Noncooperative Bargaining Models of Marriage

By SHELLY LUNDBERG AND ROBERT A. POLLAK*

In this paper we discuss some simple noncooperative models of distribution within marriage in which the equilibria are not necessarily Pareto optimal, in which history and culture can affect which equilibrium is realized, and in which distribution may depend on whether resources are controlled by the husband or by the wife. Recent moves away from single-decision-maker models of the family have permitted economists to address distribution within marriage, and cooperative-bargaining models have played the central role in these moves. The next step is to permit strategic interaction between family members, by modeling distribution within marriage as a noncooperative game. Noncooperative game theory allows great flexibility in specifying the rules of the game and, unlike cooperative game theory, imposes few a priori restrictions on the nature of equilibrium outcomes. In particular, noncooperative models neither assume nor imply that all equilibria are Pareto optimal.

I. Models of Distribution Within the Family

As Gary Becker (1981) has emphasized, the analysis of distribution between spouses begins with the marriage market. If participants in the marriage market could negotiate without transaction costs and make binding, costlessly enforceable agreements, then the marriage market would determine not only who marries whom but also distribution within marriage. Because transaction costs are substantial and agreements made in the marriage market are very difficult to enforce, we prefer to begin with the assumption that the division of any surplus is determined by bargaining within marriage.

The economist's standard models of distribution within marriage are Becker's altruist model and the divorce-threat bargaining models of Marilyn Manser and Murray Brown (1980) and of Marjorie B. McElroy and Mary J. Horney (1981). The altruist model provides a theoretical rationale for the assumption that the family acts as a single decision-maker. Divorce-threat models treat distribution within marriage as the solution to a cooperative game, usually a Nash bargaining game, in which the threat point is divorce. To examine the effects of redistributions between husband and wife in these models, consider two alternative child-allowance schemes: in the first, the government pays a cash transfer to the father; in the second, to the mother. Under both schemes, in the event of divorce the mother becomes the custodial parent and receives the child allowance. The altruist model and divorce-threat bargaining models imply that these alternative child allowance schemes lead to identical distributions within marriage. In the altruist model, the equilibrium distribution corresponds to the point in the feasible consumption set that maximizes the altruist's utility; that point is independent of which parent receives the child allowance because the feasible consumption set is identical under both child-allowance schemes. In divorce-threat bargaining models, the equilibrium is determined by the feasible consumption set and a threat point that corresponds to the utility of being divorced. The equilibrium distribution is independent of which parent receives the child allowance, although it will depend on what McElroy (1990) calls "extrahousehold environmental parameters"

*Department of Economics, University of Washington, Seattle, WA 98195. We thank the Rockefeller Foundation and the Royalty Research Fund of the University of Washington for financial support. We are grateful to Stephen Coate, Andrew D. Foster, George J. Mailath, and Dick Startz for useful comments and to Judith Goff for editorial assistance.

that affect the well-being of divorced individuals.

The ability of policymakers to target successfully the consumption of individuals within families (e.g., wives, children) depends on these transfers not being offset fully by redistribution within families. Most noneconomists who participate in public-policy debates concerning government transfer programs take it for granted that distribution within marriage varies systematically with control of resources. A growing body of empirical evidence suggests that the ownership of property and income received by husbands and wives does affect distribution. Yet the altruist model and the divorce-threat bargaining models both imply that targeted transfers will be ineffective. This Ricardian-equivalence conclusion, we think, reflects only the assumptions of the standard models, not a fundamental truth about distribution within marriage.

In Lundberg and Pollak (1993), we present the "separate-spheres" bargaining model, a new cooperative model in which targeted transfers need not be neutral. In the separate-spheres model the threat point from which cooperative Nash bargaining proceeds is not divorce, but a noncooperative equilibrium within marriage. Thus, the threat point is "internal" to the marriage rather than "external" to it. An internal threat point could be specified in a variety of ways;[1] in the separate-spheres model, it is the solution to a noncooperative game in which a household public good is provided by individual voluntary contributions. If the voluntary contribution equilibrium is a corner solution in which only one parent contributes to each household public good, then targeted transfers (e.g., child allowances) shift the threat point and, hence, affect distribution within marriage. We argue that such corner solutions are especially plausible when traditional, socially recognized and sanctioned gender roles assign exclusive responsibility for providing certain household public goods to mothers and others to fathers. If this voluntary-contribution equilibrium corresponds to a corner solution, then Ricardian equivalence does not hold.

[1]For example, it could include family violence or the threat of violence as in Helen V. Tauchen et al. (1991).

II. Cooperative and Noncooperative Models

Most applications of game theory to distribution within marriage employ cooperative-bargaining models.[2] Cooperative solution concepts, including the Nash bargaining solution, explicitly assume that the equilibrium distribution is Pareto optimal. Cooperative game theory begins by assuming that players can communicate freely and make binding, costlessly enforceable agreements; the analysis focuses on the formation of coalitions (although in two-person games the opportunities for coalition formation are severely limited) and on the distribution of the benefits of cooperation among the players. For distribution within marriage, external enforcement mechanisms are absent: husbands and wives lack access to institutions that enforce household contracts.[3]

Noncooperative game theory does not assume that the husband and wife can enter into binding, costlessly enforceable agreements, but focuses on self-enforcing agreements, that is, on agreements that correspond to strategies that the husband and wife would choose to carry out. The leading noncooperative solution concept, the Nash equilibrium, is a profile of strategies, one for each player, such that each player's strategy is a "best response" to the other players' strategies in the profile. Nash equilibrium formalizes the notion that, if the

[2]There are a number of exceptions: John Hoddinott et al. (1993) provide references and a discussion. Theodore Bergstrom (1993) and Ravi Kanbur and Lawrence Haddad (1994) discuss the noncooperative foundations of bargaining theory applied to distribution in marriage.

[3]Legally enforceable prenuptial agreements concern the disposition of property in the event of death or divorce, not distribution within marriage.

players were to meet in a pub the night before the game and to agree on an assignment of strategies, then the only assignments that are plausible candidates for equilibria are those that correspond to self-enforcing agreements, that is, to agreements the players would choose to carry out the next morning in the absence of an external enforcement mechanism. Noncooperative game theory does not, however, model the assignment of strategies to players. In games with multiple Nash equilibria, there may be no obvious way to choose among them.

Multiple equilibria and the need to choose among them suggest how history and culture might affect distribution within marriage. David Kreps (1990) points out that, in many games, there seems to be a "self-evident way to play" that corresponds to a particular Nash equilibrium. He emphasizes that which equilibrium corresponds to the self-evident way to play cannot, in many cases, be identified solely from the formal description of the game: in realistic social contexts, conventional modes of behavior may suggest a "focal-point equilibrium," thus reducing or eliminating the need for pre-play negotiations or providing a way of predicting their outcome. In the case of marriage, social conventions regarding the responsibilities of husbands and wives may indeed suggest to the spouses a particular equilibrium.

Repeated noncooperative games typically have multiple equilibria, and if distribution within marriage is modeled as a repeated game, equilibria will include both Pareto optimal and nonoptimal outcomes. The folk theorem of noncooperative game theory asserts that any vector of feasible, individually rational payoffs is a subgame-perfect Nash equilibrium of a repeated game provided the players do not discount the future "too much." Thus, Pareto optimal outcomes can emerge as solutions to repeated games even in the absence of institutions permitting the players to make binding agreements. The standard example is the infinitely repeated prisoner's dilemma: if the prisoner's dilemma is repeated as a stage game forever, then it is well known that the cooperative outcome ("don't confess") is an equilibrium despite the inability of the players to make binding agreements.

III. An Example: Marriage with Voluntary Contributions of Public Goods

We now sketch a simple repeated game in which both spouses can contribute to the supply of a single household public good. We assume that marriage lasts forever, and the objectives of the husband, h, and the wife, w, are to maximize the discounted values of infinite streams of utilities

$$\sum_{t}^{\infty} \rho_{\mathrm{h}}^{t} U^{\mathrm{h}}(x_{\mathrm{h}t}, q_t) \quad \text{and} \quad \sum_{t}^{\infty} \rho_{\mathrm{w}}^{t} U^{\mathrm{w}}(x_{\mathrm{w}t}, q_t)$$

where the ρ's are discount factors, the x's are private goods consumed by the husband and wife respectively, and q is a household public good jointly consumed by the husband and wife. Thus, interdependence in the marriage operates only through consumption of the public goods: there is no "altruism" in the sense of interdependent preferences. The quantity of the public good is equal to the sum of the individual contributions made by the husband and the wife. Husband and wife decide simultaneously on the levels q^{h} and q^{w} they will contribute, subject to the constraints that the expenditures of each spouse do not exceed the spouse's private resources.

In the repeated game, the voluntary contribution game is a "stage game" played in each period, forever, with no borrowing or saving permitted. In the one-shot game, the Cournot-Nash equilibrium is determined by the intersection of the public good "reaction functions" of the husband and wife. The husband chooses x_{h} and q^{h} to maximize $U^{\mathrm{h}}(x_{\mathrm{h}}, q)$ subject to $q = q^{\mathrm{h}} + \bar{q}^{\mathrm{w}}$ and $x_{\mathrm{h}} + pq^{\mathrm{h}} = I_{\mathrm{h}}$ where p is the price of the public good, I_{h} is the husband's (exogenous) income and $\bar{q}^{\mathrm{w}}$ is the public-good contribution of the wife. The solution to this maximization problem is the reaction function or "best-response function" of the

husband:

$$x_h = f^{x_h}(p, I_h, \bar{q}^w)$$

$$q^h = f^{q^h}(p, I_h, \bar{q}^w).$$

Similarly, the wife's reaction function for (x_w, q^w) will depend upon p, I_w, and $\bar{q}^h$.

It is straightforward to show from the first-order conditions that, in the one-shot voluntary-contribution game, distribution within marriage is invariant with respect to redistribution of resources between the spouses provided the equilibrium is one in which both spouses make strictly positive contributions. If the recipient of a child-allowance payment is changed from the husband to the wife, the husband's contribution to the public good will decrease, and the wife's contribution will increase by the amount of the allowance, provided both continue to make positive contributions. As the analogy with Ricardian equivalence suggests, in the absence of a corner solution, targeted transfers will be ineffective.

The equilibrium of the one-shot voluntary contribution game is not Pareto optimal: the public good will be underprovided. In the repeated game, however, other equilibria are possible, and the losses from noncooperation provide both spouses with incentives to depart from the Cournot-Nash solution. Crucial to achieving a Pareto optimal outcome in the repeated game is the ability of the players to punish one another for deviations from cooperation; a Pareto optimal equilibrium can be sustained by a credible punishment threat if, for each player, the one-period gain from deviating from a cooperative strategy is less than the loss associated with being punished.

In the repeated voluntary-contribution game, players can punish one another only by reducing their contributions to the public good, since we rule out divorce, physical and verbal abuse, and other interesting consequences of domestic disagreement. The "security level" for the husband and, hence, his reservation level of utility is the utility he would achieve if the wife refused to contribute to the public good; similarly, the reservation level of utility for the wife is the utility she would achieve if the husband refused to contribute to the public good. These "punishment points" imply that a redistribution of resources from husband to wife shifts the set of equilibria in favor of the wife in the sense that, if the equilibrium were chosen randomly from this set, then the expected utility of wives would be higher and the expected utility of husbands lower. The same conclusion holds if the equilibrium were chosen randomly from the subset of Pareto optimal equilibria, although this prejudges the issue of Pareto optimality. The multiple equilibria of repeated games prevent us from reaching stronger comparative-statics conclusions, but we think it is fair to say that the expected payoffs shift in favor of the spouse whose resources have increased and that the distribution of resources may matter.

To ensure that Pareto optimal outcomes are equilibria, we have assumed that the repeated game continues forever and that the players do not discount the future "too much" for the threatened punishment to be efficacious. Infinite continuation is not crucial; the assumption can be weakened to allow stochastic termination with the discount factor reinterpreted to include the probability of termination. Thus, if marriages ended only with the (exogenous) death of a spouse and if mortality probabilities were independent of age, then the folk theorem would apply directly. If mortality probabilities increase with age, then the game is nonstationary even without the possibility of divorce and, as the expected time remaining in the game decreases, Pareto optimal outcomes become increasingly difficult to sustain. Thus, distribution between aging spouses raises new issues.

IV. Another Example: Marriage as a Coordination Game with Multiple Equilibria

Consider an alternative model in which voluntary contributions are made by husband and wife to two household public goods. Suppose that coordination of individ-

ual contributions is desirable in the sense that the household is better off if the wife supplies one good and the husband supplies the other. This would be the case, for example, if household production of each good required the accumulation of specific human capital and there were increasing returns to specialization.[4] This game may possess two Nash equilibria analogous to those in the "battle of the sexes" game: one in which the wife supplies good 1 and the husband good 2, and another in which the provider roles are reversed. The husband and wife may each prefer one equilibrium over the other, but both will prefer a coordinated provision of public goods to the alternatives in which both supply the same good. The choice between these equilibria is likely to be sensitive to history and culture, which may generate a "self-evident" way to play. The separate-spheres bargaining model provides an obvious example: if some household public goods are regarded as within the wife's sphere and others as within the husband's sphere, then a reasonable focal-point equilibrium may consist of complete gender specialization in the provision of household public goods corresponding to this conventional gender assignment of responsibilities. In this noncooperative model it is once again true that distribution depends on individual resources, due to the corner solution in public-goods provision.

V. Conclusion

Noncooperative game theory provides many possible approaches to distribution within marriage, and in many cases multiple equilibria provide a route by which history and culture may influence distribution. In general, noncooperative games provide no unambiguous predictions regarding the significance of control over resources within marriage and the effectiveness of targeted transfers. In a one-shot voluntary-contribution game, corner solutions are crucial to effective targeting. In the repeated game, corner solutions are no longer crucial; the folk theorem implies that every vector of feasible, individually rational payoffs is a subgame-perfect equilibrium of the infinitely repeated game. In the repeated game, this set of equilibria shifts in favor of the spouse whose resources have increased. Thus, our analysis of the repeated game confirms and strengthens the central insight of the separate-spheres bargaining model: that distribution within marriage may depend on control over resources. Whether it does is an empirical question.

[4]Without increasing returns to specialization in good-specific human capita, both spouses could accumulate both types of human capital and alternate supplying each good.

REFERENCES

Becker, Gary S. *A treatise on the family*. Cambridge, MA: Harvard University Press, 1981; enlarged edition, 1991.

Bergstrom, Theodore. "A Survey of Theories of the Family." Mimeo, University of Michigan, 1993.

Hoddinott, John; Alderman, Harold and Haddad, Lawrence. "Household Models and Intrahousehold Resource Allocation," in Lawrence Haddad, John Hoddinott, and Harold Alderman, eds., *Intrahousehold resource allocation in developing countries: Methods, models, and policy*. Mimeo, IFPRI-World Bank, 1993.

Kanbur, Ravi and Haddad, Lawrence. "Are Better-Off Households More or Less Unequal? A Bargaining Theoretic Approach to 'Kuznets Effects' at the Micro Level." *Oxford Economic Papers,* 1994 (forthcoming).

Kreps, David M. *Game theory and economic modelling*. Oxford: Oxford University Press, 1990.

Lundberg, Shelly and Pollak, Robert A. "Separate Spheres Bargaining and the Marriage Market." *Journal of Political Economy,* December 1993, *100*(6), pp. 988–1010.

Manser, Marilyn and Brown, Murray. "Marriage and Household Decision-Making: A Bargaining Analysis." *International Economic Review,* February 1980, *21*(1), pp. 31–44.

McElroy, Marjorie B. "The Empirical Content of Nash-Bargained Household Behavior." *Journal of Human Resources,* Fall 1990, *25*(4), pp. 559–83.

McElroy, Marjorie B. and Horney, Mary J. "Nash-Bargained Household Decisions: Toward a Generalization of the Theory of Demand." *International Economic Review,* June 1981, *22*(2), pp. 333–49.

Tauchen, Helen V.; Witte, Ann Dryden and Long, Sharon K. "Violence in the Family: A Nonrandom Affair." *International Economic Review,* May 1991, *32*(2), pp. 491–511.