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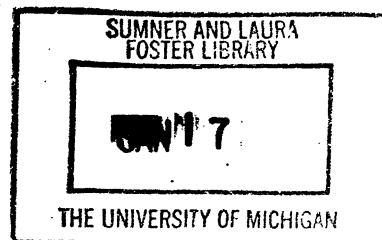
**Economics in a Family Way**

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## Introduction

Gary Becker's *Treatise on the Family* [1] is not only an impressive collection of results, but also a magnificent seed-catalog of ideas, many of which have since germinated and been raised to vigorous adulthood by Becker and his co-workers. These progeny are ably surveyed in the *Handbook on Population Theory* [56], soon to appear on your library shelves. The current paper is a much more modest advertisement for some facts and ideas that I think likely to bear fruit in the form of a richer theory of the economics of the family.

This discussion refers frequently to work in other disciplines, particularly anthropology and biology. It is easy to convince economists that economic analysis can usefully be applied to all other subjects. But economists seem less ready to believe that reading anthropology, biology, history, psychology, or sociology is important for doing good economic analysis. Because of the intimate connection between the family and reproduction, it should not be surprising that there is much to be learned about the economics of the family from the study of evolutionary biology. Given the increased prevalence in recent decades of unwed parenthood, divorce with sequential monogamy, and "non-traditional" family arrangements, it seems plausible that anthropological studies of alternative family structures would help us to understand our own.

The first section presents an evolutionary theory of interpersonal sympathy among family members. We discuss the genetic theory of *kin selection* and its implications for human preferences and relate these ideas to theories of the *cultural evolution* of preferences. The next section takes an evolutionary viewpoint in exploring the riddles posed by the *demographic transition* and the question of intergenerational flows of wealth. The third section discusses non-monogamous family structures in our own culture and in other cultures. The final section draws on a more traditional source of inspiration for economists. This section outlines an approach to bargaining theory within the family based on recent discoveries in non-cooperative game theory and discusses ways of integrating the theory of spousal bargaining with the theory of marriage markets.

## 1 Preferences in Family Matters

### 1.1 Adam Smith and Sympathetic Preferences

Let us begin with Adam. Smith opens his treatise, *The Theory of Moral Sentiments* [60] as follows:

"How selfish, soever, man may be supposed, there are evidently some principles in nature, which interest him in the fortune of others, and render their happiness necessary to him, though he derives nothing from it except the pleasure of seeing it."

In a later chapter, entitled: *Of the Order in which Individuals are recommended by Nature to our care and attention*, Smith elaborates as follows on the "principles in nature which interest men in the fortunes of others":

"Every man feels his own pleasures and his own pains more sensibly than those of other people. The former are the original sensations; the latter the reflected or sympathetic images of these sensations.

After himself, the members of his own family, those who usually live in the same house with him, his parents, his brothers and sisters are naturally the objects of his warmest affections. . . his sympathy with them is more precise and determinate, than it can be with the greater part of other people. It approaches, nearer, in short, to what he feels for himself.

This sympathy too, and the affections that are founded on it, are by nature more strongly directed towards his children than towards his parents, and his tenderness for the former seems generally a more active principle, than his reverence and gratitude toward the latter. . . .

The children of brothers and sisters are naturally connected by the friendship which, after separating into different families, continues to take place between their parents. . . .

The children of cousins, being still less connected, are of still less importance to one another; and the affection gradually diminishes as the relation grows more and more remote." (Chapter VI)

*The Theory of Moral Sentiments* was published in 1759, exactly 100 years before Charles Darwin's *Origin of the Species*. [20] Not surprisingly, Smith neither sought nor found an evolutionary explanation for a positive association between intensity of sympathy and degree of relatedness. His conclusion appears to be based entirely on empirical observation.<sup>1</sup> Yet Smith's phrase "the Order in which Individuals are recommended by Nature to our care and attention," seems felicitously to foreshadow the possibility of an evolutionary explanation for Smith's observations on the varying degree of sympathy between relatives.

### 1.2 Kin Selection in Evolutionary Biology

#### Hamilton's Rule

Modern evolutionary biologists have developed a beautiful and powerful theory of the evolutionary foundations of sympathy between relatives. The founder of

<sup>1</sup>Smith suggests that this sympathy is caused by close physical association, remarking that physical separation reduces, but does not eliminate these affections. But Smith also observes that "A jealous husband . . . often regards with hatred and aversion that unhappy child which he supposes to be the offspring of his wife's infidelity."

the modern theory of *kin selection*, William Hamilton [34] describes this theory as follows:

“The social behavior of a species evolves in such a way that in each distinct behavior-evoking situation the individual will seem to value his neighbors’ fitness against his own, according to the coefficients of relationship appropriate to the situation.”

Biologists define the “coefficient of relationship” between two individuals to be the probability that a randomly selected gene from one of these individuals and the corresponding gene from the other are both copied from a common ancestor. These coefficients of relationships can be readily calculated under various assumptions about mating patterns. In a sexually reproducing species with diploid genetic structure like our own, if mating couples are not closely related, the coefficients of relationship between kin are approximately as follows:

**Coefficients of Relationship Between Kin**

Parent-child	1/2
Full siblings	1/2
Half siblings	1/4
Grandparent-grandchild	1/4
Aunt or Uncle-nephew or niece	1/4
First cousins (under monogamy)	1/8

It has become common practice for biologists and evolutionary ecologists to predict animal behavior with a form of benefit-cost analysis, known as “Hamilton’s rule.” Hamilton’s rule states that an animal, when offered an opportunity to confer a benefit of  $B$  units of “fitness” on another animal at a cost to itself of  $C$  units of “fitness” to itself, will choose to do so if and only if

$$Br > C, \quad (1)$$

where  $r$  is the coefficient of relationship between them. Hamilton’s theory of kin selection is central to the modern study of animal behavior, playing an essential role in the understanding of cooperative behavior among animals, parent-offspring conflict, parental investment, and sexual strategies of males and females. The rich interplay of theory and empirical observation in the evolutionary theory of animal behavior is demonstrated in Robert Trivers’ *Social Evolution* [62].<sup>2</sup>

<sup>2</sup>For economists wanting an introduction to this subject, Trivers’ book seems an ideal starting point. It assumes no prior knowledge of biology but presents the relevant biological information in a way that is readily grasped by economists, and moves smoothly and quickly to matters of profound interest both to biologists and economists.

### Genetically-programmed Utility Functions

Hamilton’s Rule is usually interpreted as a prediction about genetically hard-wired traits or behavioral rules that are invoked by specific stimuli. Biologists have found many examples in which individuals routinely take actions that reduce their own survival probability but increase the survival probability of their relatives. Small birds and mammals emit shrieks and warnings at the approach of a predator. In some bird species, individuals help to feed the offspring of their parents or siblings. Caterpillars who leave a bad taste in the mouth of a predator do not improve their own survival probability by this form of revenge, but do reduce the likelihood that the predator will eat a relative.

In species that face highly variable environments, much behavior seems more complex than a direct stimulus-response connection. Individuals are able to process and use information and to choose actions in a consistent way. It is natural for economists to think of such individuals as endowed with a preference ordering or a utility function. Natural selection could act on these preferences, in the same way that it acts on hard-wired behavioral responses.

Much as economists postulate that individuals maximize “utility,” biologists postulate that individuals maximize “fitness”. Typically an individual’s fitness is defined to be the expected number of surviving offspring that the individual produces.<sup>3</sup> Hamilton proposed the following definition of *extended fitness*. Let  $F_j$  be the fitness of individual  $j$  and let  $r_{ij}$  is the coefficient of relationship between individuals  $i$  and  $j$ . The extended fitness  $H_i$  of individual  $i$  is a weighted sum of  $i$ ’s own fitness and that of its relatives, namely:

$$H_i = F_i + \sum_j r_{ij} F_j. \quad (2)$$

It is appealing to conjecture that evolutionary biologists may have discovered an evolutionary foundation for Adam Smith’s “*Order in which Individuals are recommended by Nature to our care and attention.*” Not only have they found an *ordinal* ranking of relatives that corresponds with Smith’s notion, but they appear to have found a *cardinal* quantitative measure of the degree of sympathy that nature recommends that we extend toward each of our relatives. The language of modern game theory allows us to pose this conjecture more sharply. Consider a set of relatives who interact with each other. Each relative  $j$ , selects a strategy  $s_j$  from a set  $S_j$  of possible strategies. Let  $s$  be the vector listing the strategies chosen by each player and let the “fitness” of any individual  $j$  be a function  $F_j(s)$ . For each  $i$ , define the extended fitness payoff function  $U_i(s)$  so

<sup>3</sup>This definition can be problematic. For example, it may be that by having fewer but wealthier children, one can have more surviving grandchildren. (See Rogers [55] for an interesting discussion of this issue.) The problem of defining fitness becomes even more complex if children are treated asymmetrically as in the case of primogeniture. Bergstrom [4] suggests a method for calculating reproductive values in a stratified society with primogeniture.

that :

$$H_i(s) = F_i(s) + \sum_j r_{ij} F_j(s). \quad (3)$$

The conjecture is that evolutionary forces tend to produce a population of individuals who act as if they are choosing Nash best responses in a game where their payoff functions are the extended fitness payoff functions given by Equation 3.

Hamilton's theoretical argument supports this conjecture only for the special case where benefits conferred and costs incurred interact additively. Economic models with diminishing returns and other more complicated interactions between individual contributions do not display this additivity. When interactions are not additive, it is not in general the case that individuals will be extended fitness maximizers in equilibrium. However, the first-order conditions derived from Hamilton's rule correctly characterize equilibrium behavior. The logic of kin selection and the intuition that underlies these conclusions will be clarified by a look at the special case of kin selection among siblings.<sup>4</sup>

### Kin Selection for Siblings

Suppose that individuals do not *choose* their strategies, but are *programmed* by their genes. Assume that this strategy taken is determined by the two genes that lie in a single genetic locus and that genes are passed from generation to generation according to the Mendelian laws of inheritance. A *monomorphic equilibrium* is a situation in which every individual in the population has a pair of identical genes in this locus, and these genes program the individual to use strategy  $x$ . We seek conditions under which this population will resist invasion by a mutant gene such that carriers of the mutant gene use a different strategy  $y$ . A mutant gene will be able to establish a presence in the population if, when it is rare, carriers of the mutant gene are more likely to survive than normal  $x$ -strategists. Conversely, there will be a monomorphic equilibrium of  $x$ -strategists if carriers of any rare mutant gene that leads to a different strategy are less likely to survive than the normal  $x$ -strategists.<sup>5</sup>

Mendelian inheritance is a blunt instrument which does not act on individuals independently of its effects on their kin. Someone who inherits a mutant gene is more likely than a normal individual to have siblings who also carry the mutant gene. An individual who is led by a mutant gene to sacrifice some of her own survival probability for the benefit of her siblings is also more likely than a normal individual to benefit from the generous actions of a sibling. If the mutant gene is a rare dominant gene, then almost all carriers of the gene

<sup>4</sup>This example was introduced by Bergstrom and Stark [6] and is explored in detail by Bergstrom [5].

<sup>5</sup>The discussion here concerns invasion by a dominant mutant gene. A more detailed discussion of the genetics involved, along with a treatment of the case of invasion by recessive mutant genes is discussed in [5].

will be children of one normal parent and one parent who carries a single copy of the mutant gene. By the laws of heredity, the mutant gene will then with probability 1/2 be found in each sibling of an individual who carries the mutant gene. Suppose that individuals with the normal genes are programmed to take strategy  $x$  and carriers of the mutant gene are programmed to take action:  $y$ . Then mutants who take a mutant action  $y$  toward a sibling will find that with probability 1/2, the sibling also takes the action  $y$  and with probability 1/2 the sibling takes the normal action  $x$ . Therefore the expected payoff to a carrier of the mutant gene is

$$V((y, x) = \frac{1}{2}F(y, y) + \frac{1}{2}F(y, x). \quad (4)$$

The function  $V$  is called a *semi-Kantian utility function*, since it can be expressed by a maxim that could be characterized as halfway between selfishness and the Kantian ethic:

"Act toward your sibling as you would if you believed that with probability one-half, your sibling would copy your action."

If natural selection is for utility functions rather than for hard-wired actions, then we would expect evolution to produce utility functions towards siblings that take the semi-Kantian form found in Equation 4.

In the case of a symmetric game between siblings, Hamilton's extended fitness function (given in Equation 3) takes the simple form:

$$H(y, x) = F(y, x) + \frac{1}{2}F(x, y) \quad (6)$$

which can be expressed as the rule:

"Value your sibling's survival half as much as your own."

Bergstrom [5] shows examples of simple games (including prisoners' dilemma) where the equilibrium actions predicted by the extended fitness utility function are not the same as those for the semi-Kantian utility function. However, if the fitness function  $F$  is differentiable, then the first-order calculus conditions for equilibrium in a population of extended fitness maximizers are the same as the first-order calculus conditions in a population of semi-Kantian utility maximizers.

### 1.3 Imitation and Cultural Evolution

The great variety of behavior and values across cultures and subcultures that we observe seems to be evidence that human preferences are partially formed by cultural rather than genetic influences. There is abundant direct evidence that people adopt opinions, attitudes, tastes, and goals by imitation of parents, playmates, teachers, and neighbors. In *The Selfish Gene*, Richard Dawkins [22]

introduces the term *meme* to describe a culturally transmitted norm that is passed along much in the way genes are inherited. The logic of cultural inheritance and imitation bears an intriguing similarity to that of genetic inheritance. Luigi Cavalli-Sforza and Marcus Feldman [17] define cultural transmission to be “vertical” if cultural traits are passed from parents to children, “horizontal” if these traits are passed between persons of the same age, and “oblique” if they are passed from members of an older generation to members of a younger generation who are not their own children. The work of Cavalli-Sforza and Feldman, and subsequent work by Robert Boyd and Peter Richerson [15] demonstrate convincingly that the abstract structure of cultural transmission lends itself to formal modelling almost as well as the Mendelian genetic model. Bergstrom and Stark [6] explore some applications of cultural evolution in the behavior of siblings and neighbors. While the structure of vertical cultural transmission is very close to that of genetic evolution, horizontal and oblique transmission introduce a number of new possibilities for the pathways of inheritance. It is also important to notice that cultural evolution, especially with horizontal transmission, can occur much more rapidly than genetic evolution occur, with the rise and fall of cultural institutions being observable well within the range of written history.

#### 1.4 On the usefulness of evolutionary hypotheses

Human evolution proceeds slowly. Most evolutionary biologists believe that our bodies and minds are, for the most part adaptations to hunter-gatherer life in the Stone Age. The “adaptationist” view that current preferences are the optimal preferences for reproductive success under current conditions seems indefensible. This problem is eloquently addressed by Randolph Nesse and George Williams in *Why We Get Sick* [50].<sup>6</sup> Nesse and Wilson ask:

‘Why, in a body of such exquisite design, are there a thousand flaws and frailties that make us vulnerable to disease? ...

Even our behavior and emotions seem to have been shaped by a prankster. Why do we crave the very foods that are bad for us? ... Why do we keep eating when we know we are too fat? ... Why are male and female sexual responses so uncoordinated, instead of being shaped for maximum mutual satisfaction? ... Finally, why do we find happiness so elusive? The design of our bodies is simultaneously extraordinarily precise and unbelievably slipshod. It is as if the best engineers in the universe took every seventh day off and turned the world over to bumbling amateurs.” (p. 5)

Nesse and Williams propose two kinds of answers: (i) Our bodies are the result of evolution, not design. Although evolution produces outcomes of mag-

<sup>6</sup>This book makes a very interesting case for the application of evolutionary principles to medicine.

nificent complexity and efficacy, evolved creatures remain, in many ways, prisoners of the historical path of evolution and differ drastically from the result of an optimal top-down design. (ii) Some of our physical and psychological traits that were well-adapted for the Stone Age environments are poorly adapted for the modern environment. While selection may be acting against these traits, the process is extremely slow relative to the rate of change in our environment.

Since our knowledge of Stone Age living conditions is and will remain extremely sketchy, many scholars have concluded that the evolutionary hypothesis has little empirical content and is simply an invitation to unfalsifiable speculation. A more optimistic view is that we can learn much about Stone Age conditions by observing existing tribes of hunter-gatherers. Anthropologists (see for example, Hill and Kaplan) have conducted detailed studies of economic life in present-day hunter-gatherer societies that have had minimal contact with the modern world. While these studies are of great interest, the authors are quick to acknowledge that they find great differences among existing hunter-gatherer societies. Moreover, there is no compelling evidence that the conditions that hunter-gatherers face today are sufficiently similar to those faced by the ancestral societies from which we have evolved as to allow us to make useful inferences about evolution.

Matters are made even more difficult by the fact that our preferences seem to be formed partly by cultural forces and partly by genetic coding. Thus a fully satisfactory evolutionary theory of preference formation might have to untangle the genetically inherited from the culturally inherited aspects of our preferences.

The objection that human behavior evolved in a remote, unobservable past would be quite devastating to a theory that we have evolved a series of reflexes that lead us to make specific responses in specific situations. Certainly there are examples of human responses that can be so described. Nesse and Williams cite human responses that seem to be genetically encoded, including specific food-aversions (especially among young children) that may have protected our ancestors from eating poisonous plants, reflex responses to burns, pain in injured limbs, aversion to human feces and vomit, fear aroused by certain cues, and sexual arousal. In these cases, the stimuli being responded to appear to be nearly universal in human experience and to be such that the optimal response would not have changed much through the millennia.<sup>7</sup>

For dealing with more complex situations, nature has supplied us with problem-solving abilities and a complex of rather general tastes and desires that are likely to be correlated with reproductive success in a great variety of situations. Given the great variety of environments in which our species has thrived, it is reasonable to expect that the genetic coding of preferences allows great flexibility and that hard-wired preferences are for the most part preferences that have served our ancestors’ reproductive interests well in a great

<sup>7</sup>Of course there may be selection bias here. Nesse and Williams may have noticed and written about these responses precisely because they are as comprehensible in terms of today’s environments as they must have been in the Stone Age.

variety of circumstances. These include preferences regarding such staples of the human condition as nutrition, temperature-regulation, leisure, and friendly social relations with peers and allies. Central to the experience of those whose genes have been preserved are reproduction, child-rearing and growth to maturity. Accordingly, preferences related to the desire for reproduction and to sympathetic concern for one's children and other relatives are prime candidates for genetic encoding.

Even if it is difficult to determine whether preferences are culturally or genetically determined, the hypotheses of genetic transmission and vertical cultural inheritance have similar implications for equilibrium outcomes. Oblique and horizontal cultural transmission allow outcomes that would not be sustained by genetic transmission or vertical transmission. But, as is demonstrated by Cavelli-Sforza and Feldman (and also by Bergstrom and Stark) these hypotheses impose a structure that may help us to analyze and understand the outcomes that we observe.

## 2 The Demographic Transition

### 2.1 Cultural Evolution and the Demographic Transition

The *demographic transition*, which began in Western Europe and has now spread to much of Asia, is an especially interesting instance of cultural evolution. A fall in infant mortality in the late 18th and early 19th century was followed, with a time lag, by a sharp decrease in completed family sizes in most countries of Europe. That birth rates eventually fell in response to a fall in the death rate is not surprising. Declining infant mortality means that the number of children who survive to adulthood would be much larger if birth rates stayed constant. Nor is it surprising that the response would have been lagged, as people only gradually came to understand that traditional practices lead to larger numbers of surviving children than before. Traditionalists who maintained high birth rates would have had untraditionally large families. Particularly in a peasant economy with scarce land, this may have meant that many of their surviving children would have been too poor to marry and produce children of their own. Persons with "mutant" aspirations, who planned to have fewer births and to leave more resources to each of them, might have actually produced more grandchildren and descendants than those with high birth rates. Thus if aspirations for number of births were "vertically transmitted" from parents to children, it is possible that low birth rate aspirations were passed on to more reproductive children than the high birth rate aspirations.

But the demographic transition seems to have gone beyond the reduction in fertility that would maximize surviving descendants. The number of children born to most women has fallen well below the number that would maximize the number of their grandchildren. Indeed, despite increasing per capita wealth

during the 19th and 20th centuries, average numbers of *surviving* children per family decreased rather than increased. As Cavelli-Sforza and Feldman point out, the cultural norm of having small families could not prevail if reproductive decisions were vertically transmitted from parents to children. With vertical transmission, mothers who bear fewer children would have fewer reproductive daughters to imitate their reproductive choices. The number of women who carry the low birth rate cultural trait would therefore dwindle relative to the population of mothers who choose to have many children.

Cavelli-Sforza and Feldman conclude that the norm of having small families must have been supported by *horizontal* or *oblique* transmission—people imitating their peers or parents' peers, rather than their parents. If the "small-family strategy" succeeded because of horizontal or oblique transmission, then it must have been that the small-family strategy practiced by other families was somehow more attractive to the next generation than the large-family strategy practiced by its parents. This force had to be strong enough to overcome the tendency of vertical transmission to eliminate the small family strategy.

It is useful to know that horizontal or oblique transmission is needed in order to sustain the cultural trait of wanting small families, while vertical transmission would this extinguish trait. But the question remains unanswered: "Why would we expect that aspirations to have small families would be more likely to be horizontally transmitted than aspirations to have large families." One reasonable response is that children of large families will observe that people with small families live more comfortable lives and will want to emulate them, while children from small families will not find the life styles of large families similarly tempting.

It may be illuminating to pose the question in the following way. Why would not the small-family norm eventually be overwhelmed by followers of a fundamentalist religion with a pro-natalist doctrine like the following: *It is your duty to produce three or four surviving children and it is your duty to pass this doctrine on to all of your children.* Given current income levels in Western countries, the costs of adhering to this doctrine do not seem heavy, compared to the costs of practicing obligations that historically successful religions have imposed. If this religion were successfully established and maintained, its followers would eventually swamp a population in which the average number of children per family is approximately two. There are two possible restraining forces that might prevent adherents of such a religion from outrunning the adherents of a small family norm. (i) Even though its adherents cling devoutly to the doctrine, it might be that after a few generations, their wealth would be dissipated and that most adherents simply could not afford to raise three or four children who survive to adulthood. (ii) It might eventually not be possible for believing parents would to convince more than two of their children to adopt a pronatalist doctrine.

There remains another possibility. Perhaps the low birth rates currently observed in the West do not represent long run equilibrium. If a pro-natalist



norm starts with a small number of adherents, even if they are able to pass it on to most of their children, it would take many generations for its descendants to outnumber the original population. In most countries of Western Europe and North America, low average birth rates have been present for only three or four generations—far too short a time for vertical transmission to replace the low-fertility norm.

## 2.2 The Direction of Intergenerational Wealth Flows

John Caldwell [16], a demographer, advanced the theory that there are two types of societies, *pre-transitional* societies which are characterized by high stable birth rates and by net wealth flows running from younger to older generations and *post-transitional* societies which have low fertility and net wealth flows running from older generations to younger generations. In pre-transitional societies, having children is profitable so people would choose to reproduce up to the biological limit. In post-transitional societies, where children are costly, people limit their fertility much as they limit their consumption of other costly consumer goods.

As Paul Turke [64] observes, the view that in traditional societies, resource flows were, on average, directed from younger to older generations is difficult to reconcile either with an evolutionary or a Malthusian model of populations. Hillard Kaplan [37] explains the evolutionary viewpoint as follows:

“In contrast to wealth-flows theory, models of fertility and parental investment derived from evolutionary biology expect that the net flow of resources will *always* be from parents to offspring, even when fertility is high. The logic underlying this expectation is that natural selection will have produced a preponderance of organisms that are designed to extract resources from the environment and convert those resources into descendants carrying replicas of their genetic material. . . . Organisms that extracted a net gain from offspring would produce fewer genetic descendants than those that utilized their own labor and excess energy to produce more viable offspring. This does not mean that . . . natural selection could not favor a positive flow from *some* offspring to parents or from offspring to parents at *some* ages but that the *overall* intergenerational flow of resources will be downward.”

According to Turke [64], most of the data that has been advanced in favor of Caldwell's wealth-flows hypothesis takes the form of interviews without direct quantitative measurement.

“In many such interviews parents do in fact aver that children are economic assets. Often, however, they assert as well that a reason for limiting births is that children are too costly. A commonly

given noneconomic reason is that God (in various forms) wants people to have many children. Of course, no reputable social scientist would accept interview data as a basis for concluding that God is pronatalist, and I suggest we should be just as skeptical of the claim that interview data support the proposition that children are in fact net economic assets in traditional societies.”

Turke [63] offers evidence from field studies in the Micronesian islands of Ifaluk and Yap (where people practice simple agriculture and fishing) that children tend to be a net economic burden on their parents. Thomas Fricke [25] indicates that Turke's evidence is indirect and far from decisive. In a recent paper, based on remarkably detailed fieldwork<sup>8</sup> conducted among three different tribes of hunter-gatherers, the Ache of Paraguay, the Piro of Peru, and the Masiguenga of Peru, Kaplan [37] found convincing evidence that among hunter-gatherers, resources flow from older to younger generations and not the other way around. These tribes all had very high average fertility (about 8 births per woman), but in each case, children consumed more food than they caught from birth until age 18. Grandparents continued to work hard to support their grandchildren and produced more than they ate. At almost no time in their adult lives, did adults produce less than they consumed. When people became too old and frail to work, death followed quickly. Suicide and euthanasia of the enfeebled were frequently reported.

Although the evidence indicates that hunter-gatherers do not behave in a way consistent with Caldwell's hypothesis, there remains the possibility that investment in children is financially profitable in peasant agricultural societies. As Yean-Ju Lee, William Parish and Robert Willis [42] point out, the presence of positive net flows from prime-age adults to their elderly parents would not in itself be sufficient to vindicate Caldwell's hypothesis. For children to be a profitable economic investment, it would have to be that the *amount* returned to elderly parents would be enough to repay the investment made in their children when they are small and if the parents have access to borrowing and lending markets or can buy and sell land, a present value calculation should be made, discounting future returns. The evidence available suggests that this is not the case. Eva Mueller [48] surveyed several studies of consumption and output of peasants and their children over the life cycle and concluded that

“Children have negative economic value in peasant agriculture.

Up to the time that they become parents themselves, children consume more than they produce.”

Thus any economic gain from having children would have to come in the form of a long term investment in the child's obligation to support the parent in her

<sup>8</sup>Fieldworkers walked with the male hunters on their hunting expeditions and followed the female gatherers. They weighed all of the food acquired by each individual and converted their measurements to calories. They also observed the distribution of food among the population. Thus they were able to measure output and consumption of each man, woman and child.

old age. Calculations by Mueller [48] and by Goran Ohlin [51] indicate that a parent who gave birth at age 20 and supported a child from age 1 to age 15 would receive a monetary rate of return of less than 1% on her investment if she retired at age 60 and was supported by the child until age 85 at the level of living that is normal for old people in peasant societies. When the probability that either parent or child may die before the parent reaches 85 years of age is accounted for, the rate of return becomes negative. In a peasant society, where landownership is possible and where there are markets for borrowing and lending, such low rates of return are not likely to be acceptable on purely financial grounds.

Ronald Lee and Timothy Miller [41] construct detailed estimates of intergenerational wealth flows in the United States in the 1980's, using data from the 1987 Consumer Expenditure Survey and other sources. The Consumer Expenditure Survey reports interhousehold gifts and transfers. According to Lee and Miller

"The gross flows are overwhelmingly downward, from older ages to younger ones. Young households just starting out make no transfers at all, and receive a considerable amount—nearly a thousand dollars a year. . . . As couples age, and their children become better established, fewer transfers are made. Somewhat surprisingly, however, there is no increase in transfers received; on the contrary, transfer receipts diminish steadily at older ages."

Lee and Miller calculate that the average *net* payments in gifts and bequests from the parental generation to their children amount to about \$25,000 per child.<sup>9</sup> In addition, they estimate average child-rearing costs at \$81,000 per child.

Overall, the evidence seems strongly consistent with the evolutionary view as expressed by Kaplan. Over the course of a lifetime, resources tend mainly to flow from the old to the young and not the other way around.

### 2.3 Economic Support of the Aged

In the hunter-gatherer societies studied by Kaplan, the downward flow of resources takes an extreme form. Not only do children cost more than they return, but there is *never* a substantial period of their lives when old people consume more than they produce.

In Western industrial countries, most people have a long interval at the end of their lives when they consume more than they produce. As Lee and Miller [41] point out, the elderly are typically not supported by gifts from their children,

<sup>9</sup>To calculate net payments, they subtracted payments from children to parents from gifts in the other direction. Since payments from children to parents are usually made years later than payments from parents to children, these figures are likely to understate the flow from parent to child measured in present value terms.

but rather by social security payments and by their own savings and private pension plans.

In many traditional societies [18] [16] there appear to be strong cultural norms that urge children to support their parents in their old age. Robert Lucas and Oded Stark [44] emphasize the importance in traditional African societies of remittances sent to their home families by grown children who have left home to work in urban areas. The existence of substantial remittances does not necessarily represent a flow of resources from the younger to the older generation. It may be that the remittances represent a "helpers-at-the-nest" effect, where the resources collected from older siblings are used to support younger siblings and other young kinfolk. Using data from a survey of Taiwanese households, Lee, Parish and Willis [42] found evidence of a widespread pattern of support payments to elders from their adult sons and daughters.

"... financial support, including both cash and in-kind gifts, continued in an upward direction, from adult children to parents. Whether son or daughter, most married children gave financial gifts to parents while few received gifts in return."

The experience of the generations studied by these authors is unusual in the sense that the current generation of adult children in Taiwan is far wealthier on average than their parents. Per capita income in Taiwan increased more than fivefold between 1961 and 1986.

It has been suggested [18] [6] that adults may support their parents in order to imprint a corresponding behavior pattern on their own children. Thus the more an adult contributes to his aged parents, the more he can expect his children to contribute to him in his old age. The biblical statement of the Fourth Commandment (Exodus 20:12) suggests that the ancient Hebrews may have viewed filial obligation in such a recursive way:

"Honor thy father and thy mother that *thy* days may be long upon the land..."

The clause "that thy days may be long upon the land" seems to indicate that the reason to treat your parents well is that the treatment you accord to them will ultimately be accorded to you.

It would be problematic to assume that the current generation consciously chooses the way it treats *its* parents while its offspring make no such choice but simply copy *their* parents. Bergstrom and Stark resolve this difficulty by suggesting that in equilibrium a child *might* copy its parents' actions, but with some probability the child makes an independent choice based on its own self-interest.<sup>10</sup> In this environment, imitators take the same actions as some ancestral chooser, so that everyone's behavior will be the same as the optimizing

<sup>10</sup>Rogers [54] offers an interesting model to explain why it might be that equilibrium is polymorphic, with some copiers and some independent choosers.

choice for a chooser who is aware that her actions may be copied by her children. An adult who invests in the well-being of her parents is making a risky investment which will not be returned if her offspring turn out to be choosers. A chooser decides whether to support her elderly parents or to ignore the parent and invest her money in property which she can exchange for income when she herself is old. Whether it is financially advantageous to care for the parents depends on the riskiness of imprinting a sense of obligation on one's children relative to the riskiness of buying financial assets.

While we can construct consistent models in which parental imprinting and social pressure cause adults to support their elderly parents, the cultural forces in favor of such support must somehow overcome significant pressure from natural selection. If behavior were genetically hard-wired, a gene that led people to spend resources on an elderly relative when these resources could have been used to produce an extra surviving child would eventually be eliminated by genes for maximizing the number of surviving descendants. The same problem arises if either genetic or cultural evolution selects preferences. Aged people who are inclined to the view "I don't want to be a burden on my children and grandchildren" and act on this view will eventually have more descendants than those who try to command resources at the expense of the reproductive success of their offspring. Therefore if preferences tend to be vertically transmitted, we should expect selection for individuals who want to pass resources to their descendants during almost all of their entire lives. Substantial flows of resource from young to old might be observed if there are strong horizontal transmission of cultural views or it might be observed as a "disequilibrium outcome" in societies where recent changes in medical technology have increased the survival of enfeebled elders.

### 3 Non-monogamous Household Structures

For the most part, economic analyses of the household have dealt either with single-person households or with monogamous couples and their children. An important exception is Gary Becker's *Treatise on the Family*, which devotes a chapter to polygamy in marriage markets. It might be thought that Becker's discussion of polygamy is simply a virtuoso exercise in the economics of exotica. More careful consideration suggests that the study of non-monogamous mating relationships may be truly fundamental. It is, in itself, of great interest to investigate the workings of marital institutions in other societies. Moreover, on closer inspection, our own society is far from universally monogamous and, as statistics indicate, is rapidly becoming much less monogamous.

Unwed parenthood is no longer rare. In the United States in 1960, only 5% of all births occurred out of wedlock.<sup>11</sup> In 1990, more than 25% of births were

<sup>11</sup>The statistics cited here come from a review of demographic trends in marriage, divorce

to unwed parents.<sup>12</sup> The proportion of all children who live in single-parent, mother-only households has risen from 8% in 1960 to 23% in 1990. For Black Americans, the statistics are even more dramatic. In 1990, two-thirds of births were out of wedlock and more than half of all children live in single-parent households. Not only has unwed parenthood become common, but divorce rates more than doubled between 1960 and 1990. About 20% of all marriages are dissolved within the first five years of marriage. Some estimates have it that nearly two-thirds of all first marriages will be dissolved within 40 years. In 1979, roughly one-third of all marriages involved at least one previously married person.

According to Da Vonza and Rahman, men who divorce are three times more likely to remarry than women. Divorced women who have children are 25% less likely to remarry than those without children. The asymmetry between the remarriage prospects of men and women means that it is more likely for men to have more than one wife over the course of their lives than for women to have more than one husband. Moreover, it is more common for divorced men to remarry and have children by his new wife than for women to have children in remarriages. This asymmetry has led some anthropologists [43] [28] to describe current marriage patterns in the United States as "serial polygyny."

#### 3.1 Divorce and Out-of-Wedlock Parenthood

In recent years, there have been several interesting contributions to the economics of divorce and child support.<sup>13</sup> Yoram Weiss and Robert Willis [66] [67] model child-support private provision of public goods as a problem in the private provision of public goods. Both parents care about the well-being of the child. In a household where the mother and father live together it is possible for each to monitor the contributions of the other and the outcome of this "repeated game" is expected to be an amount of child care that is close to Pareto optimal. But if the parents do not live together, they lose the ability to observe each others' contributions. In this case they will reach a non-cooperative equilibrium in which the amount of resources contributed to childcare is typically suboptimal.

If the economics of child support by divorced couples is in its youth, the economics of out-of-wedlock births is in its infancy. The most prominent progenitor in this area seems to be Robert Willis. [68] Willis addresses the question of how unwed parenthood might come to prevail in a population, even though marriage would allow significant gains from coordination of parenting effort. His proposed explanation depends on their being an excess of marriageable women

and fertility statistics by Da Vonza and Rahman. [21]

<sup>12</sup>About 30% of unwed parents in 1990 were cohabiting couples many of whom maintain stable monogamous marriages.

<sup>13</sup>Pioneering work was done by Becker, Landes, and Michael [2]. A good recent survey of work on the economics of divorce is Weiss [65]

over marriageable men. The African-American population in the United States displays exactly such a disparity. Willis builds a model based on observations of the sociologist, William Julius Wilson, [69] who identifies the pool of "marriageable black males" as those who are currently employed. Wilson found that in 1980, the ratio of marriageable black males aged 20-44 to black females aged 20-44 was about .56 in the Northeast and North Central states of the U.S. (In 1960, this ratio was about .67.) The corresponding ratio of marriageable white males to white females was about .85.

The Willis model has an equilibrium in which men choose between monogamous marriage and remaining single while fathering children by several women. Monogamous men are confined to a single mate, but are able to reach more efficient agreements with their wives about child care. Unmarried fathers are able to father children by more than one woman, but the children of these relationships are less likely to be well cared for. In this model, the fraction of the male population who marry is determined by the condition that in equilibrium married and unmarried males are equally well off. Willis defines a threshold number of partners  $P$  such that the strategy of unmarried fatherhood is as attractive as monogamy if and only if an unmarried male can expect to have  $P$  female sexual partners.

With this model, Willis finds a simple solution for the equilibrium fraction of males who marry monogamously. The algebra is as follows: Let  $W$  be the number of marriageable females, let  $\alpha W$  be the number of marriageable males (where it is assumed that  $\alpha < 1$ ), and let  $M$  be the number of monogamous marriages. Then the number of unmarried women is  $W - M$  and the number of unmarried men is  $\alpha W - M$ . Assuming that all of the unmarried women and men form partnerships, the average number of partners per unmarried man will be at the equilibrium level  $P$  only if  $W - M = P(\alpha W - M)$ . Rearranging terms in this equation, we find that the fraction of all women who marry is

$$\frac{M}{W} = \frac{\alpha P - 1}{P - 1}$$

and the fraction of all men who marry is

$$\frac{M}{\alpha W} = \frac{\alpha P - 1}{\alpha(P - 1)}$$

Each of these expressions is seen to be an increasing function of  $\alpha$  and also an increasing function of  $P$ . Therefore, in the Willis model, the fraction of members of either sex who maintain monogamous marriages will be smaller: (i) the lower is the ratio of the number of marriageable men to the number of marriageable women (ii) the smaller the threshold number of relationships  $P$  needed to induce a man to stay unmarried.

### 3.2 Polygamous Marriages

The term *polygamy* encompasses all marital arrangements where the conjugal group includes at least three persons, with at least one person of each sex. Although polygamous marriage is rare in the United States and Western Europe, it is a very common mode of family organization around the world.<sup>14</sup> *Polygyny*, where some men have more than one wife, is prevalent in 850 of the 1170 societies recorded in Murdock's *Ethnographic Atlas*. Officially recognized *polyandry*, where some women have more than one husband is currently prevalent in only a few societies [35], though it appears to have been considerably more common in earlier times. [53] The practice of *polygynandry* or *conjunct marriage*, where the conjugal group includes two or more persons of *each* sex is also found in some societies. [53] [23]

#### Polygyny and Bridewealth

In polygynous societies that have well-defined property rights in land and cattle, it is usual for brides to command a positive price. Anthropologists refer to this price as *bridewealth*. According to anthropologists Steven Gaulin and James Boster [27] "Bridewealth is common and dowry is rare." They report that of the 1267 societies recorded in Murdock's *Ethnographic Atlas*, 2/3 have positive bride prices, while only about 3% have dowries. Bridewealth is paid by the groom and his relatives to the bride's male relatives. *Dowry*, in contrast, is a payment from the bride's family to the groom and/or his relatives on the occasion of a marriage.<sup>15</sup>

Because of the nature of sexual reproduction it is possible for a male who commands a large amount of material resources to greatly increase his fertility by having multiple wives. On the other hand, holding constant the material resources available, a female gains little fertility from an additional husband and loses only a small amount of fertility by sharing a husband with co-wives. Bergstrom [3] builds a formal model of polygynous marriage in which parents seek to maximize the number of their surviving grandchildren. In this model, the only scarce resources in the production of children turn out to be women of reproductive age and material resources. Where polygyny is allowed, there would be excess demand for women without a positive bride price. In market equilibrium with a positive bride price, men must choose between allocating additional resources to the care and feeding of their current wife or wives and the purchase and support of an additional wife. In this model, wealthy men

<sup>14</sup>Anthropologists like to point out that societies that are strictly monogamous with respect to marriage are often highly polygynous with respect to mating. See Robin Fox [24], Laura Betzig [7], and Bergstrom [4] for discussions of societies with monogamous marriage and polygynous mating.

<sup>15</sup>Jack Goody [31] points out that dowry is not the same as a "negative bride price" since dowry goes to the newly formed couple while bridewealth goes to the bride's male relatives.

will have more wives than poor men, but the amount of resources supplied to a woman and her children is independent of her husband's wealth.<sup>16</sup>

Therefore there is no incentive for a woman or her relatives to seek to mate her with a wealthy man and wealthy men have to pay the same price for a bride as poorer men. In this model, polygyny tends to equalize the physical well-being and reproductive success of women, while amplifying the effects of wealth on the reproductive success of men.

The broad outlines of this model appear to fit many polygynous African societies. (See for example [32], [29], [39], and [33].) Monique Borgerhoff Mulder, [14],[11],[12], and [13] has conducted a remarkably detailed anthropological field study of the Kipsigis, a polygynous East-African tribe who engage in agriculture and herding.<sup>17</sup> Borgerhoff Mulder [14] reports that in a simple regression analysis, an extra wife adds about 6.5 children to a man's fertility, while sharing her husband with an additional co-wife reduces a woman's fertility by about .5 children. Using cross-sectional data from her study of the Kipsigis, Borgerhoff Mulder, [11] explored the determinants of bridewealth. She found that the average cost of a bride was about 1/3 of the wealth of an average household. The price paid for a bride depended positively on variables related to her health and fertility<sup>18</sup> but did not depend on differences in the wealth of the bride's and groom's family. In a subsequent study [13] Borgerhoff Mulder showed that in any year, the males most likely to attract additional wives were those who could provide the most resources (measured in acres of land) per wife. The number of wives that men had was roughly proportional to the number of acres of land that they owned with larger landowners having slightly fewer wives per acre than smaller landholders. [12]

Becker suggested that women would be better off in a society that allows polygyny than in a society with compulsory monogamy. He reasoned that relaxing the constraint that a man can have only one wife would shift the demand schedule for wives upward, leading to higher bride prices with polygyny than with monogamy. The claim that polygyny leads to high bride prices is theoretically compelling and is consistent with most anthropological field studies. But it does not follow that high bride prices imply welfare gains for females. The theory suggests, and field studies confirm that when "property rights" to an unmarried female lie with her family, her family will use the proceeds from

<sup>16</sup>The conclusions of this model turn out to be very similar to conclusions reached by biologists studying polygyny among birds and mammals. G. Orians [52] calls this the *polygyny threshold* model. Interestingly, in the polygyny threshold model, females are allocated to males in proportion to the resources that the males control, not by a price mechanism but by *female choice*. In these species, females account for the amount of resources controlled by a male and the number of other females with whom they would have to share these resources in choosing the mate who can supply them with the most resources.

<sup>17</sup>These works contains a great deal of information on the economics and demography of the Kipsigis and are likely to be of interest to many economists.

<sup>18</sup>Perhaps married readers will not be surprised to learn that the price paid for a bride was also higher, the greater the distance between parents' residence and her husband's residence.

selling their daughter to purchase wives for her male siblings rather than to raise her standard of living.

### Monogamy, Dowries, and Primogeniture

Gaulin and Boster [27] find that 3/4 of the societies recorded in Murdoch's *Atlas* as having dowries are monogamous with a high degree of economic stratification.<sup>19</sup> In a monogamous society, the wife and children of a wealthy man are more likely to be well cared for than the wife and children of a poor man. Therefore parents who want to increase the number of their descendants would prefer that their daughters married rich men. In this environment, the scarce resource "a rich husband" will attract a positive price.

Laura Betzig [8] argues that most of the historical examples of stratified societies with monogamous marriage, were also characterized by highly polygynous mating. For the nobility, marriage was an economic relationship in which the monogamously married wife was entitled to bear the only child or children to inherit a major portion of the nobleman's estate. Most of these societies practiced *primogeniture*, with the great bulk of the estate going to the oldest son born to the nobleman and his wife. There was a sexual double standard in which the wives of noblemen were expected to remain faithful to their husbands, but the husbands openly maintained sexual liaisons with numerous mistresses, concubines, and household servants. The historian, Lawrence Stone [61] offers vivid descriptions of the sexual behavior of the late medieval and early modern English nobility. Parents were willing to pay a large dowry for their daughters to become the wives of noblemen. Although their daughter's own fertility is only slightly improved by marriage to a nobleman, her descendants are likely to be numerous because, given the great wealth of the nobility and the double standard of sexual fidelity, her firstborn son is likely to father many children.

For the British aristocracy in the late medieval and early modern periods, very good demographic and economic data and detailed descriptions of inheritance practices can be found. Bergstrom [4] builds a formal model of a stratified society with monogamy and primogeniture similar to that described by Betzig. He uses historical data on the British aristocracy to estimate the parameters of his model and to test the hypothesis that the nobility were acting so as to maximize their reproductive success.

### Polyandry

Although far less common than polygyny or monogamy, several societies with polyandrous marriage structures have been studied by ethnologists. In these societies, *fraternal polyandry* was the usual pattern. A woman would be married

<sup>19</sup>Gaulin and Boster also find that according to Murdoch's classification, societies with dowries tend to be those in which the economic value of work available to women is relatively low.

to two or more brothers, who in principle are allocated equal sexual access to their joint wife. Two important sources of information on polyandry are studies by Prince Peter of Greece and Denmark, [53] who interviewed polyandrous families in Ceylon, Kerala, Madras and Tibet and by Melvyn Goldstein, [30] who interviewed a large number of refugees from central Tibet, who had made their way to northern India. William Durham [23] presents a thorough discussion of the anthropological literature on Tibetan polyandry and elaborates on theories of polyandry that were proposed by Prince Peter and by Goldstein.

According to Durham, one finds the "greatest diversity of socially sanctioned marriage customs known to anthropology" among the Tibetan-speaking peoples. Observed marital forms include monogamy, polygyny, polyandry, and polygynandry. The landless serfs, the *du-jong*, almost always married monogamously. It is among the landed serfs, the *thongpa*, that great diversity of marital customs is found. The *thongpa* lived in family units that controlled 20 to 300 acres of land to which they had permanent hereditary rights. Goldstein proposed that the entire spectrum of marital forms observed among the *thongpa* can be explained as an application of two fundamental social principles, 1) *Partible patrilineal inheritance*. In families that had male offspring, inheritance was in principle divided equally among them. In families that had no sons, inheritance was passed to a daughter. 2) *The monomartial principle*. In each generation of a *thongpa* family, the conjugal group must contain one and only one fertile woman.

In accordance with these principles, male *thongpa* who had no brothers almost always married monogamously. In families with two sons, the brothers almost always shared a single wife. Groups of three brothers sharing a wife were common, and larger groups of brothers sharing a wife were also found. But Goldstein reported that Tibetans believe that as the number of brothers sharing a wife increases, fraternal harmony becomes more difficult to maintain. Accordingly, when there are several brothers, some may become celibate monks or may be sent out as an adoptive bridegroom to a family with no male children.

If the first wife of a marriage turns out to be infertile, then a second wife, often a sister of the first wife, will be brought to the marriage. This accounts for the occasional instances of polygyny and of polygynandry observed among the *thongpa*. In families where there are daughters but no sons, the estate will pass to one of the daughters, who marries monogamously.

In these societies, the monomartial principle of one fertile woman per generation, per estate regulates fertility and hence controls the family's land-labor ratio. Brothers who would be unable to sustain independent families if they divided the land and each had a wife and children, are able to support one wife and her offspring by working together on the land.<sup>20</sup>

<sup>20</sup>Since with polyandry, more men marry than women, in the absence of infanticide there will typically be left over women who do not find mates. Female infanticide does not appear to be common among the polyandrous people of Kerala or Tibet. Unmarried women frequently work on the farm along with their brothers.

According to Durham, there is evidence that the institution of fraternal polyandry has persisted among the Tibetans for at least 1300 years. Durham argues that this persistence requires explanation and he seeks an explanation in the theory of cultural evolution. Durham maintains that the "marital ideology had, by virtue of its consequences under local conditions, net reproductive benefit for *thongpa* parents, and ... that the marriage beliefs themselves had been preserved within the cultural system primarily as a result of a *thongpa* preference for them because of their consequences."

Adherence to the monomartial principle is not enforced by law, but according to the *thongpa* is a conscious choice, based on the belief that partitioning the family estates would lead to devastating hardship for future generations. Durham suggests that the monomartial principle appears to be supported both by cultural evolution both through vertical transmission. He presents evidence that families that partition their lands between more than one conjugal group will produce more children in the first generation, but that in two or three generations, the number of surviving descendants will be smaller than the number of descendants of families who adhered to the monomartial principle. Thus if children adopt the marital principles of their parents, we would expect the monomartial principle to prevail. There is also evidence that horizontal transmission also supports the monomartial principle. Within the society, there has been recurrent experimentation with partitioning of family estates. In interviews, Tibetans describe recent instances of "deviant" behavior as having resulted in devastation for one or more heirs. They also cite the extreme poverty of the neighboring Nepalese communities who do not practice polyandry as evidence of the evils of partitioning.

### Matriarchal Societies

The Nayar of India are a matriarchal society, who had particularly interesting marriage customs.<sup>21</sup> At any one time, women would maintain formally-recognized sexual relationships with between three and twelve "husbands". When a woman became pregnant, one of the husbands who might possibly be the father had to acknowledge paternity. The putative father, however, had no obligation to the child.

Men were expected to give money to their maternal household for the support of their sisters. A husband normally visited a wife after eating supper at his mother's house, and left the wife's residence before breakfast. For a man to withhold money from his maternal family and give the money to a wife or to support his biological child was a gross violation of the social norm. Children belonged to the mother's household and were supported and cared for by child's

<sup>21</sup>Descriptions of Nayar marriage customs, are found in works of Prince Peter [53] and Kathleen Gough [59], and William Irons [36]. The ancient marriage customs have largely eroded in modern times, but much information is available from written accounts by various writers from the fifteenth to the eighteenth centuries.

mother, maternal grandmother, and maternal uncles. Children were aware of their declared fathers and had occasional dealings with them, but they had much more frequent encounters with their mothers' brothers. A woman's brothers were charged with disciplining her children and with attending to the education of her sons.

In considering the stability of Nayar institutions under cultural evolution, one must ask whether a "deviant" social norm that asks men to give money to their wives and wives' children rather than to their sisters and sisters' children would be able to invade a population of Nayars who followed the usual norm. If this behavior were genetically determined, the answer would depend on whether, on average, men are more closely related to their sisters' children or to their wives' children. If in every generation, there is a constant probability  $p$  that a man is the father of his wife's child, there is a *paternity threshold* probability  $p_t$  such that a man will be more closely related to his sister's children than to his wife's children if and only if  $p < p_t$ . Kurland [40] shows how to calculate the paternity threshold. The degree of relatedness of a man to his wife's children is  $p/2$ . A man and his sister share the same mother, but the probability that they share the same father is only  $p^2$ . Therefore the expected degree of relatedness between a man and his sister is  $(1+p^2)/4$  and the expected degree of relatedness between a man and his sister's child is  $(1+p^2)/8$ .<sup>22</sup> Therefore the paternity threshold is a solution to the quadratic equation  $p/2 = (1+p^2)/8$ . This equation has only one positive root, which is  $p_t = .268$ . Thus the genes of men who give resources to their sisters rather than to their wives will eventually dominate the population if and only if the probability that a man is the father of his wife's children exceeds .268.

If marital behavior is culturally determined, the calculations are different, but a similar principle applies. If boys learn their behavior from the males with whom they associate most closely, then in Nayar society, we notice that boys are more strongly influenced by the behavior of their maternal uncles than by the behavior of their mothers' husbands. If a deviant man contributed money to a wife rather than to his sisters, then that man's wife would on average have more children and his sisters would have fewer children than would be the case in a normal family. Even if his wife's children are more closely related to him genetically than his sisters' children, his cultural influence is likely to be stronger on the nephews and nieces whom he shortchanged than on the progeny that he enriched. His relatively numerous genetic children are likely to adopt the cultural practices of his traditionalist brothers in law, while the people most likely to copy his behavior will be the less numerous children of his sisters.

<sup>22</sup>Here we are assuming that a man's wife's other lovers are not close relatives of the man. In the case, for example, of fraternal polyandry, the relationship between a man and his wife's children is closer, because if the child is not his, it is his brother's.

## 4 Choosing Your Bed and Lying In It

Proposing marriage, an eager suitor may promise a lifetime of devoted service to the whims of his beloved. But a sensible young woman, even if she has studied game theory, is likely to be skeptical. She is more likely to base her expectations about marriage on what she knows of the way her mother and other married female acquaintances have fared, than on her suitor's flattering, but unenforceable promises.

It is not possible to write a prenuptial marriage contract that legally binds the new couple to a detailed program of behavior through the course of their marriage. Most of the important decisions to be made by the couple must be resolved as they arise, after marriage. In a satisfactory theory of courtship and mating, potential partners must anticipate that their well-being after marriage, will depend on the outcome of postnuptial bargaining. Conversely, since one's bargaining power within a marriage may depend on the threat of exercising the "outside option" of divorcing and reentering the marriage market, a satisfactory theory of bargaining within marriage should include a theory of courtship and mating.

### 4.1 Cooperative Nash Bargaining Solutions

The pioneering work on the theory of household bargaining was done by Marilyn Manser and Murray Brown [46] and Marjorie McElroy and Mary Horney [47], who studied household decision making under the Nash cooperative bargaining model. In these papers, a marriage is modeled as a static bilateral monopoly. A married couple can either remain married or they can divorce and live singly. There is a convex utility possibility set  $S$  containing all utility distributions  $(U_1, U_2)$  that could possibly be achieved if they remain married. The utility of person  $i$  if he or she divorces and lives singly is given by  $V_i$ . It is assumed that there are potential gains to marriage, which means that there are utility distributions  $(U_1, U_2)$  in  $S$  that strictly dominate the utility distribution  $(V_1, V_2)$ . These papers propose that the outcome in a marriage will be the symmetric Nash bargaining solution where the "threat point" is dissolution of the marriage with both persons choosing to live singly. According to the Nash bargaining theory, the outcome in this household will be the utility distribution  $(U_1^*, U_2^*)$  that maximizes  $(U_1 - V_1)(U_2 - V_2)$  on the utility possibility set  $S$ .<sup>23</sup> In this theory the outcome in a marriage is completely determined by the utility possibility set and by the position of the threat point,  $(V_1, V_2)$ . This theory has the interesting prediction that social changes that affect the utility of being single will affect the distribution of utility within the household and hence may change household spending patterns, even if they have no effect on the budget.

<sup>23</sup>This expression is sometimes known as the Nash product. John Nash [49] proposed a set of axioms for resolution of static two-person bargaining games such that the only outcomes that satisfy the axioms maximize the Nash product on the utility possibility set.

of the household, while changes in the apparent distribution of earned income within the household will have no effect on the distribution of utility in the household if they do not change the threat point from being single.

Shelly Lundberg and Robert Pollak [45] propose an alternative Nash bargaining model. They suggest that for many marriages the relevant threat point for the Nash bargaining solution should be not divorce, but an “uncooperative marriage” in which spouses would revert a “division of labor based on socially recognized and sanctioned gender roles.” Lundberg and Pollak suggest that with their model, if government child-allowances are paid to mothers rather than to fathers in two-parent households, this threat point will shift in the mothers’ favor. Accordingly, the outcomes of cooperative bargaining within households are likely to be more favorable to women. By contrast, in the divorce-threat model, a change in who receives the welfare payments when the couple is together will have no effect on the distribution of utilities if there is no change in who gets these payments in the event of a divorce.

#### 4.2 Noncooperative Bargaining Theory and Outside Options

Should the threat point be divorce as suggested by Mansur, Brown, McElroy and Horney? Should it be an uncooperative marriage as suggested by Lundberg and Pollak? Will the threat point depend on whether either party can end the marriage or whether mutual consent or a court decree is required to end the marriage? Nash’s axioms for the cooperative bargaining solution give us no direct guidance about the appropriate threat points for bargaining in a marriage. Recent work on the noncooperative foundations of bargaining theory not only offers a more convincing foundation for the Nash bargaining solution, but also yields useful insight into the appropriate choice of threat points.

Ariel Rubinstein [58] developed an extensive-form, multi-period bargaining game for two agents in which a cake is to be partitioned only after the players reach agreement. Players alternate in proposing how to divide the cake with one time period elapsing between each offer. Each agent  $i$  is impatient, discounting future utility by a factor  $\delta_i < 1$ , so that the utility to player  $i$  of receiving  $w$  units of cake in period  $t$  is  $w\delta_i^t$ . Rubinstein proved that in the limit as the time between proposals becomes small, the only subgame perfect equilibrium is for the cake to be divided in the first period with player  $i$ ’s share of the cake being  $\alpha_i = \delta_i/(\delta_1 + \delta_2)$ . More generally, if agent  $i$ ’s utility from receiving  $w_i$  units of cake in period  $t$  is  $u_i(w_i)\delta_i^t$  where  $u_i$  is a concave function, then the only perfect equilibrium is the allocation that maximizes the “generalized Nash product”,  $u_1^{\alpha_1} u_2^{\alpha_2}$  on the utility possibility set  $\{(u_1(w), u_2(1-w)) | 0 \leq w \leq 1\}$ . In case the two agents have equal discount rates, this outcome is the same as the symmetric Nash equilibrium where the threat point is  $(0, 0)$ .

Ken Binmore [10] extended the Rubinstein model to the case where each of

the bargaining agents has access to an “outside option”. Binmore’s model is like the Rubinstein model, except that each agent  $i$  has the option of breaking off negotiations at any time and receiving a payoff of  $m_i$  units of cake, in which case the other player receives no cake. Given that the outcome in the game without outside options is the same as the Nash cooperative equilibrium with threat point  $(0, 0)$ , one might conjecture that the effect of the outside options would be to move the threat point to  $(m_1, m_2)$ . (If negative values of  $m_i$  are considered, this conjecture might be amended to  $(\max\{0, m_1\}, \max\{0, m_2\})$ ). Binmore shows that this is not the answer. The only subgame perfect equilibrium for the game with outside options is an agreement in the first period on the utility distribution  $(u_1, u_2)$  that maximizes the Nash product  $u_1^{\alpha_1} u_2^{\alpha_2}$  on the utility possibility set  $\{u_1(w), u_2(1-w) | 0 \leq w \leq 1\}$  subject to the constraint that  $u_i \geq m_i$  for each  $i$ . In general, this solution is not the same as maximizing  $(u_1 - m_1)^{\alpha_1} (u_2 - m_2)^{\alpha_2}$  on the utility possibility set, which would be the outcome of shifting the threat point to  $(m_1, m_2)$ .<sup>24</sup>

#### 4.3 Noncooperative Bargaining Theory and Marriage

To many persons with marital experience, it seems unlikely that couples resolve disagreements about ordinary household matters by negotiating under the pressure of divorce threats. If one spouse proposes a resolution to a household dispute and the other does not agree, the expected outcome is not a divorce. A more likely outcome is harsh words and burnt toast until the next offer is made. If the couple were to persist forever in inflicting small punishments upon each other, it might well be that the outcome would be worse for one or both of them than a divorce. But divorce imposes large irrevocable costs on both parties, while a bargaining impasse need last only as long as the time between a rejected offer and acceptance of a counteroffer.

The Rubinstein-Binmore model, as applied to marriage lends formal support to these speculations. This model concludes that so long as the gains from marriage are divided in such a way that both parties are better off being married than being divorced, a divorce threat is not credible. Instead, the relevant threat is delayed agreement and burnt toast, followed by a counterproposal. Here we will explain the workings of the Rubinstein-Binmore model as applied to a highly simplified model of a household.

Consider a married couple who expect to live forever in a stationary environment. Assume that each spouse discounts future utility by the same per-period discount factor  $\delta$  and that in every time period, the utility possibility frontier is the simplex  $\{(u_h, u_w) | u_h + u_w = 1\}$ , where  $u_h$  and  $u_w$  are the utilities of husband and wife respectively. Each spouse has an intertemporal utility function of the

<sup>24</sup>Binmore, Shaked, and Sutton [9] tested this theory with a laboratory experiment in which subjects played a Rubinstein bargaining game with outside options. Behavior in this game was better predicted by Binmore’s model than by the competing model in which the outside option is the threat point.



form  $\sum_{t=0}^{\infty} u_t \delta^t$ . In any period where they remain married, but do not reach agreement, the husband will get a utility of  $b_h$  and the wife will get a utility of  $b_w$ , where  $b_h + b_w < 1$ . If either person asks for a divorce, they will divorce and the husband will get a utility of  $m_h$  forever and the wife will get a utility of  $m_w$  forever, where  $m_h + m_w < 1$ .<sup>25</sup>

The spouses alternate in offering feasible utility distributions. For concreteness, let us suppose that the wife gets to make the first offer and that she proposes a utility distribution  $(u_h, u_w) > (m_h, m_w)$ . The husband could either accept the offer, refuse the offer and make a counteroffer, or refuse the offer and ask for a divorce. If the husband accepts the offer, then the distribution of utility in the household will  $(u_h, u_w)$  and will remain the same in every subsequent period unless in some future period the husband changes his mind and decides to reject his wife's outstanding offer of  $(u_h, u_w)$ . Since this is a stationary model, if the husband accepts the offer in the first period, he will continue to accept it in all subsequent periods. If the husband refuses the offer and asks for a divorce, he will get a utility flow of  $m_h < u_h$  in all future periods. Therefore, if the only way to refuse an offer were to ask for a divorce, the wife could extract all of the gains from marriage by offering the husband a utility that is just equal to his utility from being divorced.<sup>26</sup> But the husband has the additional alternative of refusing the wife's offer and making a counteroffer in the next period. In equilibrium, it must be the case that the husband can not do better by refusing the offer and waiting for his own turn to make a counteroffer. Since the wife will want to make the smallest offer that the husband will accept, it must be that in equilibrium, the wife offers terms that leave the husband indifferent between accepting immediately and making a counteroffer. If the divorce threat is not credible for either spouse, this process has a unique equilibrium in which the wife gets  $b_w$  plus the fraction  $\frac{1}{1+\delta}$  of the total gain  $1 - b_h - b_w$  from agreement and the husband gets  $b_h$  plus the fraction  $\frac{\delta}{1+\delta}$  of the gains  $1 - b_h - b_w$ .<sup>27</sup> Thus if the wife gets to make the first offer, the equilibrium is

$$(\bar{u}_h, \bar{u}_w) = \left( b_h + \delta \frac{(1 - b_h - b_w)}{1 + \delta}, b_w + \frac{(1 - b_h - b_w)}{1 + \delta} \right).$$

If  $\bar{u}_h > m_h$  and  $\bar{u}_w > m_w$ , then the divorce threat is not credible for either spouse and the solution will be  $(\bar{u}_h, \bar{u}_w)$ . If  $\bar{u}_i < m_i$ , then the divorce threat will be relevant for person  $i$ , and as Binmore observes, the only equilibrium

<sup>25</sup> A more realistic model would allow the possibility that divorced persons can remarry with some probability at some interval of time after divorcing. While it would be worthwhile to develop the model in this direction, it appears that the qualitative conclusions would be little different from the model sketched here.

<sup>26</sup> We follow the convention in the principal-agent literature, by assuming that if the agent is offered a deal in which he is just indifferent between two options, he will take the one that the principal wants him to take. This saves mathematical clutter that would arise if we had the principal offer the agent a tiny bit more for taking the desired option.

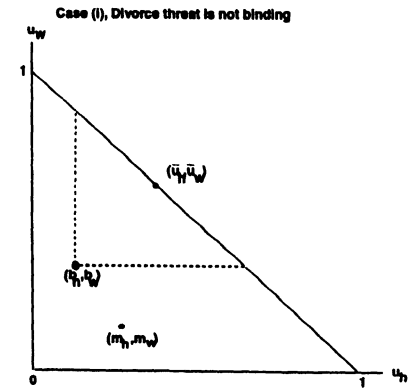
<sup>27</sup> In the Appendix, we present a simple algebraic proof of this proposition. (This proof is not new. A similar argument can be found in [10].)

outcome is one in which person  $i$  gets utility  $m_i$  and his partner gets utility  $1 - m_i$ .

If the time between offer and counteroffer is small, then the discount rate for waiting one period is close to 0, so that  $\delta$  is close to 1. In the limit as  $\delta$  approaches 1, if divorce threat is not relevant, then the gains from cooperative rather than noncooperative marriage will be divided nearly equally. Thus in the limit as the time between offer and counteroffer becomes small, the equilibrium approaches one of the following three cases.

- Case i. Divorce threats are not credible. If  $b_h + (1 - b_h - b_w)/2 > m_h$  and  $b_w + (1 - b_h - b_w)/2 > m_w$ , then the outcome is  $(\bar{u}_h, \bar{u}_w) = b_h + (1 - b_h - b_w)/2, b_w + (1 - b_h - b_w)/2$ . The geometry of Case i is illustrated in Figure 1. The point  $(\bar{u}_h, \bar{u}_w)$  is the point on the simplex that splits the gains above  $(b_h, b_w)$  equally. In the example shown here, noncooperative marriage for a single period is worse for the husband (and better for the wife) than being divorced for a single period, but the bargained equilibrium  $(\bar{u}_h, \bar{u}_w)$  is better for both spouses than divorce. It is not difficult to see that it would be possible to construct examples that fall into Case i where a single period of noncooperative marriage is worse for both spouses (or better for both spouses) than a single period of divorce, but where the equilibrium from the noncooperative threat point is better for both spouses than divorce.

Figure 1—Household Bargaining Equilibrium

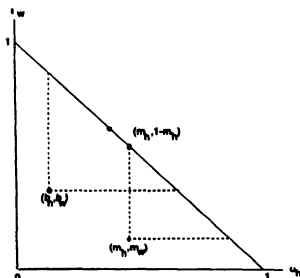


- Case ii. Divorce threat is credible for the husband, but not for the wife. This happens if  $b_h + (1 - b_h - b_w)/2 < m_h$ . In this case the solution is  $u_h =$

$m_h$  and  $u_w = 1 - m_h > m_w$ . This case is illustrated in Figure 2. In Case ii, not only is noncooperative marriage worse for the husband than divorce, but the equilibrium found taking noncooperative equilibrium as a threat point is worse for the husband than divorce. In this case, equilibrium is the outcome where the husband is indifferent between divorce and marriage and the wife has utility  $1 - m_h$ .

Figure 2--Household Bargaining Equilibrium

Case (ii). Divorce threat binds on  $u_h$



- Case iii. Divorce threat is credible for the wife, but not for the husband. This happens if  $b_w + (1 - b_h - b_w)/2 < m_w$ . In this case the solution is  $u_w = m_w$  and  $u_h = 1 - m_w > m_h$ .

The first case corresponds to the Lundberg and Pollak's cooperative solution where the threat point is not divorce, but a noncooperative marriage. In the other two cases, the divorce threat is relevant, but notice that the outcome is never the outcome predicted by the Mansur-Brown and McElroy-Horney models. In an equilibrium where both persons are better than they would be if divorced, equilibrium is calculated as if the threat point were eternal burnt toast rather than divorce. Small changes in the utility of being divorced would have no effect on the outcome of household bargaining. In the only cases where the divorce threat is relevant, the gains from marriage are not split equally as in

the divorce-threat bargaining models. In this case, one partner enjoys all of the surplus and the other is indifferent between being divorced and being single.

To some observers, this model's stately minuet of offer and counteroffer may seem not to reflect the realities of domestic conflict. But Rubinstein's canonical bargaining model can be much relaxed in the direction of realism without altering the main results. Binmore shows that qualitatively similar results obtain when the length of time between offers and the person whose turn it is to make the next offer are randomly determined after every refusal. It is also a straightforward matter to add a constant probability of death for each partner without seriously changing the model. On the other hand, stationarity of the model seems to be necessary for Rubinstein's beautifully simple result. This stationarity is lacking in a model where children grow up and leave the family and where the probability of death increases with age. It would be useful to know more about the robustness of the Rubinstein results to more realistic models of the family. For the time being, Rubinstein's model and its extensions seem to be "the only game in town" as far as giving us a theoretical basis for distinguishing among plausible alternative bargaining theories of the household.

#### 4.4 Marriage Markets for Bargaining Spouses

A satisfactory theory of bargaining between spouses should be embedded in a theory of marriage markets. In this discussion, in order to illustrate issues that arise when marriage markets are combined with bargaining between spouses, we use a much simpler model than is normally dealt with in the marriage market literature. In particular, we make the barbaric assumption that every pair of possible spouses faces the same utility possibility frontier if they marry as every other pair.<sup>28</sup> The only difference between individuals is the utility that they could achieve by remaining single.

Assume that the utility possibility frontier for every married couple is the unit simplex and that there is a continuum of persons of each sex. Let  $F_h(u)$  be the number of males in the population for whom the utility of being single is less than  $u$  and let  $F_w(u)$  be the number of females in the population for whom the utility of being single is less than  $u$ . Assume that these distribution functions are strictly increasing and continuous, and that  $F_h(0) = 0$ ,  $F_h(1) > 0$ ,  $F_w(0) = 0$  and  $F_w(1) > 0$ .

Let us first think about the marriage market that would arise if it were possible before marriage to determine the distribution of utility within marriages by a binding contract. Then there would be a unique equilibrium utility distribution  $(u_h^*, 1 - u_h^*)$  such that the number of males who are willing to marry

<sup>28</sup>The theory of mating and matching, which is thoroughly surveyed by Al Roth and Marilda Satomayor, [57] incorporates models in which different individuals could have arbitrarily different rankings over members of the opposite sex as possible partners. While the theory sketched here should be enriched to incorporate this feature, it seems apparent that the qualitative results found here would extend to such models.

and get utility  $u_h^*$  equals the number of females who are willing to marry and get  $u_w^* = 1 - u_h^*$ . When the utility distribution between husbands and wives is  $(u_h, u_w)$ , the supply of men wanting to marry is  $F(u_h)$  and the supply of women wanting to marry is  $F(u_w)$ . The unique equilibrium utility distribution  $(u_h^*, u_w^*)$  is found by solving the equation  $F_h(u_h^*) - F_w(1 - u_h^*) = 0$ .<sup>29</sup>

Suppose, on the other hand, that neither party to a marriage can credibly promise a utility distribution within marriage. Instead the utility distribution within marriages is determined by the model of non-cooperative bargaining that we have just discussed. Suppose that the utility distribution for any couple during a period where they have not reached agreement is  $(b_h, b_w)$  and that the time between offer and counteroffer is very short. Then, as predicted in our model of non-cooperative bargaining, the distribution of utility in all marriages will be (approximately)

$$(\bar{u}_h, \bar{u}_w) = \left( b_h + \frac{(1 - b_h - b_w)}{2}, b_w + \frac{(1 - b_h - b_w)}{2} \right).$$

Given this utility distribution within marriages, the number of males who wish to marry will be  $F_h(\bar{u}_h)$  and the number of females who wish to marry will be  $F_w(\bar{u}_w)$ . It is interesting to notice that there is no reason to expect that  $F_h(\bar{u}_h) = F_w(\bar{u}_w)$ . Therefore, there will in general be either more men seeking wives than women seeking husbands or vice versa. The inability to make prior commitments to utility distributions within marriage has the same kind of effect as price inflexibility in a commodity market. If, for example, the equilibrium bargained utility distribution within marriages is such as to leave an excess demand for wives, then all women who wish to marry under the current terms of marriage will be able to do so, but some men who want to marry will not find wives. Such a man would be willing to offer more favorable terms for a wife than the current equilibrium utility. If he could make such promises credible, then he would be able to induce some woman who currently prefer remaining single to marry him, but she realizes that once married, they will be playing a bargaining game in which the inevitable result is the equilibrium utility enjoyed by all other married women.

The two best-known theories of marriage assignments are the theory of stable marriage algorithms, developed by David Gale and Lloyd Shapley [26] and the linear programming assignment model which was introduced to economics by Martin Beckmann and Tjalling Koopmans [38] and applied to marriage markets by Gary Becker [1]. Both of these models are more general than the example considered here in that they allow for differences in preference rankings over possible marriage partners. In the Gale-Shapley theory no "side-payments" are allowed

<sup>29</sup>Existence follows from the assumption of continuity and the assumption that  $F_h(1) - F_w(0) > 0$  and  $F_h(0) - F_w(1) < 0$ . The assumption that  $F_h$  and  $F_w$  are strictly increasing functions implies that  $F_h(u) - F_w(1 - u)$  is a strictly decreasing function of  $u$ . Therefore equilibrium must be unique.

and there are no possibilities for negotiation about the terms of marriage.<sup>30</sup> The assignment problem assumes transferable utility, allowing binding premarital agreements on any possible distribution of utility for any possible married couple. The model of bargaining with non-cooperative marriage as the threat point could be applied to the more general environment assumed in these models. In such a model, for any possible marriage there is a unique distribution of utility that will be determined by the utility possibility frontier, the time-discount rates of each party and the distribution of utility that will prevail if they remain married but do not reach agreement. Therefore, the appropriate model would be like the original Gale-Shapley in that each person assigns a fixed utility to each possible marriage partner and that utility can not be altered by proposing different terms of marriage.

## Conclusion

An attraction of doing work in the economics of the family is that it has barely begun to exploit fascinating work in modern evolutionary biology and anthropology. A second attraction is that the economics of the family is well-poised to exploit some of the most interesting recent results in game theory. This review suggests that reexamining standard problems of economic demography such as fertility, care for the elderly, and patterns of marriage from an evolutionary viewpoint will lead to deeper insights and better-posed questions. As we observe that the family life of a significant and growing fraction of our own population is no longer characterized by stable, monogamous families, it becomes more important to try to understand the logic of other familial arrangements. There is much to be learned by attention to the great body of ethnographic work, in which anthropologists have studied alternative, stable, functioning marital systems. Modern game theory, particularly advances in bargaining theory and in matching theory has much to contribute to the understanding of the formation, functioning, and dissolution of marriages. The theoretical discussion in the last section of this review concerns courtship and marriage in a monogamous society, with divorce functioning largely as an unexercised threat. It would be interesting to apply some of these tools to less monogamous societies, including a more realistic model of our own society. Such models might encompass out-of-wedlock parenthood, unmarried cohabiting couples, "sequential polygamy" with marriages that are expected to be temporary, and interlocking reconstituted families that include children from previous marriages.

<sup>30</sup>Crawford and Knoer [19] show how the Gale-Shapley algorithm can be extended to allow side payments.

**Appendix-The algebra of noncooperative equilibrium**

Let  $u_1^h$  be the equilibrium utility for the husband if he gets to make the first offer and let  $u_2^h$  be his equilibrium utility if the wife gets to make the first offer. Let  $u_1^w$  be the equilibrium utility for the wife if she gets to make the first offer and let  $u_2^w$  be her equilibrium utility if the husband gets to make the first offer. Let  $b_h$  and  $b_w$  be the utilities that the husband and wife respectively would get in any period where they do not reach agreement. Let  $b_h + b_w < 1$  and let the utility possibility frontier for each period be  $\{(u_1, u_2) \geq 0 | u_1 + u_2 = 1\}$ . Let us suppose that there if the wife makes the first offer, the equilibrium payoffs will be  $\bar{u}_1^w$  for the wife and  $\bar{u}_2^w$  for the husband and if the husband makes the first offer, the equilibrium payoffs will be  $\bar{u}_1^h$  for the husband and  $\bar{u}_2^h$  for the wife.

In the first period, if the husband accepts the offer of  $\bar{u}_2^h$ , then since the problem is stationary, he will continue to accept  $\bar{u}_2^h$  in all subsequent periods. Therefore his utility will be  $\sum_0^\infty \bar{u}_2^h \delta^t$ . If he rejected her offer, he would receive  $b_h$  in the first period and in the next period it would be his turn to make the offer. Then he would demand  $\bar{u}_1^h$  and offer his wife  $\bar{u}_2^w$  and she would accept the offer and continue to accept  $\bar{u}_2^w$  in all subsequent periods. The husband's utility if he follows this strategy would be  $b_h + \sum_{t=1}^\infty \bar{u}_1^h \delta^t$ . In equilibrium, the husband must be just indifferent between accepting his wife's initial offer and waiting one period to make a counteroffer. This will be the case if  $\sum_0^\infty \bar{u}_2^h \delta^t = b_h + \sum_{t=1}^\infty \bar{u}_1^h \delta^t$ , or equivalently if

$$\bar{u}_2^h - b_h = \frac{\delta}{1-\delta}(u_1^h - u_2^h). \quad (1)$$

Similarly, it must be that if  $\bar{u}_1^w$  and  $\bar{u}_2^w$  are equilibrium strategies for the wife, then she will be indifferent between accepting  $u_2^w$  if it is her husband's turn to make an offer and refusing his offer and countering with a demand of  $\bar{u}_1^w$  in the next period. This leads by an exactly parallel argument to the equation

$$\bar{u}_2^w - b_w = \frac{\delta}{1-\delta}(u_1^w - u_2^w). \quad (2)$$

The feasibility constraints for offers are:

$$\bar{u}_1^w + \bar{u}_2^h = 1 \quad (3)$$

$$\bar{u}_1^h + \bar{u}_2^w = 1 \quad (4)$$

When we solve the linear equations 1-4 for the variables  $\bar{u}_1^w$ ,  $\bar{u}_2^w$ ,  $\bar{u}_1^h$ , and  $\bar{u}_2^h$ , we find that the solutions are:

$$\bar{u}_1^w = b_w + \frac{1}{1+\delta}(1 - b_h - b_w),$$

$$\bar{u}_2^w = b_w + \frac{\delta}{1+\delta}(1 - b_h - b_w),$$

$$\bar{u}_1^h = b_h + \frac{1}{1+\delta}(1 - b_h - b_w)$$

and

$$\bar{u}_2^h = b_h + \frac{\delta}{1+\delta}(1 - b_h - b_w).$$

This is the result claimed in the text.

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