Logical Relevance

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This is a study aiming to understand the use of the concept of logical relevance in evidence law in terms of its use in logic itself. How do logicians understand logical relevance?

In everyday use, "logical" means pretty much the same thing as 'rational' or 'reasonable', and "relevant to" means something like 'significant for' or 'related to'. Thus lawyers might mean by "logical relevance" simply 'rationally related to'. The use is so broad that either deductive logic or inductive logic might be meant, and one would expect that inductive use is usually meant.

However, although many lawyers today might use "logically relevant" in this broad way, legal treatises around the turn of the century indicate that something more specific was originally meant by this expression, used as a legal term. This something involves the two main areas of formal logic: deductive logic and inductive logic. Therefore let me begin by talking about logical relevance in deductive and inductive logic.

Formal logic concerns the evaluation of arguments according to their general form or structure, as opposed to their specific content. Generally this means replacing specific subject and predicate terms such as "human" with letters such as "H" in:

1. All humans are mortal.

2. Socrates is human.

3. Therefore, Socrates is mortal.

so that the form of the argument is revealed as:

1. All H are M.
2. s is H.
3. Therefore s is M.

This is a classic example of a deductive argument, because the conclusion is meant to follow with what might be called strict logical necessity. Conclusion (3) simply cannot be false, *if* premises (1) and (2) are true. Note that you could put anything in the places of s, H, and M, and the argument would be just as effective. Thus the argument is *formally* deductively valid. Note also that it is an inference going from a universal statement (1) and a particular event (2) to another particular event (3). Deductive arguments go from universal to particular or from universal to universal, typically speaking. An example of the latter would be, "All humans are mortal, all mortals perish, therefore all humans perish."

Now, an inductive argument is just any argument that is not a deductive argument. That is, the conclusion is meant to follow only with some likelihood, that is with some rational force less than strict logical necessity. Inductive arguments generally go from particular events to particular events:

1. In bloody murder #1, DNA identified the murderer.

2. In bloody murder #2, DNA identified the murderer.

3. Therefore in bloody murder #3 DNA will identify the murderer.

or from particular events to a universal statement:

1. In bloody murder #1, DNA identified the murderer.

2. In bloody murder #2, DNA identified the murderer.

3. Therefore in all bloody murders DNA will identify the murderer.

There are three main types of inductive argument admitted today: analogical, abductive, and probabilistic. Analogical arguments are based on relevant resemblances between things, but there is no special type of "analogical relevance." Usually causal relevance is meant. This most directly concerns the similar events rule in evidence law, but is involved in just about all legal reasoning. Abductive arguments are inferences to the best explanation. "The best explanation of the evidence is that Smith is the murderer, therefore Smith is likely to be the murderer." This is most directly relevant to scientific explanation, but every lawyer tries to tell a story which gives the best explanation of what happened. We might speak here of scientific relevance or more generally of explanatory relevance, but again what is usually meant is causal relevance.

Our main topic in inductive logic is probabilistic argument. There is always an aspect of analogy, or of relevant respects of resemblance, in a probabilistic argument, but these arguments are mainly based on the sheer number of particular events described in the premises. Is there any such thing as probabilistic relevance? Would it typically boil down to causal relevance, or should we be distinguishing here between causal relevance and merely statistical relevance? Or would it, perhaps, be a form of logical relevance, since mathematical statistics is broadly speaking a deductive logical study, as is mathematics in general?

Ever since Aristotle invented formal logic over two thousand years ago, logicians have understood logical relevance as being a conclusion's *following from* premises with logical necessity. Thus logical relevance has always belonged to deductive logic. In formal logic, it is the general relation of formal deducibility.[1]

The one thing all logicians agree on without exception is that logical relevance obtains only within the domain of deductive logic, and never for probabilistic arguments. In particular, the premises of a probabilistic argument are not and logically cannot be logically relevant to its conclusion. If they were, then the conclusion would follow from the premises with logical necessity, as opposed to some degree of probability. This means that as compared to logicians, legal scholars have got it backwards when they speak of probabilistic arguments as logically relevant. They are using the expression "logically relevant" to mean completely the opposite of what logical relevance has meant in logic for over two thousand years. The question is, why? The one thing legal scholars cannot have in mind is logical relevance as understood in logic. --Or can they?

Probability divides into (1) mathematical statistics, also known as the probability calculus, dating to the seventeenth century, and (2) its several interpretations.[2] The calculus itself is as unobjectionable as arithmetic or algebra. But people have never agreed on how to interpret its key undefined notion, the notion of probability, or if you like h/e, the probability of hypothesis h given evidence e. Arguably there is no single best interpretation.

Today there are three main rival interpretations.

(1) The frequency interpretation of probability starts with Aristotle, who defined "probable" as what is usually the case. John Venn was its main champion in the nineteenth century; Richard von Mises and Hans Reichenbach have been its main champions in the twentieth. The frequency theory is strictly a logical interpretation of probability, insofar as the notion of many or few members of a class is a logical notion. But insofar as actual frequencies must be established by observation, here we need empirical interpretations of the logical interpretation of probability. There is nothing wrong with having a series of interpretations of interpretations. For example, Bertrand Russell interprets ordinary things in terms of molecules, molecules in terms of atoms, and atoms in terms of quantum events.

The frequency theory is naturally popular with scientists, statisticians, and epidemiologists. In fact, it is basic for anyone who works with huge populations of repetitive items. But it is hard to apply to unusual or nonrecurrent events.

(2) The first major challenge to the frequency theory was due to John Maynard Keynes. In his seminal treatise of 1921, Keynes gave a purely logical interpretation of degrees of probability as degrees of logical relevance, where relevance is a logically intuited relationship among propositions, and where deductive logical relevance is not an unreachable asymptote but a mere end of the inductive continuum. He defines "irrelevance" as follows: if h/e2,e1 = h/e1, then e2 is irrelevant to h/e1. This notion is basic to discussions of logical relevance in legal evidence casebooks such as Richard Lempert's, and is remarkably close to FRE 401.

(3) Keynes was criticized in turn by the mathematician Frank Ramsey, who found our intuitions of degrees of probability far too vague and conflicting to be deemed logical. Ramsey

invented the subjectivist interpretation of probability.[3]

Now, FRE 401 fails to distinguish between the probability calculus and its interpretation; it leaves probability undefined. And if FRE 401 is uninterpreted, it is useless. It would be like a geometry everybody accepts, but where everybody disagrees on which figures are circles and which figures are squares (Keynes). But the very term "relevant" suggests Keynes' interpretation. Keynes is the only thinker who interprets probability as logical relevance. But FRE 401 defines relevance in terms of probability, and never defines probability. Thus if FRE 401 is due to Keynes, it gets Keynes backwards. The whole question is what probability is in the first place. The fundamental task of probability theory is to answer that question. Aristotle, Venn, Keynes, Ramsey, Mises, and Reichenbach all agree that probability is the obscure and basic notion needing explanation. But FRE 401 goes in the opposite direction and defines relevance in terms of probability.

Admittedly Keynes defines degree of probability as degree of logical relevance, and then defines irrelevance in terms of h/e probability, the latter definition going in the same direction as FRE 401. But the former definition is the basic one, and nothing in FRE 401 corresponds to it. Whether this means Keynes has two notions of relevance, a basic one and a defined one, I do not know.

Even worse, if FRE 401 is an endorsement of Keynes, then FRE 401 is a rejection of all of Keynes' rivals. And the chief rival to Keynes, the frequency theory, is the one used by scientists dealing with mass repetitive phenomena. We would be treated to the spectacle of evidence law's using Keynes' interpretation of probability to evaluate scientific theories which are based on the chief rival to Keynes. That may be the only practical way for lawyers to go. But from the theoretical point of view it is to prejudge the whole question of what probability is by assuming the Keynesian interpretation as correct and then using it to resolve any questions in favor of Keynes.

My view is that legal “logical relevance” is not due to Keynes, but possibly the other way around. Keynes goes out of his way to praise judges for understanding that probabilities cannot ordinarily be assigned exact numerical values. He clearly wishes to bring his theory of probability into line with the law in this regard. Perhaps Keynes developed his notion of logical relevance from legal ideas as well.

When did courts and legal scholars first start talking about logical relevance? What did they have in mind? What is the origin of such talk, if not Keynes? Is its origin earlier than Keynes? Anglo-American evidence law did not develop a logical interpretation of probability, but instead a logical framework for formally asserting probability. Legal scholars came to see that inductive arguments can always be rewritten as deductive arguments, and that while that could not improve the strength of the arguments interpreted at their strongest, it could articulate more clearly precisely what the induction was. The deductive arguments were very frankly conceived as old-fashioned Aristotelian syllogisms whose minor premises describe items of evidence, whose major premises describe general principles arrived at inductively, and whose conclusions describe the probability that certain material facts obtain or fail to obtain. This is what the Advisory Committee’s note to FRE 401 seems all about when it discusses deduction.[4]

To illustrate what the legal scholars had in mind, I will use our bloody murder example. Where a lawyer might simply argue:

(A) 1. In bloody murder #1, DNA identified the murderer.

2. In bloody murder #2, DNA identified the murderer.

3. Therefore in bloody murder #3, DNA will identify the murderer.

we instead will first generalize to a universal statement:

(B) 1. In bloody murder #1, DNA identified the murderer.

2. In bloody murder #2, DNA identified the murderer.

3. Therefore in all bloody murders DNA will identify the murderer.

We will then use that generalization as the major premise of this *formally valid deductive* argument:

(C) 1. Probably, in all bloody murders DNA will identify the murderer (inductive general principle).

2. Bloody murder #3 takes place (blood as item of evidence).

3. Therefore probably, in bloody murder #3 DNA will identify the murderer (identity as material fact to be proved).

While argument (C) is a deductive argument in form, that is just window dressing, since our only evidence for its major premise (1) is described in inductive argument (B). (B) and (C) taken together are a way of saying what argument (A) says, but with a higher degree of precision. The advantage of the long-windedness is only that you are forced to articulate a universal statement which will be both the conclusion (3) of (B) and the major premise (1) of argument (C). Often there is no one best way of doing that, since there are different generalizations you might make about the earlier bloody murders. Thus you are forced to make a choice about exactly what your argument is, and that will affect how good it is. This is often useful to the factfinder, and it can really make you (or your expert scientific witness) think.

There is no *interpretation* of probability in the old legal treatises, except for some remarks about the ordinary "course of events" which suggest traditional frequency interpretation á la Aristotle and Venn. But the legal talk of logical relevance does antedate Keynes' earliest work by nine years (1897-1906).

My conclusion is that it is both possible and likely that Keynes was inspired by English law. English law required evidence to be "relevant" as early as 1783, and articulated relevance as "logical relevance" as early as 1897. It is likely because Keynes himself cites cases from English law and approves of the judges' subtle understanding of degrees of probability which cannot be quantified by cardinal numbers: specifically, *Sapwell v. Bass*, 2 K.B. 486 (1910), and *Chaplin v. Hicks*, 2 K.B. 786 (1911).

There are three main problems with my conclusion.

(a) *Sapwell* and *Chaplin* fail to mention logical relevance or even relevance at all, and Keynes discusses them only to show that lawyers recognize that there are degrees of probability which cannot be numerically measured.

(b) The legal understanding of logical relevance is not the same as Keynes' understanding. Merely rewriting inductive arguments in deductive form gives them logical relevance only in the most superficial sense. Nor are there any degrees of deductive logical relevance. All the arguments would be equally deductively valid, and would differ only as to the degree of probability of truth of their respective major premises. All the arguments remain inductive at bottom, however analytically helpful the deductive format of the rewritings may be in forcing one to articulate the inductive principles one is relying on. In contrast, Keynes is holding that inductive arguments *left in their original inductive form* have degrees of logical relevance, because degrees of inductive probability *are* degrees of logical relevance. This is a deep, sophisticated, bold, and original theory, even if it is ultimately misguided.

(c) Keynes understands his degrees of logical relevance as intellectually intuited, Platonically real logical relations of premises to conclusions. I doubt that Anglo-American common law of evidence can be saddled with such an extreme metaphysical realism, or with such a pipe-smoking, armchair, a priori approach to discovering probabilities once the evidence is in. But I still think it is a fantastic coincidence that an English treatise on evidence law discussed logical relevance just a few years before Keynes started work on probability in 1906, that Keynes was familiar with English cases discussing degrees of probability which cannot be numerically measured, and that Keynes eventually advanced the theory that degrees of probability are degrees of logical relevance, even if they cannot be numerically measured. For a deep mind like Keynes', it would be a leap over a narrow ditch to learn the legal notion of logical relevance and be inspired to conceive the theoretical simplification that degrees of probability are directly and literally themselves degrees of logical relevance. For that is just what Keynes' theory is: a theoretical simplification of the legal notion of logical relevance.

NOTES

1. There seem to be three main features of logical relevance. (1) It is an *a priori* relationship, meaning it can be known independently of experience. (2) It is an intensional relation, meaning that it obtains in virtue of the meanings of the premises and conclusion. (3) Almost all traditional logicians have viewed logical relevance as a whole-part containment theory on which the content of the conclusion is somehow contained in the content of the premises. Often this has been represented by various kinds of diagrams ("Venn diagrams" are the most famous ones). It is this containment that explains logical relevance. But these three features leave much room concerning details.

In 1975 two world-class logicians, Alan Ross Anderson and Nuel D. Belnap, extended the chief ancient dispute about logical relevance in what is now considered the bible of relevance logic, *Entailment: The Logic of Relevance and Necessity*. They criticized Gottlob Frege and Bertrand Russell, two turn-of-the-century logicians who made the greatest improvements to logic since Aristotle, for using a relation called material implication as if it ensured logical relevance. Material implication is defined by this truth-table, where the boldface truth-values (T for truth, F for falsehood) are assigned to the whole sentence "P materially implies Q" strictly according to how plainface truth-values are assigned to the constituent statements "P" and "Q" as shown in the columns directly under P and Q:

	P	materially implies	Q
#1	T	**T**	T
#2	T	**F**	F
#3	F	**T**	T

#4	F	**T**	F

Note how rows #1-#4 form a matrix of all four possible truth-combinations of assignments of truth or falsehood to P and Q. Thus a material implication statement's truth or falsehood is defined for all possible truth-combinations of its constituent statements. Because its truth or falsehood is a strict function of their truth or falsehood, we say that material implication is a truth-functional statement connector.

Material implication is the minimal truth-preserving logical relationship. By definition, a material implication statement is false if and only if P is true and Q is false (see row #2). Two paradoxes of material implication were soon discovered. One paradox is that a false statement P materially implies any other statement Q, no matter how unrelated P and Q are in content. For instance, false P, "The Moon is made of green cheese," materially implies true Q, "The Eiffel Tower is in Paris." The other paradox is that a true statement Q is materially implied by any statement P, no matter how unrelated P and Q are. The same example shows this.

C. I. Lewis offered strict implication, where "P strictly implies Q" means 'It is logically necessary that P materially implies Q'. This avoids the paradoxes of material implication, but entails similar paradoxes of strict implication. Namely, an impossible statement P strictly implies any statement Q, and a necessary statement Q is strictly implied by any statement P. The same example illustrates both paradoxes: "The Moon is round and not round" strictly implies "1 + 1 = 2."

Anderson and Belnap offered a very strict and conservative relation atomizing premises and conclusion into Boolean normal forms and requiring literal containment of the conclusion-atoms among the premise-atoms. I shall not try to explain the details. The upshot is that their relation eliminates all the paradoxes mentioned so far, but ruthlessly (some would say paradoxically) eliminates much else which seems innocent, in particular, the rule of inference called disjunctive syllogism: P or Q, not-P, therefore Q. This has split the world of logic into conventional logicians and Anderson-Belnap logicians, depending on whether you admit disjunctive syllogism as a logical relevance relation.

In ancient times, Philo of Megara invented the relation of material implication. His teacher Diodorus Cronus discovered the paradoxes of material implication and invented what is basically strict implication. Nobody in ancient times came up with anything like the Anderson-Belnap relation. But plainly ancient logicians were already offering formal definitions of logical relevance. Stipulations by parties, judicial notice, and matters of law equate poorly to deductive logic, since ultimately these are almost always based on probabilities. Even matters of law may depend on probable legislative intent. What really matters here is the use of deductive reasoning, even about admitted evidence. The question is whether to allow disjunctive syllogisms. I expect that judges will be conventional and will ridicule any idea that if P or Q, and not-P, that it does not follow that Q. But since 1975, some of the world's best logicians would disagree with them. This is admittedly counterintuitive. But then logic is the business of convicting most of our ordinary logical intuitions of being wrong.

2. Within the field of probability, perhaps the most basic distinction is that between inductive probability and epistemic probability. Inductive probability is a relationship between the premises and the conclusion of an inductive argument. Epistemic probability is a relationship between a single proposition and all relevant knowledge which would make that proposition more likely or

less likely. The inductive probability of an argument is constant, invariant, and objective. In contrast, epistemic probability, though it may be objective in some sense, fluctuates across persons and times. That is because a written argument is invariant, while the pool of relevant knowledge can increase or decrease across persons and times. The basic relationship between inductive probability and epistemic probability is that epistemic probability is broader than inductive probability. If person p at time t has finite and definite pool of relevant knowledge k about the epistemic probability of hypothesis H, then the epistemic probability of H to p at t given that pool k is identical to the inductive probability of the argument whose premises exactly describe k and whose conclusion is H. As the pool of relevant knowledge fluctuates, it would be described by different inductive arguments with different inductive probabilities (Skyrms 1966: 15-18).

In the sense in which probability is the guide to life, in which we make most of our judgments of probability, we are almost always concerned with epistemic probability. That is because the sum of a person's relevant past knowledge can almost never be reduced to an inductive argument that can be written down. Such inductive arguments would have to have many thousands of premises describing relevant knowledge accumulated over many years, and there would be many questions as to its accuracy.

One might further distinguish between relative epistemic and absolute epistemic probability. The only epistemic probabilities we will ever use are relative to our finite and limited bodies of evidence. Such probabilities can conflict in a sense: people accumulate different bodies of evidence can often make opposing conclusions probable. Really they do not conflict, since after all they are relative. Absolute epistemic probability is an idealization which requires knowledge of all events in the universe which are relevant to H. Even absolute epistemic probability, of course, logically can still be mistaken.

It goes without saying that mathematical statistics, i.e. the probability calculus, cannot be brought to bear on epistemic probabilities as such, unless they admit statement in the form of a definite inductive argument. Thus mathematical statistics is restricted to inductive as opposed to epistemic probability.

Even within the domain of inductive arguments, mathematical statistics may not always be applicable in an arithmetically definite sense. That is, the content of an inductive argument need not be quantifiable in terms of some standard unit of measurement. However, there must at least be measure in the sense of greater or lesser probabilities, for mathematical probability theory to apply. This insight is due to Keynes.

Some probabilities may not even be commensurable as greater, less, or equal. In fact, most probabilities are arguably not commensurable in any straightforward way. Suppose a bloodstain and a smudged fingerprint to be at a murder scene. The blood may point to Smith and the fingerprint to Jones, but there is no common yardstick to measure which likelihood is greater in the case of a close call. This insight is due to Keynes, and it is often said to be ignored by statisticians because it robs them of their livelihood.

3. The subjectivist interpretation is an ingenious intellectual approach that does not satisfy our basic ordinary conception of probability at all.

Strictly speaking it is another empiricist theory, since we empirically introspect our degree of confidence that something will happen.

Few or none have been foolish enough to identify probability outright with subjective feelings of confidence (Black 1967: 476). There would be two problems. First, subjective certainties fluctuate across persons and times when the probability should remain the same (Black 1967: 476). Second, there is only a loose correlation between probability and subjective confidence in any particular case (HK 343, 396-98).

The sophisticated idea is first to measure degree of subjective confidence by willingness to bet, then to suppose an indefinitely huge number of subjective confidence bets on, say, indefinitely many drawings of balls from an urn. We then must "rectify" the resulting judgments of probability in two ways. First, we make them consistent with each other by removing those that are out of line with the rest. This is in effect mode averaging as opposed to mean or median, which I criticize as an illegitimate importation of frequency theory. Second, we impose a Dutch book standard that we do not allow the bettor to allow anyone to make Dutch book against him. That is, the bettor cannot let a hypothetical opposing bettor win no matter what the outcome of the drawing. That is, the bettor cannot be allowed to let the opposing bettor win 2:1 if the marble is black and also win 3:1 if the marble is white. That is logically consistent, but it is pragmatically absurd to guarantee that the opposing bettor will win no matter what the outcome.

Black says, "It is surprising but demonstrably true that if S's system of confidence values is coherent in this sense of rendering it impossible for anybody to make book against S, those values will obey the addition and multiplication rules of the mathematical theory of chances. This striking result gives the subjectivist access to the usual mathematical axioms and their consequences" (Black 1967: 476-77). What happens is that due to the huge number of bets, the idiosyncracies of the first bets are smoothed out in the long run. It does not even matter who the bettor is, even though we all have different kinds of subjective expectations.

Subjectivists have interpreted Bayes' Theorem on inverse probabilities with equal mathematical success. Once again, the idiosyncracies are mathematically smoothed out over the long run. This is once again astonishing because the initial probabilities that are inverted are based on nothing but people's subjective opinions (Black 1967: 477). Of course, Bayes' Theorem also has a logical interpretation á la Keynes and a frequency interpretation á la Mises/Reichenbach.

The subjectivist approach has several problems.

First, making Dutch book is a merely pragmatic criterion without any rational justification. Why should making Dutch book fix everything up? Only people who are really betting against each other need to worry rationally about making book. Where probability is the guide to life, we are rarely betting against Mother Nature in that sense. Making Dutch book has no rational relevance to predicting natural events.

Second, it is in fact quite rational to let the other bettor win 3:1 if H and also win 2:1 if not-H, provided that the amount of money bet in the first bet is at least three times greater than the amount bet in the second bet. Thus if on H, the other bettor must pay $100 if he loses and will get $300 if he wins, and if on not-H the other bettor must pay $10 if he loses and will get $20 if he wins, and if the probabilities are roughly equal, then the bettor giving Dutch book is actually likely to gain the most in the long run (Black 1967: 477).

Third, the subjectivist interpretation utterly fails to capture what we ordinarily mean by "probability" (Black 1967: 477). Philosophically it is too far removed from our ordinary understanding of probability as something objective and rational and as only loosely connected with our subjective feelings of confidence. Ordinarily we think of prediction as something you can practice and become more skilled at, something you can get confirmably better at. That is hard to square with understanding probability in terms of mere subjective confidence. Here I follow Max Black.

Fourth, subjectivism is no improvement on the frequency theories in its need for indefinitely many bets to work. We are just not going to be able to observe that many bets in practice, yet we do use probability in practice all the time.

But subjectivism continues to attract philosophers and legal scholars like moths to a flame. There are over three hundred articles on Bayes in *The Philosopher's Index* (PHIL-IND database in Westlaw), and, I suspect, over two thousand articles in legal publications (the database reports there are too many to list).

Neil B. Cohen seems to claim that subjectivism was developed by Leonard J. Savage in Savage's 1954 book, *The Foundations of Statistics* (Cohen 1985: 391, 422 n.38). But subjectivism was developed much earlier by the brilliant Cambridge mathematician Frank Ramsey, and may be found in Ramsey's *The Foundations of Mathematics*, posthumously edited and published in 1931 (Skidelsky 1994: 70-71; see 67-73). It was Ramsey who criticized Keynes for relying on logical intuitions which nobody could intuit. Ramsey could not discover such intuitions in himself, and found that other people's claimed logical intuitions conflicted with each other (Ramsey 1931: 161-63). It was Ramsey who decided to abandon objectivism concerning the probabilities of specific events' occurring, and to cash out the rationality of our probabilistic beliefs about specific events in terms of their pragmatic success (Ramsey 1931: 171). It was Ramsey who cashed out subjective belief in terms of observable willingness to make bets (Ramsey 1931: 172, 183). It was Ramsey who instituted the two basic subjectivist-pragmatist requirements of (i) general overall consistency in the learning process of making successful bets, and (ii) of not allowing Dutch book to be made against yourself (Ramsey 1931: 176-83; Skidelsky 1994: 70-71). It was Ramsey who argued that in the long run such a program would approximate objective probabilities (Ramsey 1931: 182-83). I would only add that Jeremy Bentham anticipated Ramsey by construing probability in terms of tendencies of facts to produce convictions in the mind, and by construing probability ultimately in terms of its utility (see e.g. Bentham 1827: 1, *pace* Ramsey 1931: 173). Thus the legal scholar Cohen's suggestion that no subjectivist theory of probability of unique events existed until Savage came along is mistaken (Cohen 1985: 391).

I advocate a mixed interpretation of probability. For mass repetitive events I follow Mises/Reichenbach. For unusual or nonrecurrent particular events, I reject both Keynes' logical interpretation and Ramsey's subjectivist interpretation and offer an empirico-rationalist interpretation of my own, explained in my long paper. My theory turns out somewhat like Russell's in *Human Knowledge: Its Scope and Limits*, but substitutes continental-style objective phenomenological objects for his British empiricist sense-data. Thus on my theory FRE 401 probability is ambiguously interpreted, and FRE 401 relevance is ambiguously interpreted, but in a benign way. For repetitive events, degrees of probability are interpreted in terms of what is more or less often the case, and FRE 401 relevance is interpreted as frequency evidence that makes a difference. For unique or nonrecurrent events, degrees of probability are interpreted in terms of what seems more or less strongly or clearly to be the case, and FRE 401 relevance is interpreted as appearance of evidence that makes a difference. Neither frequency relevance nor phenomenological relevance is logical relevance in Keynes' sense, but both may be articulated as logical relevance in the legal sense by rewriting all (inductive) probability arguments in deductive form, as will be explained shortly in the main text of this paper.

For the record, I do not claim that the frequency side of my theory resolves David Hume's famous problem of induction. To the contrary, I agree with Mises that frequency theory presupposes induction (Mises 1961: ix). But it seems to me that the phenomenological side of my theory holds out our best hope of answering Hume's skeptical argument that we cannot have non-question-begging evidence that the sun will rise tomorrow.

4. To review the treatises, see the [following chart]:

Chart of Historical Rules that Evidence must:

1996 FRE 401: be relevant in the sense of tending to make more or less probable (Am.)

1985 Cross: be logically relevant (Eng.)

1958 Cross: be relevant (Eng.)

1941 James: be logically relevant (Am.)

1906-1921 Keynes: be logically relevant (Eng. philosophy)

1903 Stephen: be relevant (Eng.; Am. ed.)

1899 Straker: ascertain fact or point in issue, for or against (Am./citing Eng.)

1898 Thayer: be logically relevant (Am.)

1897 Taylor: be logically relevant (Eng./Irish; Am. notes)

1876 Stephen: be relevant (Eng.; Am. ed.)

1876 Starkie: tend to prove or disprove point in issue (Eng.)

1868 Phillips: be relevant/confined to points in issue (Eng,; Am. ed.)

1859 Phillips: be relevant/confined to points in issue (Eng.; Am. ed.)

1830 Starkie: tend to prove or disprove point in issue (Eng.; Am. ed.)

1827 Bentham: tend to produce a persuasion for or against (Eng. philosophy/law)

1824 Peake: relate or connect to issue in dispute (Eng.; Am. ed.)

1820 Phillips: relate or refer to facts in issue (Eng.; Am. ed.)

1817 Buller: relate or connect to issue/prove no more than substance of issue

1816 Phillips: be confined to facts or points in issue (Eng.; Am. ed.)

1789 Morgan: ascertain point in issue (Irish pub.)

1785 Buller: prove no more than substance of point in issue (Eng.)

1783 Blackstone: ascertain point in issue, for or against (Eng.)

1772 Buller: prove no more than substance of issue (Eng.)

1726-1760 Gilbert: admit of degree of proof (Eng.)

1690 Locke: admit of degree of probability (Eng. philosophy)

1256 Bracton: (no relevance rule) (Eng.)

ca. 300 B.C. Philo and Diodorus: material implication, strict implication

384-22 B.C. Aristotle: formal deducibility

Chart of General Legal Phases: Evidence must:

1897-1996: be logically relevant

1859-1996: be relevant

1783-1996: (help) ascertain point in issue

1772-1996: be confined to, or prove no more than, (the substance of) what is in issue

1690-1996: admit of degrees of probability/“proof”/certainty

Both charts are terminology-driven and use some charity in interpretation. So far as these charts go, Keynes appears not as an originator but as a recent member of a long and variegated Anglo-American tradition. Keynes began work on probability in 1906 and basically finished his book by 1914, but it was not published until 1921 due to wartime conditions.

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