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SAFETY-FIRST MODELS BASED ON SAMPLE STATISTICS: A DISCUSSION*

by

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The paper by Atwood, Watts and Helmers (hereafter AWH) addresses an important problem. At a time when the economic prospects for farmers were brighter, Kliebenstein et al. concluded that cash grain farmers appeared to have "threshold" security levels. Presumably, they are no less concerned about ensuring that minimum income goals are satisfied now than they were then.

One technique which can be used to compute enterprise mixtures for decision makers who have concerns of this sort is Target MOTAD. The additional constraint proposed by AWH should make Target MOTAD more useful for many decision makers. Tauer notes that Target MOTAD is a two attribute model. The two attributes are (using AWH's notation) a target income level, t, and (the absolute value of) expected negative deviations, $\theta(1,t)$, from target income. The concept of a target income is an appealing one. It is reasonable to expect that most decision makers can select a target income level. However, it may be more difficult for them to specify a maximum acceptable level of expected deviations. Simply selecting a target income does not guarantee that income will always be at least that large. The set of enterprise mixes associated with a given target income level can be quite diverse. For example, the solutions associated with a target income of $126,587 includes the vector (160.8, 25.3, 150.3, 28.3, 35.3, 279.9) as well as the "L.P." solution (165.4, 195.4, 10.0, 13.0, 16.2, 128.4). Many of the enterprise mixes associated with a given target income can yield, for some states of nature, incomes much lower than the target income. Thus, both a target income level and an upper limit on expected deviations must be selected to determine the appropriate enterprise mix.

Imposing the safety-first constraint does not reduce the number of questions which the decision maker must answer but the questions may be easier to answer. They must now select an income goal, g, and the (maximum acceptable) probability of failing to meet that goal, λ. Making these choices reduces the set of target income and expected deviation levels to be considered. In Figures 1 and 2, the region ABC includes all of the combinations of target income and expected deviations which would need to be considered to determine the complete set of Target MOTAD solutions. (To avoid excessive clutter only three of the twenty "corners" of this region are labelled.) Selecting a goal of $90,000 and a probability of .1 restricts consideration to those combinations of target income and expected deviations which lie on or below line segment DE. Within ABC, the derivatives of income with respect to t and θ are negative and positive, respectively. Therefore, the AWH model selects some combination of t and θ (the one at point D in this case) lying on DF.

We are impressed by AWH's method even though, and in fact partly because, it will not always find the solution which maximizes expected income subject to an upper limit on the probability of receiving an income lower than the goal. It may fail to find this solution because the safety-first constraint involves a trade-off between a target level and expected deviations from that target level. For a decision maker who is concerned only about controlling the probability of below goal incomes and not with the size of any deficiencies, a different approach would be appropriate. Although the most efficient way of solving this problem may not be apparent, we are confident that the reader knows the characteristics of its solution. The results presented by AWH suggest that their method may approximate the solution.

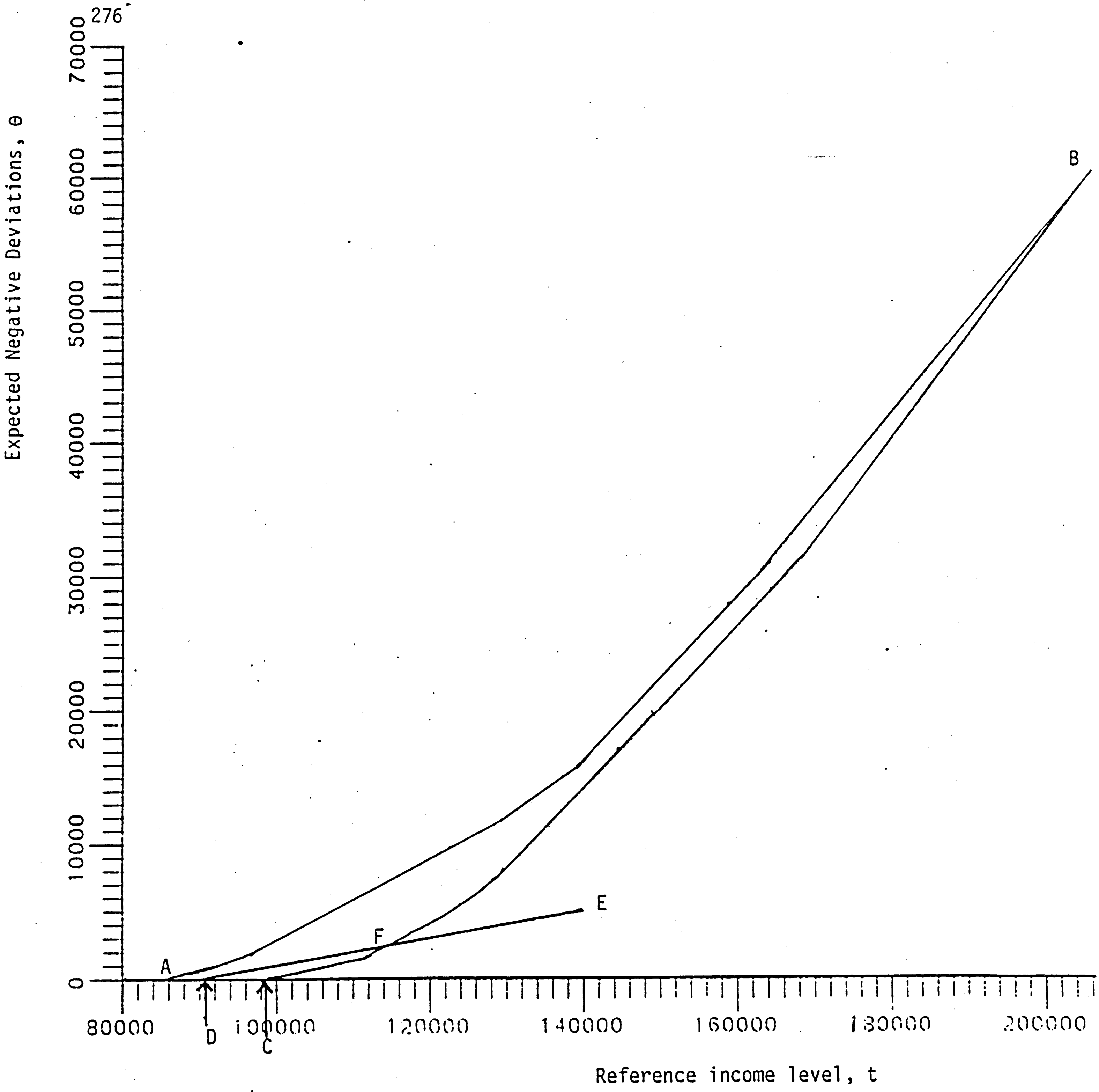

Figure 1. Relevant t, Θ Combinations

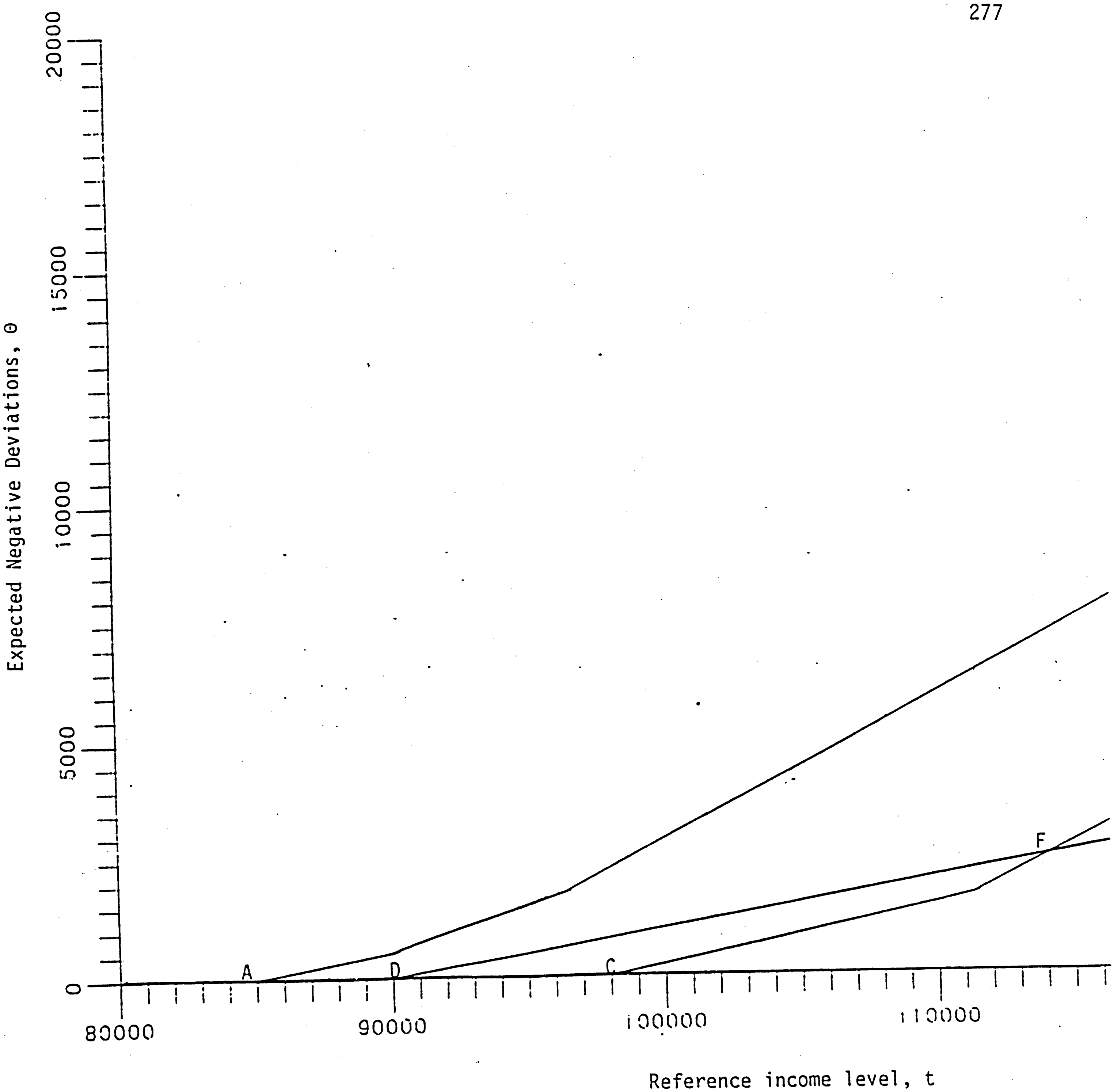

Figure 2. Relevant t, Θ Combinations (Enlarged)

Our preference for the AWH method rather than the approach just mentioned is based on two factors. The first is the fact that implementing the AWH method requires linear programming rather than some more complicated algorithm. A second factor is our belief that most decision makers are concerned about both the probability of attaining below goal income and the magnitude of the deficiency. This is consistent with most of the risk literature (e.g., Fishburn). It seems reasonable for below goal and below target income levels to be assigned (as both Target MOTAD and AWH's method do) higher marginal utilities than those assigned to above goal and above target income levels. However, we recognize that bankruptcy laws and other considerations could cause some decision makers to be relatively unconcerned about incomes below certain critical levels. For these decision makers, the marginal utility of incomes smaller than a critical threshold may be much smaller than for income levels greater than the threshold. Thus, enterprise mixtures chosen by such decision makers might only belong to the F.S.D. efficient set (rather than to the S.S.D. efficient set as well).

There are several aspects of the AWH method and paper which are not as complete as might be desired. Two of them are mentioned in their paper. They are the (absolute and relative) conservatism of inequality (5) and the effect of sampling errors. A complete discussion of the effect of sampling errors may be beyond the scope of their paper. However, it is possible to provide more information about the conservatism of inequality (5). Two kinds of information might be useful.

It should be possible to more clearly describe both those situations for which inequality (5) is an equality and those for which it is not. Very little change in the exposition would be required inasmuch as examples of both are presented in Table 4 and discussed in the text. Simply presenting the endogenously selected target levels would be helpful. It should also be possible to provide some indication of how much less conservative the AWH inequality is than those of Chebychev or Berck and Hihn. It may not be possible to make a general statement but it should be possible to describe this difference for some or all of the solutions presented in Table 4.

Although the AWH paper would have been enhanced by these additional details, their omission is not serious. Most readers who could benefit from this information could obtain it on their own. Standard texts (e.g., Mood and Graybill, pp. 148-9) and the data in AWH's paper provides all of the information which most readers would need.

The method proposed by Atwood, Watts and Helmers is a significant addition to the set of tools available for finding a satisfactory mixture of risky alternatives. Its advantages are its consistency with expected utility theory, its similarity to Target MOTAD, the nature of the questions which the decision maker must answer and the fact that linear programming algorithms can be used to obtain solutions. Its major weakness is uncertainty about the effect of sampling errors. Unfortunately, this weakness is shared by most alternative methods as well.

References

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