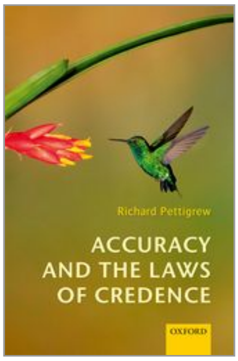

Accuracy and the Laws of Credence
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Maximin and the Principle of Indifference

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Abstract and Keywords

This chapter begins Part III of the book, which treats the accuracy argument for the Principle of Indifference and explores the consequences of various risk-sensitive decision-theoretic principles when they are used in an accuracy-based argument. This chapter looks at one of the most extremely risk-sensitive principles, namely, Maximin. The chapter shows that it entails the Principle of Indifference when allied with the veritist account of epistemic utility.

Keywords: Maximin, risk, risk aversion, Principle of Indifference

In this chapter, I begin by looking at two existing justifications of the Principle of Indifference as it applies to Kazuo, that is, $\text{PoI}_{\text{Kazuo}}$ (Sections 12.1 and 12.2).[1] These will help to motivate my own alternative accuracy-based justification for $\text{PoI}_{\text{Kazuo}}$, which I present in Section 12.3. In Section 12.4, I extend that justification to give an accuracy-based justification for PoI, the Principle of Indifference in full generality.[2]

12.1 The Argument from Evidential Support

According to the first argument for the Principle of Indifference that I will consider, Kazuo is irrational because his evidence supports each of the propositions *Red*, *Yellow*, and *Blue* equally, and rationality requires that his credence in each proposition he entertains should respect the support given to that proposition by his evidence. We might state this argument slightly differently in terms of reasons as follows: an agent needs an epistemic reason to believe one proposition more strongly than another; such a reason can only be provided by evidence; and Kazuo's evidence gives no reason to have greater credence in *Yellow* than in *Red*, and in *Red* than in *Blue*. Here is Roger White making this argument, which he calls the 'evidentialist argument'—I call it the Argument from Evidential Support.

> One's confidence should adequately reflect one's evidence (or lack of it). You need a good reason to give more credence to p than to q. Hence if one's evidence is symmetrical [as, we can assume, an empty body of evidence such as Kazuo's is] so should be one's degrees of confidence [i.e. one's credences]. This is the fundamental thought behind POI and it can't be easily dismissed. (White, 2009, 171)

(p.156) Note that, as stated, this argument attempts to establish a slightly different version of the Principle of Indifference from the one I will eventually defend here. Here it is: Write $p \approx_E q$ iff p and q are equally supported by a body of evidence E. Then White's argument is intended to establish the following principle:

> **PoI**$_{\text{Ev}}$ Suppose A, B are in $\mathscr{F}$. If the agent has a credence function c defined on $\mathscr{F}$ and a body of evidence E, then rationality requires that, if $A \approx_E B$, then $c(A) = c(B)$.

Note that PoI$_{\text{Ev}}$ applies much more broadly that PoI$_{\text{Kazuo}}$ or PoI$_3$. In principle, it applies to any agent with any body of evidence and opinions about any propositions. We can obtain PoI$_{\text{Kazuo}}$ as a consequence of PoI$_{\text{Ev}}$ by assuming that $\mathit{Red} \approx_\top \mathit{Yellow} \approx_\top \mathit{Blue}$ and assuming Probabilism, where $\top$ is a tautology and thus represents an empty body of evidence.

The problem with the Argument from Evidential Support is this. It must assume that, for every body of evidence, and every pair of propositions, there is a fact of the matter about whether or not the evidence supports the two propositions equally or not; or, what White takes to be equivalent, a fact of the matter about whether the evidence provides any reason to favour one over the other. But what warrant is there for thinking that there is such a fact that can do the job required of it? According to the most promising account of evidential support we currently have— viz., Bayesian confirmation theory—there is no such fact. According to this theory, two propositions A and B are equally supported by a body of evidence E if, for each rationally permissible initial credence function c, we have $c_E(A) = c_E(B)$ (where c_E is the result of updating c on evidence E in the rationally required way). On this account, facts about evidential support are entirely determined by facts about rational initial credences and rules for rational updating upon receipt of a body of evidence. But of course that notion of equal evidential support cannot do the job required by PoI_{Ev}. If facts about equal evidential support are in fact determined by the rational principles governing credences—as Bayesian confirmation theory suggests—and facts about a particular rational principle—namely, PoI_{Ev}—depend on facts about equal evidential support, that is circular, and PoI_{Ev} becomes trivial. If $A \approx_E B$ is best understood as saying that all rational initial credence functions assign equal credence to A and to B once they've incorporated evidence E, then PoI_{Ev} becomes simply an analytic truth. Thus, the Argument from Evidential Support owes us a notion of equal evidential support that is prior to the notion of rational credence and thus can be used to place constraints on rationality without the threat of circularity.

12.2 The Argument from Minimal Information

The second justification of the Principle of Indifference begins with an intuition that is similar to the intuition that motivates the Argument from Evidential Support. However, this time, it delivers $\text{PoI}_{\text{Kazuo}}$ and PoI_3 directly, rather than through PoI_{Ev} (p.157) along with an assumption about equal evidential support in the absence of evidence. The intuition is this: An agent's beliefs, credences, and other doxastic states should not 'go beyond' her evidence on pain of irrationality. Of course, this is not yet precise enough to provide a requirement of rationality. In the first argument, we posited facts about equal evidential support and we said that an agent 'goes beyond' her evidence if her evidence supports two propositions equally while her credences favours one over the other. In the present argument—the Argument from Minimal Information—we posit a measure of the lack of informational content of a probabilistic credence function, we construe evidence as placing constraints on an agent's credence function, and we say that (i) an agent does not *respect* her evidence if she violates the evidential constraints; and (ii) an agent *goes beyond* her evidence if she satisfies the constraints but has a credence function whose informational content is greater than it needs to be in order to satisfy those constraints. Failing to respect her evidence and going beyond it both render an agent irrational, according to this argument.

Again, the Argument from Minimal Information justifies a different version of the Principle of Indifference—it is again one that applies in a broader range of situations. To state this version of the principle, we need to define the measure of the lack of informational content possessed by a probabilistic credence function that the argument posits. Given a probabilistic credence function *c*, we define the *Shannon entropy of c* as follows:[3,4,5]

$$H(c) := -\sum_{w \in W_F} c(w) \ln c(w)$$

With this in hand, we can state our principle of rational credence:

> $\text{PoI}_{\text{MaxEnt}}$ Suppose an agent's evidence imposes constraints *C* on her credence function. Then, if her credence function is *c* then rationality requires that *c* has maximal Shannon entropy amongst those probabilistic credence functions that satisfy *C*. That is,
>
> (i) *c* is probabilistic;
> (ii) *c* satisfies *C*;
> (iii) for all probabilistic credence functions *c*′ that satisfy *C*, $H(c') \leq H(c)$.

(p.158) It is easy to prove that, on the extremely minimal assumption that an empty body of evidence places no constraints on an agent's credence function, $\text{PoI}_{\text{MaxEnt}}$ entails $\text{PoI}_{\text{Kazuo}}$ and PoI_3. Indeed, it will also entail the more general version of the Principle of Indifference for which I argue below. Thus, according to the Argument from Minimal Information, Kazuo is irrational because there are credences other than his that have higher entropy and thus less informational content whilst also satisfying the (lack of) constraints imposed by his (lack of) evidence. For the sake of exactness, let's assume that Kazuo's credences are as follows:

$$c_{\text{Kazuo}}(Yellow) = \frac{5}{10} \quad c_{\text{Kazuo}}(Red) = \frac{3}{10} \quad c_{\text{Kazuo}}(Blue) = \frac{2}{10}$$

then

$$H(c_{\text{Kazuo}}) = -\frac{5}{10} ln\left(\frac{5}{10}\right) - \frac{3}{10} ln\left(\frac{3}{10}\right) - \frac{2}{10} ln\left(\frac{2}{10}\right) = 1.02965$$

Kazuo goes beyond his evidence because there are alternative credences, which also satisfy his evidential constraints (indeed any probabilistic credences do, since Kazuo has no evidence), that have lower informational content. For instance, the uniform distribution over {*Yellow,Red,Blue*}:

$$c^{\dagger}(Yellow) = c^{\dagger}(Red) = c^{\dagger}(Blue) = \frac{1}{3}$$

For this, we have:

$$H(c^\dagger) = -\frac{1}{3}ln\left(\frac{1}{3}\right) - \frac{1}{3}ln\left(\frac{1}{3}\right) - \frac{1}{3}ln\left(\frac{1}{3}\right) = 1.09861$$

Indeed, $c\dagger$ is unique in having minimal informational content amongst all the probabilistic credence functions over that set of propositions. Thus, it is the only credence function that is not ruled irrational by $\text{PoI}_{\text{MaxEnt}}$.

The Argument from Minimal Information comes in two versions, though they both end up concluding $\text{PoI}_{\text{MaxEnt}}$. On the first, advocated by E. T. Jaynes, we lay down conditions on a function that is intended to measure the lack of informational content in a probabilistic credence function and we show that only Shannon entropy satisfies them; then we assume explicitly that rationality requires an agent to respect her evidence—that is, satisfy the constraints it imposes—but not go beyond it—that is, minimize informational content within those constraints. This is exactly what $\text{PoI}_{\text{MaxEnt}}$ requires.

> [I]n making inferences on the basis of partial information we must use that probability distribution which has maximum entropy subject to whatever is known. This is the only unbiased assignment we can make; to use any other would amount to arbitrary assumption of information which by hypothesis we do not have.… The maximum entropy distribution may be asserted for the positive reason that it is uniquely determined as the one that is maximally non-committal with regard to missing information. (Jaynes, 1957, 623)

(p.159) On the second version of the Argument from Minimal Information, advocated by J. B. Paris and Alena Vencovská, we begin by laying down conditions on a function N that takes a body of evidence that imposes constraints C and returns a credence function $N(C)$ that is intended to be the rationally mandated response to the evidence represented by C. Within these conditions, we include one that says, essentially, that the credence function $N(C)$ should not 'go beyond' C. Here are Paris and Vencovská stating this condition informally:

> $N(C)$ should not make any assumptions beyond those contained in C. (Paris & Vencovská, 1990, 185)

Finally, we show that, if the constraints C have certain properties, $N(C)$ returns the unique credence function amongst those that satisfy C that has maximal entropy. That is, $N(C) = \arg\max_{c' \in \mathcal{P} \cap C} H(c')$, as required by $\text{PoI}_{\text{MaxEnt}}$.

The problem with both varieties of the Argument from Minimal Information is the same. It is not clear why we should not go beyond our evidence; it is not clear what is so epistemically bad about having greater informational content than is absolutely necessary in order to satisfy the evidential constraints. After all, having credences with a lot of informational content seems, on the face of it, to be a virtue. According to Alethic Vindication, the ideal credence functions are the omniscient credence functions, and they have as much informational content as it is possible to have: that is, they have minimal Shannon entropy. Why, then, should we minimize informational content as much as the evidential constraints will allow us to? Doing so certainly does not seem to further the goal of accuracy—taken to be proximity to the ideal credence functions—that Veritism takes to be the sole fundamental source of epistemic value. Without an answer to this question, the Argument from Minimal Information lacks force.

12.3 The Argument from Accuracy

My proposal is this: our intuition that it is irrational to go beyond our evidence is born out of a form of epistemic risk aversion. We think that, if our credences go beyond our evidence, we risk going badly wrong in some epistemic way.

Consider Kazuo, for instance. Intuitively, Kazuo's credences go beyond his evidence. By doing so, Kazuo risks something epistemically. He risks being inaccurate in some way—or so I claim. Of course, all credence functions risk some inaccuracy—no credence function can have maximal accuracy at all possible worlds. Nonetheless, some risk more than others. We say that one credence function *c* risks greater inaccuracy than another *c′* if the worst-case scenario for *c* accuracy-wise is worse than the worse- case scenario for *c′* accuracy-wise; that is, the inaccuracy of *c* at the world at which it has greatest inaccuracy is greater than the inaccuracy of *c′* at the world at which it has greatest inaccuracy.

(p.160) Thus, consider c_{Kazuo} and $c^\dagger$. A crucial feature of $c^\dagger$ is that it is equally inaccurate at all three possible worlds, *Red, Blue*, and *Yellow*. If our inaccuracy measure $\mathfrak{I}$ is generated by a scoring rule $\mathfrak{s}$, then the inaccuracy of $c^\dagger$ at any world *w* is

$$I(c^\dagger, w) = \mathfrak{s}\left(1, \frac{1}{3}\right) + \mathfrak{s}\left(0, \frac{1}{3}\right) + \mathfrak{s}\left(0, \frac{1}{3}\right)$$

After all, at each world, one of the three propositions is true and the other two false, and $c^\dagger$ assigns to each proposition credence $\frac{1}{3}$. Thus, each world is the worst-case scenario for $c^\dagger$—of course, each is also the best-case scenario. In contrast, c_{Kazuo} is most accurate if the handkerchief is yellow/green, next most accurate if it is red/orange, and least accurate if blue/purple, since he assigns highest credence to *Yellow*, next highest to *Red*, and lowest to *Blue*. Thus, its worse-case scenario is if the handkerchief is blue/purple. Moreover, it is easy to see that, in that scenario, c_{Kazuo} is more inaccurate than $c^\dagger$ is in that scenario. And, since each scenario is the worst-case scenario for $c^\dagger$, c_{Kazuo} is more inaccurate in its worst-case scenario than $c^\dagger$ is in its. Thus, by adopting c_{Kazuo}, Kazuo risks greater inaccuracy than he needs to: if instead, he were to adopt $c^\dagger$, he would certainly still risk inaccuracy, since all credence functions do; but he would risk less inaccuracy than he risks by adopting c_{Kazuo}. Figure 12.1 illustrates the point.

Indeed, this is true of any credence function other than $c^\dagger$. That is, amongst all credence functions defined on {*Yellow, Red, Blue*}, the credence function that risks least inaccuracy is the uniform distribution $c^\dagger$, as the following theorem shows:

Theorem 12.3.1 *Suppose $\mathfrak{D}$ is an additive Bregman divergence and $\mathfrak{I}(c, w) = \mathfrak{D}(v_w, c)$. (Equivalently: suppose $\mathfrak{I}$ is an additive and continuous strictly proper inaccuracy measure.) And suppose $\mathscr{F} = \{X_1, X_2, X_3\}$ is a partition. And let $c^\dagger(X_1) = c^\dagger(X_2) = c^\dagger(X_3) = \frac{1}{3}$. Then if c is a credence function defined on $\mathscr{F}$ and $c = c'$, then*

(p.161)

$$\max_{w \in W_F} J(c^\dagger, w) < \max_{w \in W_F} J(c, w)$$

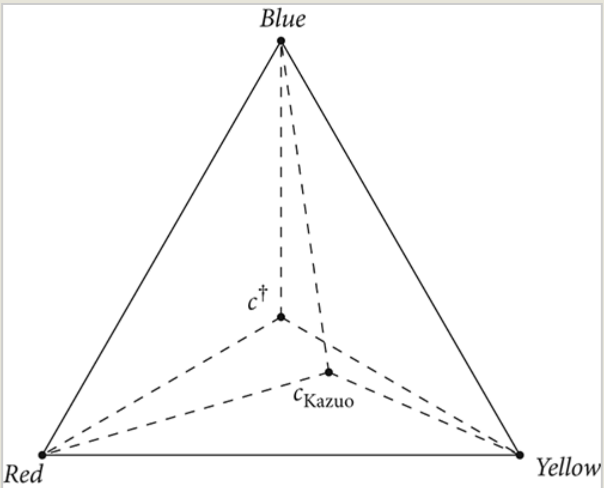

Figure 12.1 Suppose we measure inaccuracy using the Brier score. Then it is easy to see from this diagram that the worst-case scenario for c_{Kazuo} is *Blue*, and that it is more inaccurate in that scenario

than $c^\dagger$ is in its worst-case scenario, which occurs at each world.

I give a full proof of the more general Theorem 13.1.1 in the Appendix to this part of the book, but it is useful to sketch why it is true in this particular instance. First, as we noted above, the inaccuracy of $c^\dagger$ is the same at all worlds and thus its maximal inaccuracy is its inaccuracy at any world. Second, since our inaccuracy measure is strictly proper, for any credence function $c \neq c^\dagger$, there must be some world w in $\mathscr{W}_{\mathcal{F}}$ at which c is more inaccurate than $c^\dagger$—if not, then c is at most as inaccurate as $c^\dagger$ at all worlds, and thus $c^\dagger$ would expect c to be at most as inaccurate as it expects itself to be, which is ruled out by strict propriety. Thus, c is more inaccurate than $c^\dagger$ at w. So c is more inaccurate in its worst-case scenario than $c^\dagger$ is at w. But w is the worst-case scenario for $c^\dagger$, since every world is. Thus, c is more inaccurate in its worst-case scenario than $c^\dagger$ is in its worst-case scenario.

With this theorem in hand, we can give an argument in favour of PoI_3 provided we assume that rationality requires an agent not to risk greater than necessary inaccuracy. In other words, what we need is the following familiar decision-theoretic principle of Maximin, which says roughly that an agent should choose an option that maximizes its minimum utility. As before, we state this principle in general for any sort of options and for an agent with any utility function. But of course we are interested in it primarily in the case where the options are credence functions and the (dis)utility function is an (in)accuracy measure.[6]

Maximin Suppose $\mathscr{O}$ is the set of options, $\mathscr{W}$ is the set of possible worlds, and $\mathfrak{U}$ is a utility function. Suppose o, o' in $\mathscr{O}$. Then, if

(i)

$$\max_{w \in W_F} U(o, w) < \max_{w \in W_F} U(o', w)$$

and

(ii) there is no o'' in $\mathscr{O}$ such that

$$\max_{w \in W_F} U(o', w) < \max_{w \in W_F} U(o'', w)$$

then

(iii) o is irrational, for an agent at the beginning of her epistemic life.

Thus, an option is irrational if it doesn't maximize worst-case utility providing there is an option that does maximize it. Equivalently:

Maximin If

(i)

$$\max_{w \in W_F} -\mathfrak{U}(o', w) < \max_{w \in W_F} -\mathfrak{U}(o, w)$$

(p.162) and

(ii) there is no o'' in $\mathcal{O}$ such that

$$\max_{w \in W_F} -\mathfrak{U}(o'', w) < \max_{w \in W_F} -\mathfrak{U}(o', w)$$

then

(iii) o is irrational, for an agent at the beginning of her epistemic life.

Thus, an option is irrational if it doesn't minimize worst-case disutility, providing there is an option that does minimize it.

Since an inaccuracy measure is a measure of epistemic *disutility*, it is most useful to focus here on the second version of the principle: on this version, the principle exhorts an agent to minimize her maximal disutility (where her disutility function is —$\mathfrak{U}$, the negative of her utility function $\mathfrak{U}$), while the first version exhorts her to maximize her minimal utility. They are, of course, equivalent.

Thus, we have the following argument for PoI_3.

(I_{PoI_3}) **Veritism**

(II_{PoI_3}) **Brier Alethic Accuracy**

(III_{PoI_3}) **Maximin**

(IV_{PoI_3}) **Theorems 12.3.1** and **I.B.2**

Therefore,

(V_{PoI_3}) **Probabilism + PoI$_3$**

As in previous chapters, for any additive and continuous strictly proper inaccuracy measure $\mathfrak{I}$, the crucial mathematical theorem—in this case, Theorem 12.3.1—ensures that the argument just given will still go through if we replace the second premise with the claim that $\mathfrak{I}$ is the sole legitimate measure of inaccuracy, rather than the Brier score $\mathfrak{B}$. However, unlike in previous chapters, it turns out that this argument we have just given will still go through even if we don't assume that there is a single legitimate measure of inaccuracy, or if we assume that there is but we don't know which of the additive and continuous strictly proper scoring rules it is. The point is that, even with these more liberal second premises, this argument isn't vulnerable to the Bronfman objection explored in Chapter 5. Recall: in Part I, we saw that, given any continuous and additive strictly proper inaccuracy measure $\mathfrak{I}$, and any credence function c that violates Probabilism, there is a probabilistic credence function c^* that dominates c and expects itself to be most accurate relative to $\mathfrak{I}$. In Chapter 5, we noted the following: if we do not narrow down our class of legitimate inaccuracy measures to a single measure, and if we then take a supervaluationist or an epistemicist interpretation of this class as our second premise, then the argument for Probabilism will not go through using this mathematical result. The reason is this: For all the result tells us, there may be two inaccuracy measures $\mathfrak{I}$ and $\mathfrak{I}'$ such that all the credence functions that dominate c relative to $\mathfrak{I}$ do not dominate it relative to $\mathfrak{I}'$ (and vice versa). In this case, the agent with credence function c is not irrational—just as it is (p.163) not irrational in the Miners Paradox to choose an option that you know is not optimal. However, this problem does not arise in the case of our argument for PoI_3. In that case, all of the inaccuracy measures agree on the credence function that minimizes worst-case inaccuracy: it is $c^\dagger$. Thus, in place of Brier Alethic Accuracy in this argument we might instead assume:

> **Epistemicism about Inaccuracy Measures** There is an objective notion of inaccuracy, and it is determinate enough for there to be a single correct measure of it. But we do not have perfect epistemic access to it at this stage; all we know is that, whichever measure is the single correct one, it is amongst the continuous and additive strictly proper inaccuracy measures.

If we do this, then the argument above will still go through. Similarly, if we replace our second premise with this:

> **Supervaluationism about Inaccuracy Measures** There is an objective notion of inaccuracy, but it is too indeterminate for there to be a single correct numerical measure of it. Each continuous and additive strictly proper inaccuracy measure is an acceptable precisification of it.

Thus, for those convinced by Alethic Vindication, Perfectionism, Divergence Additivity, Divergence Continuity, and Decomposition from Chapter 4, but not convinced by Symmetry, the argument for Probabilism + PoI_3 via Maximin will still work.

12.4 Generalizing the argument

Before we go on to explore the crucial decision-theoretic principle Maximin, let’s see how this argument generalizes. Recall, in Part I, that we first employed dominance principles to argue for No Drop and then showed that in fact they establish the much more general credal principle of Probabilism. Similarly, in this part of the book, we begin by using Maximin to establish PoI_3, and then we generalize to show that it establishes a much more powerful principle.

To state that latter principle, we need the following terminology. Suppose $\mathscr{F}$ is a finite set of propositions and $\mathscr{F}^*$ is the smallest algebra that contains $\mathscr{F}$. Then we say that $\mathscr{F}$ is *rank-complete* if the following holds: if $\pi : \mathscr{W}_{\mathscr{F}} \to \mathscr{W}_{\mathscr{F}}$ is a permutation of the possible worlds relative to $\mathscr{F}$, and X is in $\mathscr{F}$, then $\pi(X)$ is in $\mathscr{F}$, where $\pi(X)$ is the proposition in $\mathscr{F}^*$ that is true at $\pi(w)$ iff X is true at w. If we represent a proposition by the set of worlds at which it is true, then $\pi(X) := \{\pi(w) : w \in X\}$. We might gloss the notion of rank completeness as follows: a rank-complete set of propositions contains all propositions of a given logical strength if it contains any, where (at least in the finite case) we can measure the logical strength of a proposition by the number of worlds at which it is true. Thus, suppose we have an algebra $\mathscr{F}^*$ whose atoms are the following possible worlds: $w_1, \ldots, w_4$. Thus, we can represent each element of $\mathscr{F}^*$ by a subset of $\{w_1, \ldots, w_4\}$. Then the following two sets of propositions are rank-complete: (p.164)

- $\{\{w_1, w_2, w_3\}, \{w_1, w_3, w_4\}, \{w_2, w_3, w_4\}, \{w_1, w_2, w_4\}\}$
- $\{\{w_1\}, \{w_2\}, \{w_3\}, \{w_4\}\}$

But the following two sets are not:

- $\{\{w_1, w_2, w_3\}\}$
- $\{\{w_1\}, \{w_2\}, \{w_2, w_3\}\}$

Note that any algebra is rank-complete. Now we can state our generalization of PoI_3:

> **PoI** Suppose $\mathscr{F}$ is a finite, rank-complete set of propositions. If an agent has an initial credence function c_0 defined on $\mathscr{F}$, then rationality requires that c_0 is the uniform distribution on $\mathscr{F}$. That is,
>
> $$c_0(X) = c_{\mathrm{F}}^{\dagger}(X) := \frac{|\{w \in \mathrm{W}_{\mathrm{F}} : X \text{ is true at } w\}|}{|\{w \in \mathrm{W}_{\mathrm{F}}\}|}$$

Thus, the uniform distribution over a finite rank-complete set of propositions assigns to each proposition the proportion of the possible worlds at which it is true.

We then have the following theorem:[7]

> **Theorem 12.4.1** *Suppose $\mathfrak{D}$ is an additive Bregman divergence and $\mathfrak{I}(c, w) = \mathfrak{D}(v_w, c)$. (Equivalently: suppose $\mathfrak{I}$ is an additive and continuous strictly proper inaccuracy measure.) And suppose $\mathscr{F}$ is*

a finite, rank-complete set of propositions. Then if c is a credence function defined on $\mathscr{F}$ *and* $c \neq c^{\dagger}_{\mathrm{F}}$*, then*

$$\max_{w \in \mathrm{W_F}} I(c^{\dagger}_{\mathrm{F}}, w) < \max_{w \in \mathrm{W_F}} I(c, w)$$

This then provides the basis for our accuracy-based argument for the Principle of Indifference:

(I_{PoI}) **Veritism**
(II_{PoI}) **Brier Alethic Accuracy**
(III_{PoI}) **Maximin**
(IV_{PoI}) **Theorems 12.4.1** and **I.B.2**
Therefore,
(V_{PoI}) **Probabilism + PoI**

Thus, what is wrong with assigning greater credence to one possibility over another in the absence of evidence is that by doing so you risk greater inaccuracy than you need to risk. There is an alternative credence function, namely, the uniform distribution $c^{\dagger}_{\mathscr{F}}$ on $\mathscr{F}$, which spreads credence equally over all possibilities, and that has lower inaccuracy in its worst-case scenario than you have in yours.

(p.165) It is worth noting that this version of the Principle of Indifference—that is, PoI—is the same version that gives the conclusion of the Argument from Minimal Information. In other words, for any finite, rank-complete set $\mathscr{F}$, just as $c^{\dagger}_{\mathscr{F}}$ minimizes maximal inaccuracy, so it maximizes Shannon entropy.

As above, it is worth noting that this argument will still go through with various alternative second premises. For any additive and continuous strictly proper inaccuracy measure $\mathfrak{I}$, the argument will go through if we assume that $\mathfrak{I}$ is the sole legitimate measure of inaccuracy. But it will also go through if we replace Brier Alethic Accuracy with Epistemicism about Inaccuracy Measures or Supervaluationism about Inaccuracy Measures. Again, the reason is that all additive and continuous strictly proper inaccuracy measures agree that the uniform distribution minimizes worst-case inaccuracy.

12.5 Epistemic risk aversion

So, we have an accuracy-based argument for the Principle of Indifference. In the Introduction, I said that this whole book could be read as a sustained argument in favour of Veritism. The thought is that one of the main objections to the claim that the sole fundamental source of epistemic value is accuracy is that it cannot account for certain evidentialist principles. Amongst these is the Principle of Indifference. It is an evidentialist principle *par excellence*, as witnessed by the fact that the two most prominent justifications of it rely heavily on evidentialist intuitions: the Argument from Evidential Support relies on the intuition that credences should line up with evidential support orderings; the Argument from Minimal Information relies on the intuition that credences should not go beyond the evidence. We now have an accuracy- based argument for the Principle of Indifference—it does not rely on any evidentialist intuitions. This helps to answer the evidentialist's objection to Veritism. Along with the accuracy-based arguments for Probabilism (Part I), the Principal Principle (or its variants) (Part II), and Conditionalization (and its variants) (Part IV), it goes a long way to answering that objection.

However, the accuracy-based argument for the Principle of Indifference is only as good as its premises are plausible. The only new premise is Maximin, so we focus on that.

The first thing to note about Maximin is its restricted scope. Unlike the various versions of Dominance and most of the versions of Chance Dominance that we have considered so far in this book, it is intended to apply only at the beginning of an agent's epistemic life—it governs her only at the point when she is setting her initial credences; that is, at a point when she has no credences to guide her decisions, epistemic or otherwise. Thus, our application of the decision-theoretic principle in the epistemic setting is akin to John Rawls' application of it in the political setting (Rawls, 1975, Sections 26–28). Just as Rawls holds that the best society is that chosen by an agent behind the veil of ignorance who employs Maximin, so our Argument from Accuracy (p.166) turns on the assumption that rational initial credences are those chosen by an agent behind the veil of ignorance who uses the same principle.

Why should such an agent use this decision-theoretic principle? Part of the answer lies in epistemic conservatism. We are familiar with this position from William James' writings—though James himself was no friend of it.

> There are two ways of looking at our duty in the matter of opinion,—ways entirely different, and yet ways about whose difference the theory of knowledge seems hitherto to have shown very little concern. We must know the truth; and we must avoid error,—these are our first and great commandments as would-be knowers; but they are not two ways of stating an identical commandment, they are two separable laws. […] Believe truth! Shun error!—these, we see, are two materially different laws; and by choosing between them we may end by coloring differently our whole intellectual life. We may regard the chase for truth as paramount, and the avoidance of error as secondary; or we may, on the other hand, treat the avoidance of error as more imperative, and let truth take its chance. (James, 1905, Section VII)

Thus, for James, there are two goals: *Believe truth! and Shun error!.* The extreme epistemic conservative—W. K. Clifford, for instance, at least on James' reading— pursues only the latter; the extreme epistemic radical pursues only the former; more moderate positions can be obtained by weighing the two goals against one another.

What do these goals amount to for an agent whose doxastic state includes credences rather than full beliefs? *Believe truth!,* it seems to me, exhorts the agent have highly accurate credences. *Shun error!,* on the other hand, demands that she avoid highly inaccurate credences. The epistemic radical, therefore, will adopt credences that present the possibility, if not the guarantee, of highly accurate credences. That is, she will apply the decision-theoretic principle of Maximax: whereas Maximin condemns as irrational those credences whose worst-case scenario is worse than the worse-case scenario of some other credences, Maximax condemns as irrational those credences whose best-case scenario is worse than the best-case scenario of some other credences. It is easy to show that, together with Brier Alethic Accuracy, Maximax entails that the only initial credence functions that are not irrational are the omniscient credence functions—indeed, that is true whichever additive and continuous strictly proper inaccuracy measure we take to be legitimate. The Cliffordian epistemic conservative, on the other hand, will take measures to avoid having more inaccuracy credences than is necessary—that is, she will apply Maximin. Thus, Maximin is the principle of the extreme epistemic conservative; and so the Principle of Indifference follows if we grant extreme epistemic conservatism.

I have no further argument to support extreme epistemic conservatism. Indeed, it seems to me that it is not a position to which we might argue from more basic principles. We have reached normative bedrock, as James recognized:

> We must remember that these feelings of our duty about either truth or error are in any case only expressions of our passional life. (James, 1905, Section VII)

(p.167) As a result, for those who are not extreme epistemic conservatives, it might be best to read this part of the book as spelling out the consequences of various positions on the spectrum between extreme epistemic conservatism—which corresponds to extreme risk aversion—and extreme epistemic radicalism—which corresponds to extreme risk-seeking—when they are combined with our favoured account of epistemic value, namely, veritism. In this chapter, we have seen the consequences of the positions at the end points of this spectrum: extreme epistemic conservatism gives the Principle of Indifference; extreme epistemic radicalism rules out all but the omniscient credence functions as irrational. In the next chapter, we will consider other positions on the spectrum.

12.6 Language dependence

First, however, I'd like to consider briefly a standard objection to the Principle of Indifference. It is often said that the Principle of Indifference is inconsistent.[8] Consider again Kazuo, who is wondering about the colour of the handkerchief in my pocket. If we apply the Principle of Indifference to the partition $\{Blue, \overline{Blue}\}$, then it rules out as irrational all but the assignment of credence $\frac{1}{2}$ to *Blue*. If, on the other hand, we apply it to the partition {*Blue, Yellow, Red*}, then it rules out all but the assignment $\frac{1}{3}$.

Whatever the merits of this objection against other versions of the Principle of Indifference (such as PoI_{Ev}), it does not affect PoI. According to PoI, if the set of propositions to which Kazuo assigns credences is $\{Blue, \overline{Blue}\}$, then PoI tells him to assign credences equally to each element in that partition, giving credence $\frac{1}{2}$ to each, including *Blue*. After all, if $\mathrm{F} = \{Blue, \overline{Blue}\}$, then $c^{\dagger}_{\mathrm{F}}(Blue) = \frac{1}{2}$. If, on the other hand, it is the propositions in {*Blue, Yellow, Red*} to which he assigns credences, then PoI tells him to spread his credences evenly over these three possibilities, giving a credence of $\frac{1}{3}$ to each, including *Blue*. After all, if $\mathscr{F}$ = {*Blue, Yellow, Red*}, then $c^{\dagger}_{\mathrm{F}}(Blue) = \frac{1}{3}$. Since it is never the case that the set of propositions to which he assigns credences is both $\{Blue, \overline{Blue}\}$ and $\{Blue, Yellow, Red\}$, no inconsistency arises.

What this shows is that, while the Principle of Indifference is not inconsistent, the credence it mandates for a given proposition depends on the propositions about which the agent has an opinion. However, far from being paradoxical or inconsistent, this in fact seems exactly right. What rationality demands of an agent is determined by the resources that are available to her. If her conceptual scheme is impoverished to the extent that she distinguishes only blue/purple from its complement, then rationality requires one thing. As her conceptual scheme expands to permit more possibilities, however, so that she can now distinguish red/orange from yellow/green, rationality requires something else.

Notes:

([1]) It is worth noting that Jon Williamson (2007) provides a third justification for the Principle of Indifference. However, his justification is explicitly non-epistemic. It is a pragmatic argument akin to the Dutch book argument for Probabilism. Thus, it is answering a different question from the one addressed here, where we seek a purely epistemic justification for the principle.

([2]) This chapter develops arguments that were first presented in (Pettigrew, 2014b).

([3]) Recall: $ln\ x$ is the natural logarithm of x. That is, $ln\ x = \log_e (x)$.

([4]) The equation below is defined only if $c(w)$ is defined; and $c(w)$ is defined if there is a unique probabilistic extension of c to $\mathscr{F}^*$. In this part of the book, we simply assume that we are working with sets $\mathscr{F}$ for which this is always true. Indeed, when we state PoI, we will assume that $\mathscr{F}$ is what we will call rank-complete. If $\mathscr{F}$ is rank-complete, then the proposition w is in $\mathscr{F}$ for each world w in $\mathscr{W}_{\mathscr{F}}$.

([5]) Recall from Part I above: We let $\mathfrak{L}$ be the inaccuracy measure that takes the inaccuracy of a probabilistic credence function at a world to be the negative of the natural logarithm of the probability it assigns to that world. Thus, $\mathfrak{L}(c, w) = -ln\ c(w)$. Then $H(c) = \mathrm{Exp}_{\mathfrak{L}}(c|c)$. That is, the Shannon entropy of c is the expected inaccuracy of c by its own lights relative to the inaccuracy measure $\mathfrak{L}$. ?? is what we might call strictly Ħ-proper: that is, for all probabilistic c and c' with $c \neq c'$, $\mathrm{Exp}_{\mathfrak{L}}(c|c) < \mathrm{Exp}_{\mathfrak{L}}(c'|c)$. $\mathfrak{L}$ is not generated by a strictly proper scoring rule. We will have more to say about it below.

([6]) This is the version of Maximin given in (Pettigrew, 2014b).

([7]) This theorem is a consequence of Theorem i3.1.1, which we state in the next chapter and prove in Appendix IV.

([8]) The water/wine paradox from von Mises (1957) and the cube factory paradox from van Fraassen (1989) are the most famous attempts to demonstrate this.