

Author's reply to first referee comment on "Decision-Making under Radical Uncertainty: An Interpretation of Keynes' Treatise".

The referee notes that "much ... conceptual vagueness is endemic to the field, and total clarity may be very hard to achieve" (para 8) and is unsure ... as to the various meanings of the uncertainty terms that are being employed" (para 2). They particularly refer to my horse-racing example (paras 4-6). I shall attempt to be clearer.

As a mathematician, I regard the meaning of mathematical probability (e.g. Kolmogorov 1936) as reasonably clear. I also suppose that, as in Geometry (Einstein 1922), the relationship between a mathematical concept and reality is inevitably unclear or false. The 'usual view' among economists (as elsewhere) I understand to be that this does not matter. Beyond this there are many variants on the notion of rational choice, for example von Neumann and Morgenstern (1944: 17, 26-29). The key points are (i) that uncertainty is only taken account of through the probabilities (ii) that this is not regarded as problematic for economic questions of interest. Ellsberg (1961), building on Keynes, challenges this, as do I, but for a different reason, of more relevance to the issues of Turner. To be clear, I do not propose any definite theory of radical uncertainty, only to show that its existence matters and that – at least in some cases – the lack of a definite theory need not prevent us from recognizing and taking account of it, sometimes by extending the mathematical theory (e.g. Keynes 1921), sometimes by being cautious about applying the results of the usual theory.

If, like the referee, we regard probabilities as well founded when there are 'limiting frequencies', then there is still radical uncertainty about whether such limits exist, which may be more or less significant. For example, a regular gambler will have a track record and hence 'limiting frequencies' of a kind, but with greater radical uncertainty than one might wish. What I take to be the usual view in economics is that, 'pragmatically', one can still estimate probabilities and make decisions irrespective of how well-founded they are. (As discussed by Ellsberg 1961). But Keynes' (1921) contrasting view is that this can matter, and I seek to show an example, concerning 'bubbles'. I may differ from the referee in thinking that ill-founded probabilities may still be useful – provided that we understand their limitations.

A lifetime of frequent gambling on horse-races seems little different to me than investing in a stock market. In both cases people make judgments about the key factors, make estimates based on experience (e.g. statistics), and decide where to place their money. It seems to follow from Keynes, and to be in any case reasonable, that if someone could set up a school and teach people to make good money from such 'investments' for decades then we ought to regard their application of probability theory as at least as well founded as is typical in the natural sciences – and much more so than is typical of the human sciences. There would typically be differences between the cases, but I suppose that a single domain-dependent set of criteria, such as Keynes', ought to apply.

My horse-racing example is taken from Smith (1961). The referee's comments have stimulated me to develop it a little. Suppose that a gambler considers a two-horse race, and – without knowing what odds are being offered – judges that a victory is equally probable for either horse. He now finds that one horse is 3:1 on, the other 2:1 against. In the unrealistic spirit of much academic decision theory, suppose now that the gambler is faced with many such situations, which are identical apart from the fact that half the time he is betting 'at home' and considers himself to be familiar with all the relevant factors, and half the time he is somewhere totally unfamiliar, 'away'. Then according to the usual decision theory, he ought to make the same decision in all cases, since all the variables are the same. But is this reasonable? In the 'home' case his probabilities are based on experience and presumably much sounder, so that in the limit one would reasonably expect his winning to be about what he expected them to be, whereas away there is no reason to doubt the bookmaker's odds. If

we only take account of the probabilities then we are ignoring this critical factor. Perhaps in economics we should also take account of our track record in similar cases, such as when thinking about the potential for crises, where our record is not good.

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