given he did the murder and how non-firm is the evidence given he did not do it.

They test the hypotheses that people's judgments can be explained as approximations to Bayesian inference over appropriate causal models and that base-rate neglect often occurs whenexperimenter-provided statistics do not map clearly onto parameters of the causal model participants are likely to invoke.

The intuitive statistician hypothesis using classical Bayesian norms was not long-lasting as it was not able to account for a rapidly accumulating body of experimental evidence that people reliably violate Bayesian norms.

When people are confronted with a judgment task, they facethree distinct aspects of judgment: (a) constructing a causal model,(b) setting the model's parameters, and (c) inferring probabilitiesof target variables via Bayesian inference over the model.

The need to make intuitive statistical judgments is a pervasive fact of life in human society. But if people relied only on purely statistical information, they would be in dire straits, as the remarkable flexibility, success, and inductive potential of

commonsense would be impossible. Fortunately, people's physical, biological and social environments are causally structured, and their intuitive theories of the world are often—but not always—sufficient to capture the most relevant structures for enabling appropriate causal Bayesian inferences. In experimental studies, if we present participants with a clear causal structure and statistics that clearly map onto that structure, we can nearly eliminate traditional judgment errors, such as base-rate neglect, and dramatically boost the incidence of correct Bayesian reasoning.

This extension of our study of Causal thinking to Behavioral Economics can be further analysed after initial testing in our further research.[43]

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43 Gigerenzer, Gerd, and Ulrich Hoffrage. "How to improve Bayesian reasoning without instruction: Frequency formats." *Psychological review* 102.4 (1995): 684.
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