

the comparative explanatory power of the different major political economy views.

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Steven J. Brams and Alan D. Taylor, *Fair division: From cake cutting to dispute resolution*. New York: Cambridge University Press, 1996. xiv + 272 pages. \$ 54.95 (cloth); \$ 18.95 (paper).

Readers who take the time to explore this volume about fair-division procedures will rediscover the pleasures of delving into the careful and enthusiastic reporting of highly original and creative work. The authors report their own discoveries of two very powerful procedures which can be used for a variety of fair-division problems long thought unsolvable. The two great steps forward are 1) their discovery of an algorithm for a n-person fair division of a single (divisible) good (reported in Chapter 7), and 2) their development and application of a point-allocation procedure for an efficient, envy-free and equitable division of a set of indivisible objects (reported in Chapters 4 and 5).<sup>1</sup>

The point allocation system (called adjusted winner) is brilliantly sketched, and conveniently developed for interesting applications to property division in divorces and treaty negotiations. Objections are developed that the system is manipulable because parties do not have an incentive to be truthful. Problems

exist when the parties have information regarding each others' preferences. Then manipulability can undermine the attainment of the other desiderata. For this reason, they put forward another system (proportional allocation) which gives up efficiency but gives individuals incentives to be truthful. A combination of the two procedures is then persuasively argued to be practicable in a number of contingencies. The authors go on to show that there is no general way for a point allocation system to satisfy more than 2 of the three desiderata (efficiency, envy-freeness, and equitability) (p. 82ff).

The chapter describing the technical solution of the cake-cutting problem for any  $n$  is another tour de force. Its clarity is all the more praiseworthy given the complexity of the actual application of the algorithm.<sup>2</sup> The technique is then shown to be applicable to some situations in which there are some divisible, and some non-divisible goods.

The authors go on to develop extensions of their analysis to problems of fair division in elections and in auctions. These extensions appear somewhat less organic to the material at the heart of the book. Voting, for example, is analyzed in terms of fair division of representation in a legislative council: always a timely and interesting topic, but not one tightly woven into the notion of the development of an algorithm which leads to fair division. Further, most of the chapter is devoted to a variant of Steven Brams's approval voting. The material on auctions is less parochial, and certainly of interest, but not necessarily in the context of this volume.

But the pleasures of the authors' enthusiasm for discovery do not come costlessly. Many of the other pages contain a dense review of the nature, limitations, and development of what amounts to a plethora of fair division schemes which make up a rather non-elegant branch of applied mathematics.

The contrast between the review of the old, and the development of the new could not be greater. The reviews are too often a merely extensive (and exhausting) step-by-step analysis of the many procedures or algorithms of fair division. The authors orient their evaluation of these algorithms with a view on some of the desiderata we might hope for from a procedure of fair division: efficiency, proportionality, non-envy (or envy-freeness), equitability, and non-manipulability. Since many of the analytic problems and the possibilities of fulfilling the desiderata depend upon the number of individuals who are to receive shares, and the nature of the good being divided (continuous and discrete), the book is organized by the number of persons in the group and divisibility of the items being divided. Given the continual evaluation on the basis of the desiderata, and the many specific procedures considered, the book itself becomes quite disjointed. I found that the organization tended to bury the larger lines of inquiry in the superfluous details of exploratory dead-ends.

Mechanisms of fair division, for various reasons (see note 2) can be applied mainly to small groups, such as couples, households, a few nations, etc. This might lead us to ask, “What is the status of such desiderata in general, and these particular ones specifically in these contexts?” The largest subset of such groups probably is families. For example, what conditions would lead families to wish these desiderata to govern the division of their education or health budget? In other words, “Under what circumstances would these desiderata be desirable, or even acceptable; when would they be more questionable?” Any study premised on desiderata should probably begin with an exploration of the value and limitations of the desiderata, one at a time, and in combination.

Readers of *Public Choice* will have no difficulty with either efficiency or non-manipulability. Some of the other desiderata such as equitability (Elster and Roemer, 1991), and non-envy, may be less generally understood. Based on a type of interpersonal welfare comparison, Brams and Taylor describe equitability as “captured by the following question:

Is your announced valuation of what you received equal to your opponent’s announced valuation of what he or she received?” (p. 71)

Whether this question captures its meaning as poorly (especially in non-market contexts) for you as it does for me, must be left to each reader’s own judgment.

Turning to non-envy: non-envy can be thought of as requiring that everyone believes they received the division which they most prefer. Here, Brams and Taylor’s motivation again leaves something to be desired:

an *envy-free division* is one in which every person thinks he or she received the largest or most valuable portion of something – based on his or her own valuation – and hence does not envy anyone else (p. 2.).

Envy, anger, love, etc. are psychological terms, and the authors’ “hence” may not quite follow from any of the psychology. An envious person may justify the emotion by some *inter-personal* projection such as “Martha got a much better deal than I did,” even when he recognizes objectively that he got the most valuable portion. Hence there is no necessary relation between envy = free divisions and the non-existence of envy.<sup>3</sup> Hence, whenever the authors connect the satisfying of the desiderata, singly and as a group, in the justification of their “big claims” relating algorithmic outcomes to some sort of real world “solution” to a problem, they leave something to be desired. I would have preferred to see a more in-depth exploration of the desiderata before the desiderata are touted as desirable in any particular context. Of course, there is an intellectual tradition behind each of the desiderata which could have been

brought to bear. I believe a serious discussion of their properties could have greatly enriched the book.

But this critique does not take away from the great achievement inherent in the major findings: the authors' development of the fair-division procedures mentioned above. The volume is valuable because of what must be termed the head-turning original contributions of the authors.

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## Notes

1. It is interesting to note the choice criteria utilized in these algorithms: minimax. This should be quite clear from the well known and simple Johnny splits, Cathy chooses, cake division algorithm. Johnny's division of the cake into 2 equal pieces comes from his attempt to insure that he can get *at least* half. This can lead to inefficiencies. If the cake is not homogeneous, and the preferences are not identical, Johnny (who say, likes chocolate) could slice the cake differently. He could leave one (smaller) piece with more chocolate, and another large piece for Cathy (who, let's assume does not prefer chocolate). Both could be expected to prefer that outcome.
2. So, for example, the algorithm which is developed by the authors for the n-person fair division of a single object requires that the object be cut into  $2^{n-2} + 1$  pieces. For  $n = 2$  this is 5 pieces, but for  $n = 7$  it is 33 pieces. Hence, one can imagine that the step by step description of a real life application of the procedure gets burdensome. For  $n = 4$ , it takes about 2 pages of text and 6 diagrams.
3. Envy and non-envy are not unknown motivations in politics. The great levelling ideology of the Chinese revolution used a promise of non-envy (and perhaps even partial achievement of such results among poor peasants) to generate envious criticisms to buttress the power and status of its elites (Chang, 1991).

## References

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John M. Carey, *Term limits and legislative representation*. Cambridge, UK: Cambridge University Press, 1996. xiii + 216 pages. \$59.95.

John M. Carey's *Term limits and legislative representation* is one of the more unusual contributions to the growing body of scholarship analyzing the