Traité du Calcul des Probabilités et de ses Applications. By Émile Borel. Volume 3, Part 6. *Théorie Mathématique de l'Assurance Maladie.* By Henri Galbrun. Paris, Gauthier-Villars, 1934. viii+219 pp.

Nearly the whole of Volume 3, dealing with the applications of the theory of probability to the economic and biologic sciences, is the work of Dr. Henri Galbrun, actuary for the Bank of Paris and the Netherlands. Only one of the six sections of Volume 3, namely, Section 3, treating of demography and biology, was written by another author, Professor R. Risser, of the École Polytechnique.

Risser's first two chapters—on sickness and disability—deal with somewhat the same field as Galbrun's Part 6 on sickness insurance. But Risser's discussion of the various probabilities involved is introductory to his consideration of the method of constructing tables giving rates, whereas Galbrun passes from probabilities to the present value of life annuities subject to specific conditions as to health or sickness. Risser (p. 18) takes disability "invalidité" in a general sense, without reference to its permanence. But Galbrun (Part 4, p. 2), following actuarial usage, regards "invalidité" as "permanent disability." Galbrun's Parts 4 and 5, then, deal with the status of permanent disability, together with that of death, for which there is only a one-way passage. But this Part 6 takes up sickness, admitting of a number—in Galbrun's theory, an infinite number—of instances of sickness and recovery. This leads naturally to the use of Volterra integral equations—which was also a feature of Risser's brief treatment of probabilities, with provision for a two-way passage as regards "invalidité."

This Part 6 by Galbrun on sickness insurance is a continuation of the author's excellent presentation of the problems of actuarial mathematics. The first six chapters deal with the probabilities that arise when in addition to the possibility of dying, there is the possibility of entering into or recovering from sickness again and again. At the end of each of these chapters there is a very helpful summary of numbered formulas—356 formulas in all. Then there are 137 more formulas in Chapter 7, mainly devoted to forms of life annuities, with the sickness contingency involved. In the final form, these formulas are in general simple. Indeed, the author compares the formulas (64), (85), (88), (102), (114), and (116) with the simple formula for the continuous temporary life annuity, without sickness contingency (65), page 193. He finds that the only change in passing from (65) to the other formulas is the replacement of the simple probability that a man of age x will live to age β by the probability that he will so live under specified conditions as to health or sickness. The discounting factor in the integral remains the same.

In conclusion, pages 209–218, the author considers the extent of the variation of the actual payments from the theoretical which may be expected,—by making use of the Tchebycheff inequality. This inequality, designed originally for the case of alternatives—such as living and dying—is worked over for the case of more than two possibilities, so as to take care also of health and sickness.

The author refers to the preceding Parts 4 and 5 of Volume 3, in particular to Chapter 6 of this Part 5 for various theoretic and delicate questions which arise in the consideration of probabilities.

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