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THE DEMONS OF DECISION

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THE DEMONS OF DECISION

For three centuries, philosophers have mounted defenses against the *melan genie* with an obsessive intensity comparable to the Reaganite determination to squander American wealth on defenses against a Communist threat. And for three centuries, skeptics have argued for the futility of the expenditure of conceptual effort with no more success than critics of the Pentagon have had in stemming the flow of funds to the military and its industrial minions. My own sympathies are with the skeptics. However, their own intense involvement with the obsessions of the epistemological fear mongers and their failure to address the analogue of the problem of conversion from military to civilian industry in an acceptable manner often deprive the skeptical position of the subversive force it ought to have.

Charles Peirce and John Dewey pointed us in a more promising direction. Like many other skeptics, they abandoned efforts to identify an incorrigible foundations for knowledge. Instead, however, of substituting an account of the causal origins of human knowledge as an alternative to foundationalism, they focused on the investigation of the structure of inquiries aimed at revising and improving the knowledge we have and, in the case of Dewey, not only the knowledge but also our moral, political, economic, and aesthetic values. According to the Deweyite version of this approach, an inquiring agent takes for granted all sorts of background assumptions at a given time. While one may concede the logical possibility that these assumptions are false, from the agent's point of view there is no serious possibility that the settled assumptions are false in any sense which guides the agent's practical deliberations and scientific inquiries. Still error is logically possible. Worse yet, the sources and methods we rely on to obtain new information are not foolproof and we know this to be so. The testimony of our senses and of other oracles is not perfectly reliable. And inferences beyond what is entailed by the available knowledge incur risk of error. Anyone who is anxious about malevolent demons will fixate on these points. Dewey, however, would have insisted that as long as we provide for the revisability of our knowledge in acceptable ways, we are not doomed to being lost in a deceit from which we can never escape.

By way of contrast, those still seized with fear of the malevolent demon will restrict those assumptions which they count as certain—i.e., as part of their standard for serious possibility, corpus of knowledge or body of

evidence—to those items, if any, which they can guarantee secure against the demon's trickery. The difference between foundationalists and many of their skeptical critics has not been over this point but only regarding how restrictive these assumptions need to be. I have preferred to turn my back on this epistemological paranoia and, with Peirce and Dewey, to take a look at the question of the revision of cognitive states and values.

In recent years, however, the spectre of the malevolent demon has been revived as a source of philosophical argument in a new guise—that of a dutch bookie. In this discussion, I shall try to explain the anxiety, to relate it to worries about the *melan genie* and to argue for a way in which we may exorcise the demon.

As is well known, authors like Ramsey and de Finetti showed that agents who fixed rates at which they were prepared to accept gambles on propositions in a manner satisfying the requirements of the calculus of probabilities could be guaranteed against a predicament in which they could never gain no matter what possibility obtained and would lose under some eventualities. De Finetti and Ramsey took for granted that an agent's fair betting rates reveal the degrees of credal probability the agent is committed to assigning to hypotheses at a given time. In my opinion, rational agents sometimes and, indeed, typically should not be committed to fair betting rates on propositions and, hence, ought not have numerically definite degrees of credal probability. Nonetheless, in those special cases where agents do appropriately assign such fair betting rates, the degrees of credal probability such assignments reveal should obey the requirements of the calculus of finitely additive probability in order, among other things, to avoid choosing dominated options.

This concern to avoid dutch books is not itself a manifestation of the new epistemological demonophobia. Compare the assessment of probability with evaluations of possibility. When one turns one's back on the cartesian malevolent demon, one is prepared to be certain of the truth of propositions even if one recognizes the logical possibility of their falsity. Logical possibility need not be the same as serious possibility and it is serious possibility which is relevant in guiding conduct. I grant that the agent should regard avoiding error as a value in revising his judgements of serious possibility. He should not erroneously rule out as false some proposition which is true; but his understanding of truth and falsity at a given time is controlled by the standard for serious possibility to which he is committed at that time and that commitment entails the truth and, indeed, certain truth of every item in the corpus of assumptions which constitutes the standard.

Turning one's back on the malevolent demon, however, does not entail lack of concern with the requirements entailed by endorsing a standard for

serious possibility at a given time. For example, to rule out some proposition and its negation is tantamount to ruling out all logical possibilities as serious possibilities and this leads to a breakdown in the functioning of the standard as a standard for serious possibility. Similarly since all items incompatible with the settled assumptions in the standard are to count as impossibilities according to the standard, the agent is committed to the infallible truth of all logical consequences of items in the corpus as well as all logical truths.

The dutch book reasoning of Ramsey and de Finetti is to be understood in the same spirit. Just as a standard for serious possibility discriminates between propositions with respect to serious possibility, an agent's credal state discriminates between serious possibility with respect to credal probability and, insofar as such credal probability discriminations can be made numerically definite, they are intended to determine fair betting rates for the agent at that time. Given this function of the credal state, it would be counterproductive to embrace numerically definite probability judgements violating the requirements of finitely additive probability measures.

Both the requirements of deductive closure on standards for serious possibility and of conformity with the demands of finitely additive probability on states of credal probability judgement concern conditions of synchronic rationality imposing rather thin constraints on the "consistency" or "coherence" of credal states to which agents are committed at a given time. I say "committed" because no flesh and blood person or human institution is capable of fully living up to the demands of coherence. Neither persons nor institutional agents have the capacity to calculate and store the information required to be fully coherent and are impeded in exercising the capacities they have by psychological or social disturbances. For this reason, some may regard the thin constraints of rationality as legislative for angels and other ideally situated agents rather than humans and human institutions. I disagree. We can expect ordinary mortals and their institutions to be committed to coherent systems of judgements of credal probability even if such commitment outstretches both their performance and their competence. Rather than adjusting our prescriptive ideals to meet our limited capacities (which vary widely from agent to agent), we should seek ways and means to enhance our capacities to live up to our commitments.

The injunction to obey the requirements of the calculus of probability understood as a condition of synchronic rationality is not focused on avoiding the snares of a cartesian melan genie. It insures that the agent who is able to live up to his commitments will not choose from among the options he recognizes to be feasible for him to exercise one which is clearly inferior

according to his goals or values. It does not guarantee him against the logical possibility of misidentifying his feasible options or being certain of the truth of false propositions any more than the injunction to be committed to a deductively closed and consistent set of certainties does. And it allows for the revisability of the agent's states of credal probability just as we provide for the revisability of the agent's standard for serious possibility or corpus of knowledge.

Thus, the obsession with diabolical dutch bookies which I aim to consider is not to be attributed to either Ramsey or de Finetti. The new paranoia is manifested in the argument for conditionalization attributed by Paul Teller to David Lewis (Teller, 1973) grounded on a concern to avoid dynamic dutch books, in the treatment of these matters by Michael Goldstein (1981), by Bas van Fraassen (1984), and by Brian Skyrms (1985). A similar neurosis arises in connection with other issues such as planning future consumption in a way which takes future preferences into account (Strotz, 1955–56 and Hammond, 1977 and 1984). And the anxiety could be injected into some well known controversies concerning the design of experiments such as the dispute over "optional stopping". I shall not be able here to address the variety of implications demonophobia has for decision theory, statistical theory and economics. In this paper, I shall stick to territory relatively familiar to philosophers who have been interested in revision of probability judgement and in decision making.

Just as the classical anxiety about grand deceivers impelled philosophers to restrict the domain of assumptions which are to be judged certain to those which are immune to the threats of demonic deception and, hence, also immune to legitimate revision, so too the new dutch book arguments restrict very severely the extent to which credal probability judgements are open to revision.

This result may seem surprising. The argument attributed to Lewis recommends a principle prescribing how revisions in credal states (i.e., states of credal probability judgement) ought to be made given certain revisions in the corpus of knowledge or standard for serious possibility. The trouble is that the principle prescribing revisions in credal states saddles agents with their past convictions in a way which renders these past commitments immune to revision. My first task will be to explain this point.

Let K be an agent's standard for serious possibility at some time t and suppose that at t' new information e is added to K together with the deductive consequences of K and e to form the corpus K_e . Let the credal state (state of credal probability judgement) B relative to K be representable by a finitely additive probability measure $Q(x/y)$ defined for all propositions y consistent with K and for all x (if $K \vdash y$, $Q(x/y) = Q(x)$) and such that

$Q(x/y) = Q(x'/y')$ whenever $K \mid - (x \equiv x')$ and $K \mid - (y \equiv y')$. The probability measure Q_e relative to K_e is the *conditionalization* of Q relative to K if and only if $Q_e(x/y) = Q(x/y \& e)$.

The principle for revising credal states Lewis's argument purports to vindicate requires that if the shift in corpus from K is to K_e (i.e., is the expansion of K by adding e), Q_e should be the conditionalization of Q . I shall call this principle *temporal credal conditionalization*. It is often called "conditionalization" in the literature but I wish to distinguish it from other principles which might also be called "conditionalization".

Notice that anyone at t who is committed at that time to updating his credal state via temporal credal conditionalization may be regarded as being committed at that time to a system of assessments as to what his credal state should be were he to expand his current corpus K by adding e to K via some form of expansion for any proposition e representable in the framework we are considering. This system can be represented by a function $C(K_x)$ defined for all potential expansions K_x expressible within the framework including the degenerate expansion of K into itself and taking as values credal states B_x representable by probability measures which are conditionalizations of the function Q representing the credal state B relative to K .

The agent at t is committed to this system of hypothetical appraisals regardless of whether he actually does expand his corpus in a way which reaches one of the expansions or not. Once this is recognized, we can envisage the agent as transforming his corpus not only by expansion—i.e., by adding information consistent with it, but by contraction as well. He might shift from K_e at t_2 to K at t_3 , after having shifted from K at t_1 to K_e at t_2 . Clearly the second shift cannot be regarded as an instance of the principle of temporal credal conditionalization. But if the agent at t_2 retains the same C -function that he had at t_1 , and continues to be faithful to it at t_3 , his credal state at t_3 ought to be the same as the one he initially had. This means his shift in credal state from t_2 to t_3 ought to be the inverse of temporal credal conditionalization.

Thus, the domain of definition of the function C may be extended beyond the set of consistent expansions of the current corpus K to include all consistent expansions of some minimal or urcorpus UK representing a state of maximal ignorance where all logical possibilities are serious possibilities. I call the system of hypothetical judgements so extended a "confirmational commitment". That is to say, a confirmational commitment is represented by a function $C(K) = B$ from potential expansions K of an urcorpus UK to credal states relative to such corpora.

I have argued that advocates of temporal credal conditionalization tacitly presuppose that agents ought to endorse such confirmational com-

mitments at least for expansions of the current corpus and that the extension of such commitments to a richer domain of all expansions of a minimal urcorpus representing a suitable state of ignorance is not unreasonable once one has gone that far.

Advocates of temporal credal conditionalization, however, make two other assumptions about confirmational commitments both of which are controversial.

The first assumption is the principle of *confirmational conditionalization*. If K_c is the consistent expansion of K , $C(K_c)$ is the conditionalization of $C(K)$. Observe that this principle is not to be confused with temporal credal conditionalization. Confirmational conditionalization is a constraint on confirmational commitments. If C is the confirmational commitment an agent endorses at time t —i.e., the agent's assessment of what his credal state should be were his corpus some consistent expansion K^* of the urcorpus UK for any such consistent expansion—that commitment should satisfy the formal requirement of confirmational conditionalization. This constraint is a principle of synchronic rationality imposed on confirmational commitments endorsed at definite times just as consistency and closure are synchronic constraints on corpora and coherence synchronic constraints on credal states.¹

Confirmational conditionalization does not imply that the agent ought to revise his credal state over time in conformity with temporal credal conditionalization. To obtain temporal credal conditionalization, one must make the second controversial assumption—*confirmational tenacity*. One must embrace the requirement that the agent ought hold his confirmational commitment fixed between t and t' when the corpus is expanded.

Given confirmational conditionalization and tenacity, and given that the credal states are always numerically definite, confirmational commitments reduce to what Carnap in his later work represented by credibility functions (Carnap, 1960). According to Carnap, such credibility functions represented permanent dispositions of mature agents to update their credal states due to modifications of their corpora of knowledge. At an early stage in his investigations of probability, Carnap held out the hope that principles of a so called “inductive logic” could be constructed which would be sufficiently powerful to be able to oblige all rational agents to endorse the same confirmational commitment—at least as long as they worked within the same conceptual framework. But even after he gave up his impossible dream, he held on to both confirmational conditionalization and confirmational tenacity as is manifested in his endorsement of temporal credal conditionalization.

Observe, however, that if rational agents are free to endorse different confirmational commitments without any reason favoring one over the

other, it becomes eminently questionable whether they ought to be saddled with the confirmational commitments they endorsed at some early stage as confirmational tenacity requires. The recommendation is quite analogous to the idea that once an agent embraces a standard for serious possibility he ought never to revise it even though there is no logic which mandates the adoption of one consistent and deductively closed corpus over another. Confirmational tenacity becomes an instance of the method of tenacity which Peirce discussed in "The Fixation of Belief" and the deficiencies of one resemble the deficiencies of the other. But since endorsement of temporal credal conditionalization presupposes endorsement of confirmational tenacity, any argument—including Lewis's—for temporal credal conditionalization becomes an argument for a form of tenacity. And just as appeals to the threat of a *melan genie* were deployed to support a need for an incorrigible foundation for human knowledge secure against error, consideration of diabolical, dynamic dutch bookies become the crux of an argument for endorsing fixed confirmational commitments.

In my opinion, we should turn our back on worries about diachronic dutch bookies just as we should turn our backs on grand deceivers. In place of confirmational tenacity, we should endorse a principle of confirmational inertia which enjoins one to avoid modifying a confirmational commitment once endorsed without justification just as one should avoid revising a corpus of knowledge without justification. Of course, that is just the beginning of the story; for an account of the conditions under which revisions of bodies of knowledge, confirmational commitments and credal states are justified needs to be given.

Offering such an account cannot even be begun here. My concern now is with the roadblock placed in the path of those who would undertake such a project by those who threaten us with diachronic dutch bookies.

Before turning to the use of diachronic dutch book arguments in favor of temporal credal conditionalization, some brief mention should be made of the issues raised by confirmational conditionalization. The status of confirmational conditionalization is itself a controversial issue. Serious authors like R. A. Fisher (1959) implicitly and H. E. Kyburg (1974) explicitly have rejected it and have made this rejection integral to an important approach to statistical inference. I have discussed these matters elsewhere (Levi, 1980) and shall, therefore, focus on but one consideration that may, perhaps, help support endorsement of confirmational conditionalization.

Suppose that e is consistent with X 's corpus at K . Authors like de Finetti assume that the conditional credal probability $Q(h/e) = r$ relative to K may be used to assess the values of so-called "called off bets." X may be offered an opportunity to accept or reject a gamble where he receives $1-P$ utiles if $h \& e$ is true, $-P$ utiles if $\sim h \& e$ is true and 0 utiles if e is false given

that he accepts the gamble and neither gains nor loses if he refuses the gamble. The decision matrix looks like this:

	h&e	~h&e	~e
G	1 - P	-P	0
R	0	0	0

If the agent's probability assessments obey the requirements of the calculus of probabilities and we wish to assess the relative values of the options G and R, there are two ways to do this.

Method 1: Identify the unconditional probabilities x , y and $1 - (x + y)$ of the three states respectively and compute the expected values for G and R. The expected value of G is $(1 - P)x - Py$. That of R is 0. The expected value of G will be positive if and only if $P < x/(x + y)$ and this condition is met only if $x + y > 0$.

Method 2: Compute the conditional expected values of the two gambles. The conditional expected value of G is $(1 - P)r - (1 - r)P$ and the conditional expected value of R is equal 0. This is positive if and only if $r > P$.

In the case where $x + y = Q(e)$ is positive, these two methods will yield exactly the same assessment of the gamble. However, if $Q(e) = 0$, this need not be the case. The first method will assign equal 0 value to G and R. But the conditional expected value of G could be positive (Levi, 1978 and 1980, ch. 5).

According to de Finetti (1937) among others, the conditional probability $Q(h/e) = r$ is to be used to determine whether to accept or reject so called "called off bets" such as the one under consideration. In a bet which is called off in case e is false, the agent is assured in terms of the payoff structure against winning or losing regardless of the option chosen. That is to say, the agent receives the same whether he accepts the gamble G or rejects it.

As we have seen, if we follow de Finetti's understanding of conditional probability, however, we have a conflict of prescriptions in cases where e is a serious possibility yet bears credal probability 0. One solution is to prohibit assigning 0 probability to serious possibilities. That is not de Finetti's way and rightly so. There are many contexts where it seems plausible to assign 0 probability to serious possibilities. For example, I may not know the value of the binomial parameter p representing the chance of a given coin landing heads and assign 0 credal probability to each hypothesis as to the exact value. Yet each such hypothesis may very well be a serious possibility. Another possibility is to prohibit conditional probabilities being defined when the condition bears 0 probability. But probabilities condi-

tional on the precise value of p are used all the time. The option I favor (Levi, 1978 and 1980, ch. 5) is to use method 2 where method 1 yields a tie in expected utility between the options G and R . If one deploys this essentially nonarchimedean way of assessing expected value, the argument advanced by A. Shimony (1955) and others which purports to show that allowing the assignment of 0 probability to serious possibilities produces a threat of a strict version of synchronic dutch book is undermined. The case for prohibiting the assignment of 0 probability in such cases is disarmed. In my opinion, this is a distinct advantage of the proposal.

Using conditional probability to evaluate called off bets in this manner does not imply that conditional probability determines what the agent's unconditional credence $Q_e(h)$ for h ought to be were he to expand from K to K_e . To suppose that $Q_e(h)$ should equal $Q(h/e)$ is to insist on confirmational conditionalization and this supposition is not implied by the de Finetti construal of conditional credal probability.

In order to explain the ramifications of confirmational conditionalization for the evaluation of risky propositions, suppose the agent considers the following hypothetical predicament. He is to face the option G' where he wins $1 - P'$ utiles if h is true and loses P' utiles if h is false and the alternative R' where he receives 0 utiles for sure. He is to face this choice on the assumption that his corpus of knowledge is altered by adding e . $\sim e$ is no longer a serious possibility. In this hypothetical choice between G' and R' , the agent is guaranteed against gain or loss in case e is false because of epistemic considerations. In the previous choice between G and R , he was guaranteed against gain or loss because of the payoff structure. In the one case, the falsity of e is not a serious possibility. In the other it is but its significance as a serious possibility has been neutralized by the payoff structure. In both cases, the logical possibility that e is false is neutralized. Unless a case can be made for thinking that the manner of neutralization should make a difference to the way gambles are evaluated, it seems plausible to require that the gamble be assessed in the same way in the one case as in the other. That is to say, the fair value for P' at which G' is ranked together with R' ought to equal the fair value for P at which G is ranked together with R in the case of the called off bet. Since the fair value of P is $r = Q(h/e)$, it follows that $Q_e(h)$ should equal $Q(h/e)$. On the assumption that the only kind of good reason for differentiating between the two cases is a revision of confirmational commitment, confirmational conditionalization is mandated.

This argument for confirmational conditionalization does not go so far as to support temporal credal conditionalization. An agent offered G and R at t before adding e to K might, prior to making a choice, add e so that the

pair of options are, as far as he is concerned, reduced to G' and R' . If in the interval from t to t' , the agent had acquired some good reason to modify his confirmational commitment, that good reason would be grounds for revamping his assessment of the two options.

Staunch dissenters from confirmational conditionalization like Kyburg will not be cowed by such arguments. They are free to question the claim that the only reason for discriminating between the two modes of neutralization is a revision of confirmational commitment. The best one can do in response to such dissent is to explore the ramifications of conformity with and violation of confirmational conditionalization in decision making and statistical inference. Such an undertaking is beyond the scope of this paper.

Regardless of our differences concerning confirmational conditionalization, Kyburg and I agree in rejecting temporal credal conditionalization. My current concern is to explain how I can agree with Kyburg on this point even though I insist on confirmational conditionalization.

Consider D. Lewis's appeal to the dynamical dutch bookie.

At time t , agent X endorses confirmational commitment C and corpus K which determines credal state B according to which $Q(h/e) = r$ and $Q(e) = x$. At that time, the agent also intends at the next stage t' to revise his confirmational commitment to C' according to which $C'(K) = B'$ is represented by a probability measure $Q'(h/e) = s < r$. We shall suppose that X is certain that he will carry out his intention and, as a consequence, is certain that if he does expand his corpus K by adding e to K to form K_e , his unconditional credal probability $Q^*(h)$ for h will equal $s < r$ in violation of temporal credal conditionalization. According to the Lewis argument, at time t before initiating his conversion from C to C' , X can recognize that he is vulnerable to a dynamical dutch book. The argument runs as follows:

At t , a diabolical dutch bookie can offer him the opportunity to accept or reject a gamble on h called off if e is false whose payoffs are given in the following table:

	$h \& e$	$\sim h \& e$	$\sim e$
GG	$1 - r$	$-r$	0
RR	0	0	0

Given that refusing GG (i.e., accepting RR) brings a sure payoff of 0 utiles, the gamble is just fair as far as X is concerned at t and, hence, he may be prepared to accept it. If one likes, one can increase $1 - r$ by a small amount to make the gamble better than fair.

In addition, X is offered a gamble (EE) on e where he receives $d(1 - x)$ utiles if e is true and $-dx$ utiles if e is false. Here $d = r - s > 0$. Again the gamble is just fair and so x may be prepared to accept the gamble.

Assuming, for the sake of the argument, that the payoffs are additive, the net return from the pair of gambles (GG) and (EE) is given in the following table.

h&e	~ h&e	~ e
1 - s - dx	- s - dx	- dx

The payoffs are negative in case e is false and in case ~ h&e is true. But it will be positive in case h&e is true. There does not appear to be a sure loss. That is to say, accepting the pair of gambles (GG) and (EE) is not dominated by (RR).

We can also assess the value assigned to the eventuality that e is true. It is the expected value conditional on e. From the point of view at t when $Q(h/e) = r$, this expected value conditional on e is equal to $(1 - x)(r - s)$ which is positive. Once more there is no trouble.

Observe, however, that at t', if the agent also finds out that e is the case, the expected value conditional on e is the same as the unconditional expected value. This expectation will be computed using $Q^*(h) = s < r$ and will equal to $-dx = (r - s)x < 0$. Hence, the agent will be prepared at t' to pay the bookie -dx utiles to be rid of the gamble (GG).

Given that the agent knows at t that he will alter his credal probabilities at t' so that $Q'(h/e) = s < r = Q(h/e)$ and given also that he X fears that he will be offered an opportunity to be rid of the gamble at t' if e is true, X can anticipate at t that he will take the opportunity and will end up at t' with a loss of dx utiles if e is true just as he will if e is false. A similar argument with suitably changed signs on the payoffs can be deployed in case $r < s$. In order to avoid being conned into such a diachronic dutch book, X should not revise his confirmational commitment. He should obey temporal credal conditionalization.

The rigidity implied by this result breeds additional rigidities. Let us enlarge the language for which the standard for serious possibility, credal state and corpus of knowledge is defined so that propositions specifying the features of the agents current and future credal states may be described. Suppose that at t_0 , the agent's credal state is represented by a credal probability function P_0 and at t_1 by P_1 . If $P_0(H/P_1(H)=r) = s$, then, by temporal credal conditionalization, $P_1(H)$ should equal s precisely in the case where $P_1(H) = r$. But this is inconsistent unless $r = s$. Hence, we seem driven to the conclusion that the following should hold:

$$(1) \quad P_0(H/P_1(H) = r) = r$$

['r' is a standard or L-determinate designator.]

Condition (1) has been defended via an appeal to temporal credal conditionalization which is in turn justified by diachronic dutch book

arguments by Goldstein (1983) and van Fraassen (1984). Van Fraassen calls this principle “reflection”.

I do not quarrel with the special case of reflection where $t_1 = t_0$. However, the general principle of reflection has an implication which seems to me profoundly objectionable. (So I agree with Skyrms (1980) appendix 2 on this point—although for reasons which are different from his.²)

Suppose at time t_0 , H is in the agent’s standard for serious possibility K_0 . As a consequence, $P_0(H) = 1$ and $P_0(H/X) = 1$ for every sentence X consistent with K_0 . In particular, $P_0(H/P_1(H)=r) = 1$. But unless $r = 1$, this result conflicts with reflection—i.e., condition (1). Hence, we must conclude that unless $r = 1$, $P_0(H/P_1(H) = r)$ is not well defined—presumably because the condition $P_1(H) = r$ is incompatible with K_0 . That is to say, given the reflection principle, the agent’s corpus at t_1 should contain H if it contains H at t_0 . Reflection precludes revising the corpus K_0 by contraction—i.e., by removing any item in it. The only way of modifying a corpus of knowledge is by expansion—i.e., by adding items to K_0 consistent with it.

Thus, the diachronic dutch book arguments support not only a rigidity in confirmational commitments but a rigidity in standards for serious possibility. Once a proposition has been added to a standard for serious possibility so that its negation is not regarded to be a serious possibility, it cannot be removed from that status. The infallibility of the proposition relative to that corpus entails a commitment to its incorrigibility. And this, so I contend, is untenable.

Are appeals to threats of diachronic dutch book compelling? I think not. Consider the scenario envisaged by Lewis. We have been given that the agent expects to revise his confirmational commitment at t . There are still three cases to consider.

Case 1: The agent is sure that he will not have the opportunity to renege on his acceptance of the gambles (GG) and (EE) at t . Thus, given that at t he is committed to maximizing his benefits using his credal state at t , he may accept them both. Given his conviction that he will not have the opportunity to renege at t' , he is quite convinced he is not threatened by a dutch book. To be sure, he anticipates that when he changes his confirmational commitment, he will evaluate the gambles differently; but as long as he is insured against acting on these new evaluations, he is secure against allowing a dutch book to be made against him relative to the evaluations he makes of his prospects at the initial moment of choice when he is making his plans.

Case 2: The agent knows that he will have the opportunity to renege at t' . And given his conviction that he will violate temporal credal conditionalization, he knows that he will renege on his choice of the two gambles. Thus, the agent no longer regards himself as having as a feasible option pur-

chasing the called off bet (GG) and not renege subsequently. His option is either to refuse that bet at t or to accept it at t and renege subsequently. Relative to his cognitive commitments at t , he should refuse the bet even though the betting rate for (GG) is fair on the understanding that he can avoid renege subsequently. This does not mean that his credal state at t for h given e is different from r . It remains what it was. It just means that he does not regard himself as having as feasible the purchase and enjoyment of the fruits of the called off bet.

It may, perhaps, be objected that the agent knows at the initial moment that he is objectively capable of refusing to renege on the bet at the later time even though he knows that he will renege. For the sake of the argument, I am willing to grant that the notion of objective feasibility can be construed in a manner which makes this entirely plausible. However, even if true, the point is irrelevant. For the deliberating agent, members of the set of feasible options must not only be objectively feasible for him to implement but, for any member of the feasible set, it must remain a serious possibility as far as he knows that he will choose that member. If he knows that refusing to renege is objectively feasible but that he will not choose it, it does not belong in the agent's set of feasible options.

Case 3: X has the opportunity to renege as in case 2 but he also has the opportunity to take steps to preclude his having the opportunity to renege. Perhaps, he can do the analogue of binding himself to the mast as in the case of Ulysses or, perhaps, he imposes psychological or moral bonds upon himself to prevent his renegeing. In this situation, he may very well accept the called off bet and renounce his future choice.

Of course, there are cases where the agent may have some doubt as to whether he will be able to renege or not. In that event, the problem raises questions of risk or uncertainty but, once more, does not threaten the agent with deliberately choosing a sure loss.

The moral of the story is this: Insofar as it makes sense to avoid choosing a feasible option which is dominated by some other *feasible* option—and that is what the injunction against dutch books is customarily understood as urging—violations of temporal credal conditionalization are not prohibited.

Suppose, however, that the agent X regards himself as being in a case 1 predicament where he is sure that he does not have the opportunity to renege but it turns out subsequently that he was mistaken and at t' he does indeed renege. As I said, from his initial point of view, he did not choose a dutch book; for he did not choose an option from those assessed as feasible by him at that moment which was dominated by some other such feasible option. Nor did he do so at t' as long as he evaluates gains and losses

relative to his asset position at t' . However, at t' , the agent judges that he was mistaken concerning the plans feasible for him to choose at t and that the plan he chose at t was, relative to his asset position at t , dominated by another option available to him at t .

The appeal to diachronic dutch book arguments is designed to prevent being ensnared in such retrospectively identified dutch books in case 1 and case 3 predicaments. (And, in case 2 situations, they are designed to prevent the regret which might arise from mistakenly supposing that opportunities to renege at t' would be available.) If one does have such worries, invoking the Lewis argument does begin to make a modicum of sense.

Observe, however, that in the scenarios we have envisaged, the agent takes for granted that he has some given list of feasible options from which to choose. Given his convictions, it is not a serious possibility for the agent that his options are other than he takes them to be. Granted that there is a logical possibility of error; but such logical possibility is not, for the agent, a serious possibility. Unless we are fearful of the tricks of the cartesian malevolent demon, there is not the slightest reason to take these logical possibilities into account. The injunction against book requires the agent to avoid choosing an option feasible for him as judged relative to the information available to him at the moment of choice—not relative to some other perspective. I suspect that the anxiety to avoid diachronic dutch books is not only similar to but reduces to the fear of the classical malevolent demon. Fear of diachronic dutch books due to violation of temporal credal conditionalization is in this respect derived from the same source as fear of being a brain in the vat. If we succumb to the fear, we shall be immobilized and seek to impose excessive rigidities on our cognitive states restricting our standards for serious possibility to the logically and conceptually necessary and freezing our confirmational commitments in concrete.

There is another aspect of the issue concerning the extent to which we should take diachronic dutch books seriously which deserves attention but which due to limitations of time will receive only brief mention here.

R. Carnap is one of the few authors in the Bayesian tradition who took the problem of revising confirmational commitments seriously. He took the position that the choice of a so called “inductive method” is not a theoretical question but a practical decision (Carnap, 1951). R. C. Jeffrey (1965) by way of contrast does not take Carnap’s inductive methods (i.e., confirmational commitments) into account at all. Nonetheless, he proposes an account of revision of probability judgement over time which can be regarded as an account of how confirmational commitments are revised in response to sensory stimulation. Whereas, for Carnap, change of confirmational commitment resembles conceptual change as Carnap conceived it, for Jeffrey it is change induced by the importuning of the environment.

In spite of their differences, Carnap and Jeffrey share one assumption in common—to wit, that a revision of confirmational commitment should be a change from one numerically definite confirmational commitment to another.

I have taken the position elsewhere (Levi, 1974 and 1980) that when revising confirmational commitments one should often move to a position of suspense between rival numerically definite “inductive methods”. Just as one should move to a position of suspense between theory T_1 and theory T_2 when one contemplates a shift from the first to the second so that one can first explore the merits of the alternatives without begging questions, one should not replace one numerically definite confirmational commitment by another before first moving to a position of suspense relative to which the merits of the rival commitments can be examined in a nonprejudicial way. One of the ramifications of this view is that rational agents ought often to endorse states of credal probability judgement at a given time which are numerically indeterminate.

The point of view I am advocating is not a new one. Nor is the currently fashionable rejection of it by those who deny the very feasibility of moving to a neutral position in revolutionary contexts in science. I have never seen a decent argument as to why moving to a neutral position lacks feasibility except, perhaps, in the case of changes in logic or set theory or mathematics where it is envisageable that there may not be a neutral basis from which to assess the truth of rival points of view. No doubt there are serious psychological and social impediments to suspending judgement between controversial rival points of view; but this in itself fails to support the idea that we should adjust our ideals to accommodate our frailties.

I do not intend to elaborate on this theme here but instead to take brief notice of the way demonophobia may be deployed to mount objections to this way of thinking.

One of the ramifications of allowing states of credal probability judgement to go indeterminate is that evaluations of feasible options in decision problems as better and worse may also fail to be determinate. Indeed, there may be no weak ordering of the set of feasible options which is revealed by how the decision maker would react to pairwise choices among the feasible options. Indeed, according to my view, indeterminacy in judgements of credal probability is paralleled by indeterminacy in evaluations of options and their consequences with respect to the agent’s desires, moral and other value commitments.

Peter Hammond (1976, 1977) has pointed out that in so-called “dynamic choice problems,” such indeterminacy in valuation and probability judgement can lead to decisions being taken which exhibit what he takes to be an incoherency. The sort of incoherency in dynamic choice to

which he refers exhibits essentially the same features as those which worry Lewis, et al. who urge us to avoid succumbing to dynamic dutch books. The moral of this story is that concern with dynamic coherency not only mandates an excessive rigidity in our judgements of probability but precludes the kind of indeterminacy in judgements of probability and valuation which I contend should be appropriate to being in suspense concerning these matters. Hyper precision as well as hyper rigidity is a product of our fear of demons.

I shall use an example, undoubtedly oversimplified, to illustrate the point.

Jones needs a new secretary for both typing and stenography. He has applied to two agencies. Agency I has supplied him with two candidates: Jane and Dick. Agency II has supplied him with one candidate: Lilly. The scores of the three candidates on the tests are 100, 91 and 90 in typing and 90, 91 and 100 in stenography. Jones knows all this. Jones must now decide which of the two agencies to use. Suppose he must pay a fee to the one he chooses and he cannot afford to pay the fee to both. So once he has chosen an agency, the only candidates he has available to hire are those presented by that agency.

On strictly professional considerations, Jones would not choose Dick in a three way choice. But he would not be in a position to decide between Jane and Lilly. In that case, he might appeal to secondary considerations such as which candidate comes from the most disadvantaged group. For the sake of the argument, suppose Dick is most disadvantaged; but he has been ruled out in a three way choice. The next most disadvantaged is Jane.

Thus, Jones decides he will pay the fee to Agency I and hire Jane. However, once he has paid the fee, he no longer has a three-way choice but does have a choice of hiring Jane or Dick. Because Jane is the better typist while Dick is the better stenographer, Jones might not find a professional basis sufficient for a choice and might appeal once more to reverse discrimination to hire Dick. But this runs counter to the plan he set up initially when he decided to pay the fee to Agency I.

This process illustrates what Hammond would call a dynamic inconsistency. X initially intended to follow a given plan of action which entailed a partial implementation right away (paying the fee to Agency I) followed by an opportunity to renege on the plan or carry through. When he reaches the second moment of choice, he reneges on his initial choice.

Notice that in this situation X does not alter any of his valuations of the options except insofar as paying the fee to Agency I forecloses the opportunity of hiring Lilly. His valuations of the surviving options remain as they were when he faced the three-way choice initially. Still the agent chooses Dick rather than Jane at the second stage and, moreover, could have

predicted that he would do so at the initial stage. Thus, he anticipates choosing an option which, from his initial point of view, was not an admissible one.

Generalizing from considerations such as this, Hammond contends that the demands of dynamic coherence require that an agent's valuations of options induce a unique complete ordering of the set of alternatives. Indeterminacy in valuation is irrational because it leads to dynamic incoherence. Hammond has extended this argument to support a case for numerical definiteness not only in utility judgement but in probability judgement as well (Hammond, 1984).

But where is the incoherence? If Jones knows that upon paying the fee to Agency I he will choose Dick, then from his initial point of view, he is confronted with two options—not three. He can hire Dick by going to Agency I or Lilly by going to Agency II. And given the conditions stipulated for the example, he will chose Dick. This is precisely like case 2 before.

Suppose, however, that Jones must not only decide which agency to use but also commit himself in advance as to which candidate from that agency to hire so that he has no opportunity to renege subsequently. Then all three options are feasible for him at the initial moment but he has no opportunity to renege. In this respect, his predicament is like case 1. And there is no question of dynamic inconsistency. Clearly he should "precommit" to hire Jane.

Finally, the agent may have the opportunity to renege but, as in case 2, is quite capable of carrying through with the decision taken initially even though deliberation at the second stage recommends renegeing. From his initial point of view in this case-3 type predicament, hiring Jane is the option to follow resolutely without listening to the siren song of his later deliberation.

In none of these cases do we find any kind of instability in the decisions the agent takes at the initial planning stage. To be sure, in the case-2 type predicament, he will end up choosing Dick. But there is no dynamic incoherence here because, given what the agent knows, hiring Jane was not a feasible option for him anyhow.

It is also the case that if Jones is convinced that he will not have the opportunity to renege on his initial choice, chooses to Agency I and then finds out he was mistaken, he may very well renege. But unless one fears the malevolent demon, the possibilities the deliberating agent should take into account are the serious possibilities—i.e., the possibilities compatible with what the agent knows or takes for granted.

I am contending that Hammond's insistence on dynamic coherence is cut from the same cloth as the demand to avoid dynamic dutch books. I find it reassuring that this is so. I have contended for some time that

revisability of probability and utility judgement calls for accepting the rationality of indeterminacy and the urgency of exploring accounts of choice where probability and utility judgements go indeterminate in rather strong ways. Thanks to Hammond, we now see that worries about the diachronic demons of decision can lead both to a reluctance to revise probability and utility judgements and to an insistence on numerical definiteness. To my way of thinking these ways of thinking lead to an untenable dogmatism. This is somewhat ironic given the professed antidogmatic stand to which so many probabilists pay lip service. If we do not want to place road blocks in the path of inquiry, we shall pack the demons of decision off to Las Vegas where they are unlikely to add to the harm already done. We will thereby leave ourselves free to evaluate planning for the future in a manner more sensible than the demands of dynamic coherence imply.

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NOTES

1. I first introduced the distinction between confirmational conditionalization and temporal credal conditionalization (then called “intertemporal credal conditionalization”) in (Levi, 1974). The distinction was subsequently deployed in several publications including (Levi, 1977) and (Levi, 1980) where the notion of inverse credal conditionalization was also discussed. It should be emphasized that the synchronic constraint imposed on confirmational commitments by confirmational conditionalization does not include a commitment to remain loyal to the confirmational commitment one is currently endorsing or to conform to temporal credal conditionalization.

2. Since I endorse (1) in the special case where $t_0 = t_1$, I also maintain that the agent is committed to being certain as to what his current credal state is. (See Levi, 1980, pp. 186–87 and footnote.) I do not, of course, deny that we often lack information about our cognitive states including our credal states; but such ignorance represents a failure on our part, for the most part excusable, to live up to our commitments.

REFERENCES

- Carnap, R. (1952), *The Continuum of Inductive Methods*, University of Chicago Press.
- De Finetti, B. (1937), “Foresight: Its Logical Laws, Its Subjective Sources,” in H. E. Kyburg and H. E. Smokler (eds.) *Studies in Subjective Probability* (1967), Wiley.

- Fisher, R. A. (1959), *Statistical Methods and Scientific Inference*, 2nd ed., Hafner.
- Goldstein, M. (1983), "The Prevision of a Prevision," *Journal of the American Statistical Association* 78, pp. 817-19.
- Hammond, P. J. (1977), "Dynamic Restrictions on Metastatic Choice," *Economica* 00, pp. 337-350.
- Hammond, P. J. (1984), "Consequentialist Behaviour in Decision Trees is Bayesian Rational," unpublished paper.
- Jeffrey, R. C. (1965), *The Logic of Decision*, McGraw Hill.
- Kyburg, H. E. (1974) *The Logical Foundations of Statistical Inference*, Reidel.
- Levi, I. (1974), "On Indeterminate Probabilities," *The Journal of Philosophy*, 71, pp. 391-418.
- Levi, I. (1977), "Direct Inference," reprinted in I. Levi, *Decisions and Revisions*, 1984, Cambridge University Press.
- Levi, I. (1978), "Coherence, Regularity and Conditional Probability," *Theory and Decision* 9, pp. 1-15.
- Levi, I. (1980), *The Enterprise of Knowledge*, MIT.
- Shimony, A. (1955), "Coherence and the Axioms of Confirmation," *Journal of Symbolic Logic* 20, pp. 8-20.
- Skyrms, B. (1980), *Causal Necessity*, Yale.
- Skyrms, B. (1985), "Dynamic Coherence and Probability Kinematics", unpublished paper.
- Teller, P. (1973), "Conditionalization and Observation," *Synthese* 26, pp. 218-238.
- Strotz, R. H. (1955-56), "Myopia and Inconsistency in Dynamic Utility Maximization," *Review of Economic Studies* 23, pp. 165-80.
- Van Fraassen, B. (1984), "Belief and the Will," *The Journal of Philosophy* 81, pp. 235-56.