particular differential in rates. In fact, in some developing countries this period may be prolonged due to rapidly increasing populations. However, it is inconceivable that we should assume that population will continue to increase at a high rate forever. After all, there is just so much room on our planet!

It is also inconceivable that interest rates could forever be lower than rates of increase of wages. In fact, it is entirely possible to have a situation in which wages would remain stable and prices would decrease due to better productivity. In that case, the assumptions adopted for the proposition would not be fulfilled, since interest rates would still be positive. Similarly, we can see that over the long run, interest rates will be higher than increases in wages, since in a free economy all factors tend to adjust each other toward a state of equilibrium.

I might point out that the assumptions would be valid for a temporary period in countries with inflationary problems. Under these circumstances, there is no advantage in accumulating reserves unless these are invested in inflation-safe assets. This fact has been recognized earlier (for example, see my paper "Actuarial Analysis of Pension Plans under Inflationary Conditions," *Transactions of the Sixteenth International Congress of Actuaries,* Vol. 1, June 1960).

AUTHOR'S REVIEW OF DISCUSSIONS

As the reviewers perceived, I had a modest objective in mind when I wrote this paper. The objective was to illustrate, by a detailed examination of a simple model, the profound difficulties involved in attempting to establish the superiority of any particular social insurance funding method by a chain of purely mathematical reasoning; even when this reasoning proceeds from apparently plausible assumptions. The two reviewers have contributed to the achievement of this objective in a more colorful and forceful fashion than I did.

Mr. Singer's discussion of the marginal rate of time preference contributes significantly to the establishment of the intended point. I acknowledge the relevance of the questions about time preference rates that Singer, with the help of Aesop, has proposed. The relevance of these questions further reduces the possibility that a single, time invariant, time preference rate assumption may be used to reach any meaningful decision on financing a comprehensive social insurance program.

May I also acknowledge that there are a great many verbal interpretations that may be made of the results contained in my tabular presentation. Singer has added several that I failed to state and certainly there are many others that could be proposed. I carried out my table to the extent that I did solely because there are six possible orderings among three unequal numbers and it appeared that the objectives of the paper would be advanced if each of these inequalities was exhibited.

Mr. Myers' suggests that a twin of the paper under discussion be written with the same subject but with the emphasis on the practical problems associated with various social insurance funding methods. I certainly agree with Myers on the need for such a paper. Solid scholarly investigations of the practical impact of various social insurance funding methods are scarce. The implications of the choice of a social insurance funding method may be awesome. Even Aaron, in his short theoretical note in support of current cost funding, acknowledged that his conclusion would be invalid if the current cost method would tend to reduce savings and investment and thereby reduce the growth rate of real income. A major study which would survey the actual experience of nations that have elected various funding methods for their social insurances systems would be of immense value. My only hesitancy about urging such a study is that the author and his readers should recognize that in our dynamic world where not only technology but social institutions and even habits of life are changing, the conclusions of such a practical study might remain valid for only a short period of time.

One could quite properly be accused of glibness if he did not at least acknowledge the deep difficulties involved in designing a methodology for such a study. The problem is to measure the impact of the social insurance funding method when many other influences are simultaneously operating on the economic and social indices being monitored for the purpose of recording the impact of social insurance funding.

May I suggest, however, that a North American actuary who elects to embark on such a study is rather fortunate. Within the English language actuarial literature, the discussions carried on in Canada, the United Kingdom, and the United States on social insurance funding are well recorded. The economic reasoning that motivated the recent funding decisions for the Canada Pension Plan are especially interesting. The confusing issue as to whether a current cost social insurance system retards savings and investment in a developing country or whether it constitutes investment in human welfare that in some way will pay off in economic growth is discussed in a

series of papers published in *The Role of Social Security in Economic Development,* Research Report 27, Social Security Administration, Office of Research and Statistics.

The two reviewers and I, in a certain sense, have avoided the central issue. Singer came close to it when he suggested the explicit introduction of a utility function rather than forcing individual preferences to be reflected only through a constant average marginal rate of time preferences. To the practical minded man, who has a distaste for theory, it may seem perfectly obvious that mathematical decision analysis of any sort has no application in such a complicated public issue as social insurance funding. To such a person this decision is a political one to be decided solely by the political process, either by an edict from the sovereign in a totalitarian country, or by legislative compromise in a republic. Yet, since actuarial science is concerned with making coherent economic decisions in the face of uncertainty, an actuary rather instinctively believes that analytic methods should be used to guide this decision.

The present discussion, ignited by Aaron's paper, is built on the premise that individual preferences may, in a natural way, be averaged in constructing a preferences ordering for society. Each of us, as participants in the political process, recognize the difficult problems involved in this averaging process. The two reviewers and I have pointed out technical problems in this process with respect to social insurance funding. Untouched, but just below the surface of our discussion, is a serious technical question which is only partly solved. That is, can individual preferences among uncertain prospects be averaged in some way to construct a social preference for what, in the aggregate, are relatively certain social states? The practical man would answer *no* and state that this is the business of politics. The theorist would answer with a hopeful *yes* but admit that there are many unresolved issues in building an adequate theory for this problem. Perhaps the major reference in this area is the following book:

Arrow, Kenneth J., *Social Choice and Individual Values,* John Wiley, and Sons, 1951.

On the technical issues raised by the reviewers, I must plead guilty of introducing sloppy notation in defining $W(t)$. I wish that I had used simply w as the average real wage rate at time zero but I did not and I am left only the alternative of apologizing to my readers. The second technical issue raised by the reviewers concerned the language used in introducing the annual rates g and h which, as they indicated, are analogous to the force of

interest. On this issue I can only express my sorrow that the language troubled the reviewers but I am less certain in this case about the proper remedy. The word *rate* is a very troublesome one. Students of compound interest are inflicted with the burden of learning a multiplicity of symbols and terms (annual effective interest rate, nominal annual rate, force of interest, nominal annual discount rate, annual effective discount rate) for describing the same growth of capital function. Nesbitt and Van Eenam ("Rate Functions and Their Role in Actuarial Mathematics," *RAIA* Vol. 38, 1948) wrote a paper in which they defined basic rates and rate functions and then they derived much of the mathematics of life contingencies from these definitions. In this paper the force of mortality and the force of interest are called *rates.* In many differential equations books the factor which actuaries call the *force of interest* is called a growth rate. In statistics, the force of mortality is called the *failure rate* or the *hazard rate.* Although I regret the confusion that my choice of language caused, I do not know how to straighten out the many different concepts of *rate.* It appears, however, that the use of the term *force,* when applied to rates of increment or decrement, seems to be largely confined to actuarial literature.