NATURAL ECONOMY VERSUS POLITICAL ECONOMY

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Summary

In political economy, competitive striving is limited by a system of law and property; in natural economy, no such limitations exist. In the one case competition characteristically takes the form of vying for exchange partners; in the other, of taking. The actual world of human affairs is only an imperfect political economy, since natural-economy forms of competition are evident in such activities as externalities, crime, and redistributive politics.

Nevertheless, conflict tends to be limited and positive cooperation can emerge even under natural-economy conditions. Biologists have distinguished three forms of cooperation: (1) helping others where merely incidental to self-help, (2) helping kin, and (3) reciprocal exchanges. These interact in various ways. The viability of a helping pattern depends importantly upon the intensity of competition and upon the reaction of the aided organism to the help provided. The techniques for achieving cooperation in the absence of contractual enforcement in the biological realm have analogs in the human sphere, including: dealing with relatives, merger of interests via the division of labor, repeated business association, and commitment to a reward-punishment mode of behavior.

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I.   ECONOMICS AND SOCIOBIOLOGY

Charles Darwin thought like an economist. One of his favorite phrases was "the economy of Nature," and in his analysis of the workings of biological mechanisms he regularly used economic concepts like scarcity, cost, competition, specialization, and the division of labor (Ghiselin 1974).

The recent revival of Darwinian evolutionary selection theory as applied to problems of social behavior, which has come to be known as sociobiology (Wilson 1975), also has a distinctly economic aspect. Looking over the whole realm of life, sociobiology is attempting to find the general laws determining the multifarious forms of association among organisms. For example: Why do we sometimes observe sex and families, sometimes sex without families, sometimes neither sex nor families? Why do some animals flock, others remain solitary? Within groups, why do we sometimes observe hierarchical dominance patterns, sometimes not? Why do organisms in some species partition territories, others not? What determines the selflessness of the social insects, and why is this pattern so rare in Nature? When do we see resources allocated peacefully, when by means of violence? These questions are both posed and answered in recognizably economic terms. Sociobiologists ask what are the net advantages of the observed association patterns to the organisms displaying them, and what are the mechanisms whereby these patterns persist in social equilibrium states. It is perhaps this assertion of economic-behavioral continuity between man and other life forms (termed "genetic capitalism" by one detractor) that explains the hostility of some ideologues to sociobiology -- just as Darwin's assertion of physical continuity between man and other species was found offensive by many Victorians.

Since there is such a striking similarity between the <u>basic</u>
<u>problems</u> attacked by economics and by social biology, we can expect to
find parallels in the corresponding <u>logical structures of thought</u>. The
common root problem is scarcity. But why are resources necessarily scarce?
Ultimately, scarcity is the consequence of the multiplication of populations --
a keystone of Darwin's theory, arrived at by his study of the economist
Malthus. More broadly, we can say that scarcity of resources is inevitable
because of the expansive tendency of ways of life that have proved success-
ful at extracting those resources.

As for logical structures, economics and biology both involve an
intertwining of two levels of analysis. On the <u>individual or organism level</u>
the acting units or entities choose (or at any rate somehow hit upon)
strategies or techniques that promote their own success in the struggle
(competition) for advantage. These techniques will, importantly, involve
greater or lesser degrees of friendly or hostile interaction with other
individuals or organisms, but the economic man or the sociobiological organism
does not gratuitously act to help, or for that matter to hurt, others.
He or it will do one or the other, will help or hurt, only in response
to what is, ultimately, self-advantage (Ghiselin 1974, Dawkins 1976). It
is at this point that sociobiology becomes disturbing to the Rousseau-Marx
school[1/], philosophers who want to believe that <u>unselfishness</u> is normal
in Nature or at any rate in the natural man. And in consequence that
selfishness in man as he actually behaves in the world is an anomaly due
to bad institutions, rather than to anything intrinsic in his essential
makeup. (That so often these dedicated believers in the fundamental
goodness of man are found viciously abusing anyone

with opposed opinions is perhaps revealing of the underlying truth of the matter, but this point need not be pursued here.) Returning to the parallelism of biology and economics as systems of thought, on the _social level_ of analysis the outcome is an equilibrium (or at least, a time-path of movement toward equilibrium) in which, on the margin, every surviving life-form and every strategy adopted by life-forms is just barely viable given the choices of all the others. For, if it is more than barely viable, on the margin, that life-form or strategy will multiply and expand until the law of diminishing returns eliminates the advantage.

There are, on the other hand, certain real or seeming differences between economics and biology in modes of thought and logical structures, three of which can be mentioned here:

1. The first is the question of _rationality_. The human being can rationally choose or "optimize" his course of action (or so we like to think) whereas, below the human level and except possibly for a few of the higher animals in limited degree, biologists who speak of "choice" and "strategy" are only using metaphors. What happens in the biological realm is that, given a sufficiently long run, _natural selection under Malthusian competition_ allows survival only of the most successful among the possible strategies. So the result ends up almost _as if_ baboons or rats or crabgrass plants were consciously optimizing. Even in the economic literature, curiously, there is a school of thought (Alchian 1950, Enke 1951, Winter 1964, Nelson and Winter 1974) that minimizes the role of subjective "rational" _choice_ of, as opposed to environmental _selection_ of successful strategies. And coming at things from the opposite direction, a number of economists (Fredlund 1976, Kagel et. al. 1975) have conducted experiments or otherwise

observed that animals faced with economic choices are really not so dumb! For the purposes of this paper, rational forethoughtedness is best thought of as simply one of the possible mechanisms or strategies of striving for advantage -- like long necks for giraffes or fleet-footedness for deer. Certain organisms face environments where "hard-wired" or instinctive responses suffice for viability; others live in circumstances such that reserving a degree of freedom for purposive choice has won out in the game of life.

2. The second divergence is epitomized by the difference between the biological term "fitness" and the economic concept of "tastes." For the biologist, natural selection has inevitably shaped life into organisms driven as if they were maximizing something quite objective and unambiguous: reproductive survival, or fitness. Social scientists generally, and economists among them, find unappealing the idea that our deep-seated desires and our superficial whims reduce down to serving biological fitness, to multiplying the number of our descendants. Rejecting the reductionism of the biological explanation of human aims or goals, the modern economist has jumped to the opposite extreme. He takes our goals for living, to which he attaches the demeaning term "tastes," as purely subjective and arbitrary, something totally inexplicable (or at any rate belonging in someone else's explanatory jurisdiction). Economists today would do well to go back to the master, Adam Smith, who did not regard the fundamental drives of men as arbitrary and inexplicable, who clearly understood that human desires are ultimately adaptive responses shaped by man's biological nature and situation on earth (Coase 1976, p. 539).[2/]

3. The central theme here will be another main difference between the analytical approaches of economics and of biology toward social behavior, a difference summarized in the distinction between "natural economy" and "political economy" -- both being sub-categories of _universal economy_ (Ghiselin 1978).

In traditional political philosophy, or legendary political history, the step from natural economy to political economy was taken only by man -- in the form of the social contract of Rousseau or Hobbes. The thesis of comparative sociobiology is that there is no such sharp discontinuity in social organization, just as there is no sharp discontinuity in physical form, between man and other branches of life. Within a social group, _law_ emerges when what might be called "moralistic aggression" (Trivers 1971) by third-party intervenors serves to control internal conflict. We see this already wherever parents regulate offspring rivalry, behavior widespread in the animal kingdom. _Government_ may be said to exist when, in groupings larger than a single family, control tasks are performed by specialists in that function. In the biological realm, some species have dominant individuals or cliques that approach primitive government within packs or troops. The immunities from invasions thus created prefigure the human institution of _property_ (Fredlund 1976).[3/]

These political-economy institutions provide two classes of advantages. On the first level, law and government deter or limit the internal fighting and consequent losses of strength that would be disfunctional for the group as a whole. Individuals need not divert effort to continual patrolling and monitoring. This is a kind of minimal or negative cooperation. On the second level, positive cooperation in the form of _exchange_ of resource

entitlements becomes a possibility -- and, ultimately, the more sophisticated

dealings in deferred reciprocations that constitute the essence of

contract.

Yet the institutions of political economy can never be so perfect

as to entirely displace, even in human societies, the underlying realities

of natural economy. Every living organism remains to some degree in a

Hobbesian "state of nature." In particular, the intercourse among

the nations of mankind lies outside the scope of effective law. Even

under law and government, the rational self-interested individual will

strike a balance between lawful and unlawful means of acquiring resources --

between production and exchange on the one hand and theft, fraud, and

extortion on the other. For that matter a perfectly law-abiding individual

(if there is any such) could not have such confidence in third-party

enforcement as to entirely forego personal vigilance and self-defense. And

setting aside violation of law, the structure of the law itself will neces-

sarily have greater or lesser imperfections. It is not always practicable

to define rights to property in such a way as to ban socially wasteful

activities designed to capture benefits while imposing costs on others (what the

economist calls "externalities"), or, much more important, to foreclose efforts

aimed at influencing government or revising the law so as to redefine rights

in one's favor. This latter activity is of course the stuff of redistribut-

ive politics. In short, while the intellectual division of labor whereby

biologists concentrated on natural economy and economists on an idealized

political economy is an entirely understandable one, in the actual world

the separations are by no means clean-cut. Mankind still lives, to an

important degree, outside the sway of the cooperation-supporting institu-

tions of political economy. Yet, as we shall see, forms of cooperative association can emerge even under natural economy!

II. COMPETITION IN RELATION TO COOPERATION AND CONFLICT

Competition is the all-pervasive law of natural-economy interactions. The source of competition is the limited resource base of the globe in the face of the universal Malthusian tendency to multiply. By natural selection the biosphere has come to be filled by life forms successful at multiplying and pressing upon one another for command over resources. This teeming of life is therefore both cause and consequence of biological competition.

Figure 1 portrays what competition looks like from the biological point of view. For two interacting biological entities F and G -- whether species or genes or characters or strategies -- the essential is that the equilibrium viable number of each decreases with the actual number of the other. That is, the curve $\hat{N}_F$ (showing the level of N_F where its time-rate of change becomes zero) is a decreasing function of N_G. Similarly, $\hat{N}_G$ is a decreasing function of N_F. As the directional-change arrows indicate, Figure 1 shows a competitive <u>coexistence equilibrium</u> at the intersection of the $\hat{N}_F$ and $\hat{N}_G$ curves. (By changing the values of the parameters determining $\hat{N}_F$ and $\hat{N}_G$ we could also display <u>corner</u> equilibria, where F drives G to extinction or vice versa.) Figure 2 is the corresponding picture of a <u>cooperative</u> interaction between F and G, where the equilibrium viable number of each entity is an <u>increasing</u> function of actual numbers of other. (Again, the diagram shows a stable coexistence equilibrium, other cases being also possible.) And finally, in Figure 3, a mixed or asymmetrical

"predator-prey" situation in which (so to speak) G is helpful to F --

since $\hat{N}_F$ is an increasing function of G -- but F is hurtful to G. (Here

the arrows indicate a cyclic pattern, which may be either damped or explosive.)

These biological equilibria correspond to what the economist calls Nash-

Cournot solutions, in which each party takes the actions of the other as

given, thus ruling out purposive pursuit of mutual gain.

One puzzle immediately comes to mind here. From the biological picture

in Figure 1 it appears that competition is necessarily anti-social: any

benefit for F comes at the expense of G. And yet economic tradition, start-

ing with the "Invisible Hand" of Adam Smith, has always viewed competition

as ultimately a force for harmonizing interests. How can this divergence

be resolved?

First of all, competition for the economist ordinarily refers to a

three-sided interaction: vying against a rival or rivals, but for the

opportunity to engage in mutually advantageous exchange with a third party.

Some instances of biological competition are essentially of this nature,

as when males vie to mate with females in situations where the females retain

the option of choice. But, more commonly, biological competition is direct

two-sided striving (as when males combat for females, who are left no option

but to mate with the victor). Human examples of two-sided striving of

course also abound, as in duels for survival -- Rome versus Carthage, or

Ike Clanton versus Wyatt Earp.

Secondly, the modes of competition may be more or less wasteful and

anti-social. Biologists have found it useful to distinguish between

"scramble" and "interference" modes. Scramble competitors ignore one another,

interacting only through depletion of resources. The winning organisms are those most efficient at extracting energy and other inputs from the external environment. Interference competitors, in contrast, gain and maintain control over resources by directly fighting off or hampering their rivals, a process that is evidently inefficient for the social aggregate. Of course, under (idealized) institutions of political economy "interference" competition is not permitted. A businessman is allowed to compete in various ways, but not by blowing up his rival's shop. This does not quite get to the heart of the matter, however. Even "scrambling" competition may be socially wasteful, and even if the resources scrambled for are to be used for exchange with third parties. Though less obviously so than in the case of interference competition, scrambling also is socially inefficient in that effort is being invested to preclusively appropriate resources that would have been socially available even without that effort -- or to redistribute them or to prevent such redistribution. This is the source of the difficulty in the classic "overfishing externality" model (Gordon 1954), a situation which corresponds exactly to biological scramble competition.

Figure 4 displays the nature of the social loss from preclusive competition (as in scrambling or fishing) between two maximizing entities A and B. The $\hat{A}$ and $\hat{B}$ curves correspond to the $\hat{N}_F$ and $\hat{N}_G$ curves of Figure 1. Figure 4 provides a "utility" interpretation of the derivation of these curves. Since B's preclusive efforts are always a bad for A, the indifference curves for A represent higher levels of satisfaction moving south. And similarly, B's indifference curves are higher moving west. A's own effort is a good to himself, up to a point (he receives a positive net marginal product), but

eventually becomes a bad (negative net marginal product). And similarly for B. These properties explain the general shapes of the indifference curves. Since A controls his own effort only, for any level of B's effort A's optimum is found where his indifference curve becomes horizontal (zero net marginal product). Similarly B finds his optimum where his indifference curve becomes vertical. These conditions determine the $\hat{A}$ and $\hat{B}$ curves, whose intersection is the coexistence equilibrium E (as in Fig. 1). The region of mutual advantage shows that a social gain over this equilibrium could be achieved. That is, organisms A and B could both be made better off if agreement were possible, or if rights to the resources could be appropriately pre-assigned.

We have seen, therefore, that the beneficence of the "Invisible Hand" is associated not with competition per se, but with a severely constrained type of competition that ideally characterizes the market economy: vying to engage in exchange with third parties, by offering them better terms, and under circumstances where resources all have assigned ownership so that no effort is wasted in striving to preclusively appropriate or redistribute them. These conditions of course require a system of law and property rights, as can only arise under political economy.

III. COOPERATION, CONFLICT, AND THEIR LIMITS

If competition is the basic law of life, and if competition leads to social advantage only under an ideal political economy with its institutions of law and property that facilitate cooperation through mutually advantageous exchanges, how is that cooperation is often observed in the biological sphere in the absence of law and property? Consider the "mutualism" of the flowers and the bees, a relation that seems very much like exchange

in that it involves reciprocal conferring of benefits. Or another example: small cleaner fish that provide grooming services to larger fish while feeding on their external parasites. This is even closer to exchange since the cleaner fish do not groom at random, but have a regular clientele of customers (larger fish who can be trusted not to eat their barbers!). Furthermore, even one-way transfers -- gifts, unilateral conferring of benefits -- take place on both the human and non-human levels. And where conflict occurs, as of course it does, how and why is it that the battle is often limited rather than all-out, as it might have been (Lorenz 1966)?

Biologists have examined the problem of social cooperation (West Eberhard 1975, Trivers 1971, Wilson 1975) under the rubric of "altruism," in which they have been followed by a number of economists (Becker 1976, Kurz 1977). Terminologically, this is most unfortunate. The word "altruism" has psychological connotations that are often irrelevant or misleading. More important, it leads almost inevitably to semantic confusions. For example: "If the well-being of organism B is desired by (enters into the utility function of) organism A, isn't A's seeming altruism toward B just pursuit of A's own goals, and so not really altruism?" A total pseudo-issue, of course. Here's another one: "If an altruism choice or strategy is to be viable in competition with non-altruism, altruism must contribute to self-survival more than non-altruism does, and therefore it can't really be altruism!" All such muddles could be avoided if we drop the term "altruism" and ask instead: What are the determinants of the entirely objective phenomenon that can be called helping? Patterns of helping can usefully be analyzed under three main headings proposed by biologists: (1) helping that is merely incidental to selfish behavior, (2) helping associated with kinship, and (3) helping that is involved in reciprocal interactions.

Incidental helping poses no problems. It is the kind of unwitting or
unwilling assistance that animals give to parasites -- in the case of
mankind, the "foreign aid" programs we provide for rats, houseflies, and
common-cold germs. (How absurd to call this altruism!) But incidental
helping overlaps also with reciprocal helping, in cases like the flowers
and bees where species have become co-adapted to help one another incidentally
to helping themselves.

Kinship helping raises more interesting economic issues. The biologists'
basic helping rule (Hamilton 1964) is shown in inequality (1): evolutionary
selection impels a Donor organism D to aid a Recipient organism R if:

$$(1) \qquad \frac{c_D}{b_R} < r_{DR}$$

-- that is, if the cost-benefit ratio c_D/b_R of the action is less than the
degree of relatedness r_{DR} between the pair. Biological cost and benefit are
measured in terms of reproductive survival or fitness W: cost c_D is a
decrement to Donor's own-fitness W_D and benefit b_R is an increment to
Recipient's own-fitness W_R. The biological logic is that the gene controlling
helping behavior in Donor D values its own survival (using the language
of conscious optimization metaphorically, though the actual process is the
result of blind natural selection) equally with survival of any identical
copy itself, and r_{DR} measures the chance of organism R having an identical
copy. Specifically, a gene for kinship helping instructs a man (other things
equal) to give his life if he can thereby save two siblings, four half-sibs,
eight cousins, etc.

Looking at this as the economist would, optimal action always involves an interaction of preferences and opportunities. The relatedness factor is the operative preference element. In effect, Donor organism D is maximizing an "inclusive fitness" concept W_D^*, of which his own-fitness W_D is only one component. Specifically:

$$(2) \qquad W_D^* = W_D + r_{DR} W_R$$

Inclusive fitness is then a weighting of the W's by degree of relatedness to Donor (he is, of course, always 100% related to himself). Diagrammatically (Fig. 5), inclusive fitness W_D^* as the biological utility function leads to linear "indifference curves" with slope $-r_{DR}$ on W_D, W_R axes. The shaded opportunity set represents the attainable region for Donor D. At the optimum point G^*, the cost-benefit ratio c_D/b_R (the slope $-dW_D/dW_R$) along the boundary of the opportunity set just equals the indifference-curve slope $-r_{DR}$.

In the diagram, relatedness r is shown as a constant feature of the interaction between two organisms, as of course it always is, but the cost-benefit ratio c/b is a diminishing-returns function of the amount of helping. The c/b ratio can also be a function of a number of other determinants, and in particular may vary over the life cycle as between organisms of given relatedness. One example relevant for humans: because offspring generally need help more urgently, and parents are in a position to give it, from cost-benefit considerations we would expect to see parents aiding children more than children aid parents -- even though relatedness r is the same both ways. Some biologists (e.g., Dawkins 1976) have argued that kinship helping can scarcely be important beyond the immediate family, since r falls off very rapidly toward zero as kinship distance increases. But as West Eberhard (1975) points out, one individual might sometimes be able to influence fitness of a great many others -- so that increase in numbers affected

may offset decrease in average r. In human endeavors this provides a bio-
logical explanation for the grueling hours and selfless devotion often
observed of leaders in war, politics, or even business.

A couple of interesting complications concerning kinship helping
can be pursued here -- the first having to do with competition and the
second with the question of Recipient's reaction to Donor's help.

First, with regard to competition. Under kinship helping it certainly
seems that the Recipient R is getting the better of the deal. But our
fundamental premise is that all forms of life and all strategies are in
competition. Then why should not a gene NH for not-helping one's kin
out-compete the help-kin gene H? The organism bearing the H gene will some-
times be a Donor, sometimes a Recipient of aid -- but the carrier of the NH
gene will be exclusively a Recipient. Since we are ruling out the
reciprocation element, non-helpers cannot be punished for being bad boys.
The NH gene is thus a "free rider," and other things equal it always pays to
be a free-rider rather than pay the fare. Indeed, the economist Tullock
(1978) claims that this argument refutes Hamilton's helping rule. Where
the critic went wrong was in failing to appreciate that helping only one's
kin means that helping acts will be preferentially directed to fellow-carriers
of the helping gene. It is true that the H gene tends to lose sway within
the family but it nevertheless (if the condition is met) gains in prevalence
within the population.

This can be shown explicitly, for a simplified special case (a "sexual
haploid" organism) by asking under what conditions W_H will exceed W_{NH} --
the "fitness" or viability of the helping gene H will exceed that of the non-
helping gene NH?[4] Here c and b are cost and benefit as before, N is the

population number, and $\underline{p}$ the proportion bearing the helping gene. The key variable is the discrimination factor, $\underline{m}$, which represents <u>the proportion of helping acts received by fellow-helpers</u>. Then, $W_H > W_{NH}$ requires:

$$(3) \qquad -c + \frac{bmNp}{Np} > \frac{b(1-m)Np}{N(1-p)}$$

On the left-hand-side, the first term $-c$ represents the cost of the helping act to Helper (in fitness units, and normalized so that there is one helping act per time-period). The numerator of the second term, $bmNp$, represents the aggregate benefit of helping acts per time-period that are directed at fellow-helpers -- while the denominator Np is the number of helpers in the population. The ratio of the two then shows the average per-helper benefit of helping acts, in fitness units per time-period. The RHS, analogously, shows the average per-non-helper benefit of having helpers in the population. Inequality (3) reduces to:

$$(4) \qquad \frac{c}{b} < \frac{m-p}{1-p}$$

Thus we see that for helping to be competitively viable, a necessary (though not sufficient) condition is $m > p$ -- fellow-helpers must receive helping acts <u>in bigger proportion than their proportion in the population</u>.

Let us suppose we are talking about helping one's siblings, for whom relatedness r_{DR} equals $\frac{1}{2}$. Supposing that the helping gene H arose as a new mutation in one's parent, $\underline{p}$ being at first effectively zero in the population at large, then the probability that one's sibling also bears the H gene is one-half. And as $\underline{p}$ goes to unity, $\underline{m}$ must also approach unity. Indeed, it is algebraically clear that for sibling helping, in general:

$$(5) \qquad m = \frac{1+p}{2}$$

Making this substitution in (4) we directly verify the helping rule (1) for siblings:

(6) $\qquad \dfrac{c}{b} < \dfrac{1}{2} = r_{DR}$

Note that this viability analysis leads to <u>corner solutions</u>, $p = 1$ or $p = 0$, according as the inequality condition is or is not satisfied. What might lead to <u>interior solutions</u> for $\underline{p}$? This could come about if, for a particular type of helping act, c/b were an increasing function of $\underline{p}$ -- i.e., if there are diminishing returns to helping as the proportion of Helpers rises. The interpretation would be that competition is becoming increasingly severe, perhaps because with larger $\underline{p}$ and thus more helping acts the population $\underline{N}$ tends to grow until it presses increasingly upon its external resources.[5/]

The cost-benefit ratio c/b is therefore importantly a function of <u>intensity of competition</u>. Several further aspects of competition are brought out if we look at what might be called the <u>generalized helping/hurting rule</u>:

(7) $\qquad \displaystyle\sum_{\substack{\text{losers} \\ (i)}} r_{iD}\, c_i < \sum_{\substack{\text{gainers} \\ (j)}} r_{jD}\, b_j$

Here the Donor's acts help some, and hurt others. His "as-if" optimization of inclusive fitness sums the costs versus benefits for all affected parties, weighted by relatedness. Of course, he counts himself, with a relatedness of unity, in either the loser or the gainer group, whichever is appropriate.

Again, competition enters in the form of some constraint connecting the costs and benefits. The most extreme such constraint, which may be called <u>absolute competition</u>, is defined by the condition:

(8) $\qquad \Sigma c_i = \Sigma b_j.$

That is, benefits conferred on some organisms must be exactly balanced by

costs imposed on others, equal in aggregate. In _two-party_ absolute competition ("It's either him or me!") the c/b ratio must be unity, hence kinship helping could not be viable -- except for identical twins, for whom $r = 1$. If absolute competition governs, the generalized helping rule can be written in the following special form, where $\bar{r}$ is the average relatedness of members of the population to Donor:[6]

$$(9) \qquad \sum_{\substack{\text{losers} \\ (i)}} c_i(r_{iD}-\bar{r}) < \sum_{\substack{\text{gainers} \\ (j)}} b_j(r_{jD}-\bar{r})$$

Under absolute competition it is not the simple relatedness, but relatedness greater or less than the average in the population that serves as the factor for weighting cost or benefit.

As a further special case, suppose now that for all losers of fitness, the c_i equal a common value c -- and for all gainers of fitness, the b_j equal a common value b. Then, if $\bar{r}_{iD}$ is the average relatedness of losers to Donor and $\bar{r}_{jD}$ is the average relatedness of gainers to Donor, the generalized helping rule under absolute competition reduces to:[7]

$$(10) \qquad \bar{r}_{iD} < \bar{r}_{jD}$$

That is, help any group more closely-related to you at the expense of groups less closely related. Crudely speaking, under absolute competition anyone is your enemy who is less closely related to you than the average in the population!

Absolute competition is not universal, of course. But even apart from that, there is an important consideration which mitigates the rather terrifying xenophobic implications of the above rule. To wit, that (as Darwin emphasized) organisms more closely related tend to be in closer competition. If we consider birds in a nest, in terms of relatedness a single nestling

would "choose" to take food from inhabitants of other nests rather than deprive his own sibling. But of course he is only in a position to compete for food with his own siblings, the inhabitants of his own nest. This phenomenon operates to increase enmity within and to reduce enmity between families, groups, and species. The bottom line is that since the motive to help (the relatedness factor r) and the competitive gain from hurting both tend to be increasing functions of closeness of kinship, the final outcome is delicately balanced and depends upon the specific details of the situation. Sociobiological considerations may lead sometimes to xenophobic wars, but under other circumstances to often equally bloody civil wars. Or, looking at matters more optimistically, to mutual help sometimes among close relatives, sometimes between distantly-related organisms. In each case it is the balance of the preferences and opportunities, of relatedness and cost-benefit considerations, that governs.

We can now turn to the second complication — Recipient's reaction to Donor's helping (or hurting). From the economic point of view, Donor's aid or injury will affect Recipient's "fitness wealth" one way or the other and thereby change the balance of preferences versus opportunities for the latter. Specifically, depending upon the directionality of these wealth effects, Recipient may react by helping or hurting Donor (or third parties) in a way that Donor should take into account.

One instructive instance studied by economists is the "rotten-kid theorem" (Becker 1976). Here we postulate an utterly selfish "rotten kid" K, who simply wants to attain a position with highest I_K in Fig. 6 (on axes representing Daddy's income I_D versus Kid's income I_K). Daddy, on the other hand, has a degree of love and concern for Kid as shown by his normal-looking indifference

curve, U_D, on these axes. But the two are not in absolute competition, and indeed can mutually benefit from cooperation. Suppose that Kid is in a position to make the first move, and Daddy the last. Then if Kid were short-sightedly selfish, he would choose an optimum at R^*. But, knowing that Daddy is unselfish and will react positively to aid, Kid should choose the joint-income optimum J^*. The reason is that Daddy will then make 1:1 transfers of income to Kid, by moving along the 135° line SS to an optimum at A^*. Note that Daddy is a truly unselfish or "hard-core" cooperator (Wilson 1977), Kid a merely pragmatic one, but they both benefit.[8]

We have here an opportunity set rewarding cooperation (in a context excluding <u>contractual</u> reciprocation). In these circumstances one way of achieving cooperation is for either or both parties to evolve "love" for the other -- more specifically, to become motivated to share any increments of income with the other. Evidently, the mechanism can work, as shown in the diagram. Indeed, it is easy to see that if Daddy were <u>less</u> loving (if his indifference curve were to shift to the somewhat more selfish pattern U_D'), he would only react to Kid's aid by more limited income transfers along SS to an optimum at B^* -- but this would be insufficient to motivate Kid to cooperate in the first place. So Daddy is better off not only "altruistically" in utility terms for being unselfish, but (and this is essential for the viability of such "Golden-Rule" behavior) he is better off even in terms of <u>real measurable income</u>![9] Where the economist would say that Daddy had a "taste" for helping his offspring, for the biologist this attachment or affection can only have evolved as a <u>means</u> of achieving higher fitness.

We have already crossed over into a discussion of the third category of aid -- reciprocal helping, a pattern which can come about even in the absence of relatedness. But relatedness, since it provides a degree of initial payoff in inclusive-fitness units for helping seems to make it easier to evolve what looks like an extra "irrational" degree of love. Note also that Nature seems to allow for scarcity of love power -- the greater is Daddy's degree of affection, the less need Kid's be to achieve mutual gain through cooperation.

Let us focus more closely now on the reactive aspect of helping. Consider first interactions among non-kin, where $r_{DR} = 0$. Then the helping rule (1) reduces simply to $c_D < 0$; in the absence of kinship, there must be a negative cost (positive selfish benefit) to the Donor of any help he gives Recipients. We can think of this cost c_D as decomposed into a primary cost term c_D^o and a reactive cost term c_D'.

(11) $$c_D \equiv c_D^o + c_D'$$

"Incidental" helping is associated with a negative c_D^o (the helping act has a primary selfish benefit to Donor); "reciprocal" helping is associated with a negative c_D' (Recipient's reaction to help aids Donor D).

Reciprocation of help brings us close to the exchange interactions of the economist. The basic rule of reciprocal interactions is, "Help your helper!" In biological terms, "Increase an unrelated organism's fitness, assuming there is direct cost to yourself, only if he will react by increasing your fitness (and do so by a large enough amount)!" But there are two main paths of reciprocation. First, it may be that Recipient R is an individual

who would <u>unconditionally</u> help you in return. His reactive "wealth effect,"
in terms of helping you, is positive and quantitatively large enough to
make your negative reactive cost term c_D' over-balance your positive direct cost
c_D^0. If the beneficiary is your kin, there will in general be some favor-
able reaction on his part to your aid -- but, as we saw in the rotten-
kid example above, possibly not quantitatively enough to motivate your
sacrifice. In that case, your potential beneficiary can guarantee to
reactively help you <u>more</u> than he otherwise would by evolving a degree of un-
controllable or "irrational" love for you (like Daddy above) and this may serve
the purpose of warranting your aid to him. Among unrelated organisms,
perhaps the bond <u>between dog and man</u> (under natural economy, since you
cannot write a contract with your dog) exemplifies how love or its func-
tional equivalent gratitude motivates helping. Essentially the same
phenomenon clearly occurs in a negative sense as well. Animals and even humans
do sometimes react with uncontrollable or "irrational" rage to punish those who hurt
them. So we have deterring of hurting as well as inducement of helping in
the natural economy through reactive responses whose delivery is guaranteed
by emotion.

The second type of Recipient who will reactively help you, unconditionally,
is someone who is (on the margin) an incidental helper to you. Again, the
reaction must be quantitatively great enough if it is to warrant your
sacrifice. This process is presumably what leads to co-adaptation for
mutual aid between unrelated organisms like the flowers and bees.

However, <u>cheating</u> is a pervasive phenomenon that tends to limit all
these cooperative arrangements. Cheating in Nature takes many forms. A

Recipient may pretend to a higher degree of relatedness r (as when a cowbird lays her egg in another bird's nest). Or Recipient can fake a higher potential benefit from aid, as when a nestling screams for food as hard as it can, whether or not truly hungry. Or it can pretend to be a reactive helper, as when a mimic cleaner fish upon being allowed to approach a "client" just takes a bite and escapes! Or an even more extreme case of pseudo reactive helpers: there are carnivorous plants who prey on their would-be pollinators. Of course, analogous phenomena are not unknown in human affairs.

It may be that, for any or all of the reasons suggested above, unconditional positive reactions are inadequate to induce the initial helping act even though there does still exist a potential mutual gain from reciprocated help. That is, exchange would be mutually beneficial but, having received his end of the bargain, the initial Recipient party lacks sufficient motivation to make the required reciprocal sacrifice. We have here a classical Prisoners' Dilemma situation, which can be solved by shifting from natural economy to political economy -- that is, to a system of third-party enforcement of contract. (Of course, cheating remains a problem under political economy, indeed it is given a number of new dimensions.)

We have now located the context in which political economy can become an element in the picture of social cooperation. But the main emphasis here has been upon seeing the picture as a whole: since political-economy institutions are always and necessarily imperfect, social cooperation rests to a degree upon foundations that must remain viable even under natural economy. There have to be human makeshifts and substitutes for enforcement of contract, and these can be better understood if we examine the working of the same mechanisms in the nonhuman sphere.

Some of these makeshift arrangements can be briefly discussed here, with comments on their relevance for the human economy.

1. Cooperation Among Relatives:

Relatedness provides warrant in fitness terms for some helping acts even without reciprocation (as we saw under the heading of kinship helping). But somewhat more subtly, it also promotes _mutual_ helping by tending to increase the probability and magnitude of unenforced reciprocation. In human affairs, we know that business enterprises very often are undertaken by family units: examples include the Rothschilds, the Medicis, the new publishing house charmingly named Thomas Horton and Daughters, and even the Mafia! And of course an enormous fraction of all economic activity takes place within the bosom of the family.

2. Repeat business:

Suppose that two parties have the opportunity to engage not in an isolated business transaction, but in a _sequence_ of repeated interchanges each of which would be mutually beneficial. Evidently, then, the motivation for either party to cheat at any point in the series is attenuated by the prospective loss of future benefit. In the case of cleaner fish, the bigger client fish does not usually eat his barber. The little fellow has provided good service in the past, has proved himself not one of those mimic cleaners who bite and run, and so can be relied on in the future. In human affairs the prospect of repeated association is obviously an extremely potent force motivating good behavior in all types of social interchanges. As one example of specific relevance to business association in the narrower sense, the sociologist Macaulay (1963) has shown that appeal by commercial firms to judicial enforcement of contract is relatively rare, largely because of the effectiveness of this alternative mechanism for enforcing cooperation -- fear of loss of future business.

3. Merger of interests:

To the extent that members of a group share a common fate or outcome, helping one another becomes self-help. Merger can be regarded as an extreme form of repeated business relationship, in which each participant has made himself irreversibly vulnerable to severe loss should the association break down. There are two main types of merger, which may be called complementation versus supplementation relationships (Hirshleifer 1977a, p. 38). Complementation involves division of labor through acceptance of specialized roles. An obvious example is the division of labor between males and females in bearing and caring for offspring. In the human realm, this is also a kind of familial cooperation, but one which must not be confused with cooperation among relatives -- since male and female parents are not ordinarily closely related. They are more in the nature of business partners, with 50% shares in the business of producing offspring. Supplementation as a pattern of merger, on the other hand, is particularly valuable where the advantage of grouping stems not from specialization of role but rather essentially from size of the cooperating unit. I.e., where returns to scale exist. Cartels are associations of this nature, but cartels are ordinarily rather vulnerable to disruption through cheating. Much more important in animal and human affairs are the returns to scale associated with military power ("God is on the side of the bigger battalions" -- Voltaire.) There is reason to believe that the need to fight and to fight off other human groups has very strongly influenced the social instincts of mankind (Alexander 1975).

4. **Conditional commitment:**

The Prisoners' Dilemma arises in all sorts of interchanges, from business transactions to criminal partnerships to military deterrence of conflict. The essence of the problem is that the recipient of aid or injury -- however desirous _ex ante_ of receiving aid or avoiding injury -- may not find it rational _ex post_ to reciprocate in kind. Having received the loan, the borrower is not directly motivated to repay. If an aggressor were to destroy most of our population in a surprise nuclear attack, little or nothing might be gained after the fact by having our surviving forces engage in a punitive retaliatory strike against enemy population. But guaranteeing in advance to return (even though irrational _ex post_) good-for-good or evil-for-evil affects the other party's _ex ante_ calculations -- and thus tends to promote cooperation and limit conflict (Schelling 1960). Uncontrollable emotions of loving gratitude or vengeful rage achieve this object in natural economy. Of course, sophisticated human contrivances may provide other mechanisms of uncontrollable reaction. A neat modern example is the "Doomsday Machine," which (if all goes well!) deters aggression by guaranteeing to blow up the whole world should an aggressor initiate a nuclear attack.

We have seen how what might be called the Silver Rule -- to return good-for-good, and evil-for-evil -- can be socially effective in deterring aggression and rewarding cooperation. What about the Golden Rule -- to return good-for-good, and good-for-evil? One's first impression is that the Golden Rule could never be viable. After all, in the competitive picture there will always be followers of what could be called the "Brass Rule" -- be well-behaved if absolutely necessary but otherwise grab the marbles! Brass types can be kept in line when Silvers are around to mete out reward and punishment, but the Golds would seem to be natural prey. Yet the rotten-kid

example above showed that a Brass-Gold combo might indeed be viable for both parties! So even unconditional love seems to have a place in natural economy.[10/]

IV. CONCLUDING REMARKS

The central thesis of sociobiology, the continuity of forms and patterns of social organization over all the realms of life, has surely been adequately established -- as far back as Darwin, at least. What is a less familiar and accepted idea is that these patterns of social organization respond to universal economic laws. They are the product of scarcity of resources, of the limited availabilities of materials and energy in the face of the unlimited expansive tendency of life. Depending upon the specifics of the situation, different types and intensities of association will win out in this all-pervasive competition. It is the great law of diminishing returns, in its multifarious forms, which assures that no single tendency will win out everywhere, so various forms of life will maintain sway over different resource bases or niches. Thus in certain circumstances the economics favor sexual reproduction, in others asexual; sometimes parental care, sometimes parental indifference; sometimes we will see packs and herds, sometimes solitary individuals; partitioning of resources sometimes by territory, sometimes by dominance, sometimes by inter-individual or inter-species specialization by area or food type or size or hunting times or seasons, and so on in infinite variety.

That economics can contribute to biology is evident, and indeed we are seeing more and more explicit use of economic models in biological studies of optimal foraging, of investment in offspring, of selfish versus unselfish behavior, etc. But to look at the other side of the picture, can biology contribute to economics? The contributions that biology might make

fall into two categories: the _analogical_, and the _substantive_. Where the two sciences have studied formally similar problems, but results achieved by one remain unknown to the other, analogical borrowing is clearly possible. One example: biologists have a more elaborately structured theory, and one that is far more empirically validated, of the phenomena described under the heading of specialization and the division of labor (see Ghiselin 1974, Ch. 8). But what is more important, substantively sociobiology claims (Wilson 1977) that it will provide an ultimate foundation for the sciences of man -- in the same sense that chemistry is ultimately founded upon atomic physics.

Economists, like other social scientists, have tended to resist the application of biological categories to human beings. Frank Knight (1922), one of the few great modern economists who attempted to say something about the intrinsic nature of man, his wants and goals in relation to his economic behavior, nevertheless declared: "On every count this biological interpretation of human conduct falls down; no hunger and sex theory of human motive will stand examination." To make the statement is to appreciate its absurdity. Hunger and sex, though not _all_-important, are scarcely _un_important motivators of human beings. And we have seen that much subtler phenomena -- love and rage and family feeling and group loyalty -- can all emerge as motivators under the pressures of natural selection.

The potential substantive contributions of sociobiological thinking to economics relate most obviously to the _nature of man_. Contra Frank Knight, man's nature is importantly channeled by his biological heritage. His wants and goals are not "mere" arbitrary tastes, nor are they entirely his to choose. Not only the obvious drives of hunger and sex, but subtler aspects of his wants like the desire for novelty or the urge to nurture his

children, or the impulse of gratitude for benefits received may be deeply ingrained in his evolutionary past. The economist's working hypothesis should be not that preferences are arbitrary, but that beneath the ephemeral surface phenomena men's wants have certain permanent analyzable characteristics, which came about because they are adaptive -- or at least were adaptive in the evolutionary past -- to his form of life. Of course man as a rational or rationalizing animal can, to a degree, oppose these inbuilt drives -- sometimes to his advantage, sometimes not -- but never without difficulty.

Perhaps the grossest flaw in the economist's traditional view of the human being is illustrated by the attention we devote to his man-thing activities as opposed to man-man activities. Our textbooks talk of tastes for cheese or shoes or automobiles, rarely of desires for children or mates or subordinates or fraternal associates. Other social scientists, though without having been able to provide a better analytical model, have justly scorned this view of man as rational unaffiliated thing-consumer, interacting with others only through market exchange. There is however a thrust within modern economics to overcome this limitation and use our analytical tools to study the human interactions involved in phenomena like mate choice and crime and charity and politics. Sociobiology provides a foundation for this widened view of economics.

Interaction via market exchange under the rules of the game here called political economy is only a part, often a small part, of the economic picture. Not only plants and animals, but human beings as well, interact economically to a very large degree under natural economy rather than political economy, without benefit of law or property or contract. Economists have been studying only a chapter of the book of economic life. By following in the direction pointed out by sociobiology, we will be able for the first time to take cognizance of the book as a whole.

FOOTNOTES

*An earlier version of this paper was presented as the Gilbert Memorial Lecture, University of Rochester, March 30, 1978.

[1] Marx himself was an enthusiastic Darwinist; he offered to dedicate _Das Kapital_ to the English biologist. Marx even saw in Darwin's exposition of the competitive struggle for existence a biological "basis in natural science for the class struggle in history" (Himmelfarb, 1959, Ch. 19).

[2] There is one important difference, however. Smith tended to regard the innate qualities of man as serving _the good of the species_. In contrast, the modern biological view emphasizes that characters are selected if they promote the fitness _of their bearers_, even though possibly disfunctional for the species as a whole (Williams 1966, Ghiselin 1974).

[3] Property as a social institution must be distinguished from mere _de facto_ control over resources: e.g., where animals succeed in excluding competitors from territory only by dint of continual patrolling and combat. Whether a given pattern falls into the one category or the other could be tested by observing what happens to an animal who falls ill or otherwise suffers weakened ability to defend his dominion. Does he nevertheless retain control?

[4] The development here is an adaptation of that given in Charnov (1977).

[5] On this, see also Frech (1978).

[6] Since under absolute competition $\sum_{(i)} c_i = \sum_{(j)} b_j$, this condition can be combined with condition (7) in the form:

$$\sum_{(i)} r_{iD} c_i - \bar{r} \sum_{(i)} c_i < \sum_{(j)} r_{jD} b_j - \bar{r} \sum_{(j)} b_j$$

This leads immediately to inequality (9) in the text.

[7] If b and c are constants, the helping rule (7) can be written:

$$c \sum_{(i)} r_{iD} < b \sum_{(j)} r_{jD}$$

or $\qquad c\ Np\ \bar{r}_{iD} < b\ N(1-p)\ \bar{r}_{jD}.$

But the absolute competition condition (8) can also be written:

$$c\ Np = b\ N(1-p)$$

The form of inequality (10) then follows by cancellation in the preceding.

[8]Provided that, as asserted, it is Daddy who "has the last word." Since Kid as merely pragmatic helper acts cooperatively only in the hope of inducing reactive aid from Daddy as hard-core helper, actual cooperation can only ensue where the latter has the final free choice of action (Hirshleifer 1977b).

[9]However, while Daddy can gain from being unselfish, he need not be _so_ unselfish as to end up at point A* in the diagram; any solution along SS northwest of point F would suffice to induce Kid to cooperate. Presumably, natural selection would tend to produce only the degres of unselfishness represented by a tangency position at F (Wintrobe 1978).

[10]The Silver Rule, on the other hand, is clearly more effective in promoting social cooperation over a wider range of situations. The rotten-kid type of cooperation, Fig. 6 shows, can come about only if rather restrictive conditions hold. But the Golden Rule does have one practical advantage over the Silver Rule. An organism can follow the Silver Rule only if it has both reward and punishment acts in its repertory. The Golden Rule requires no such ability to discriminate.

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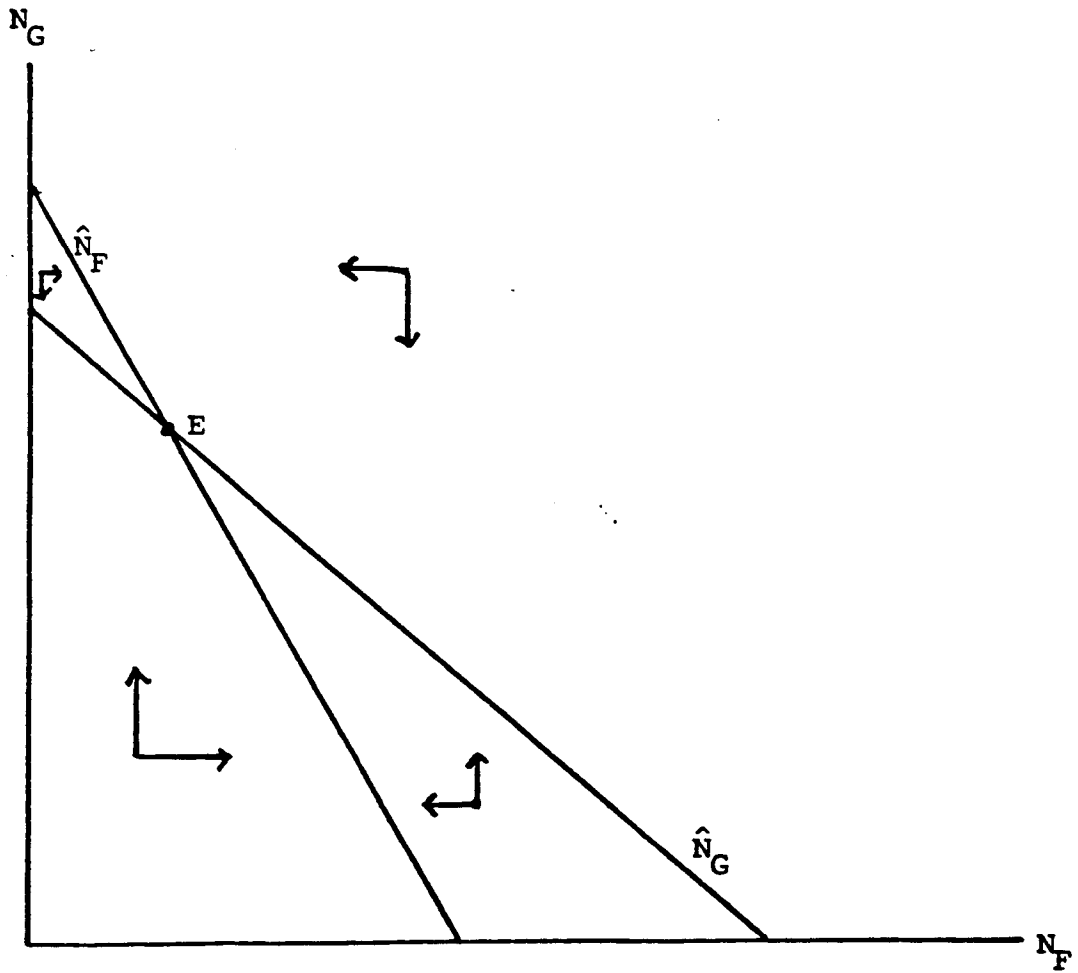
Figure 1

Stable Competitive Equilibrium
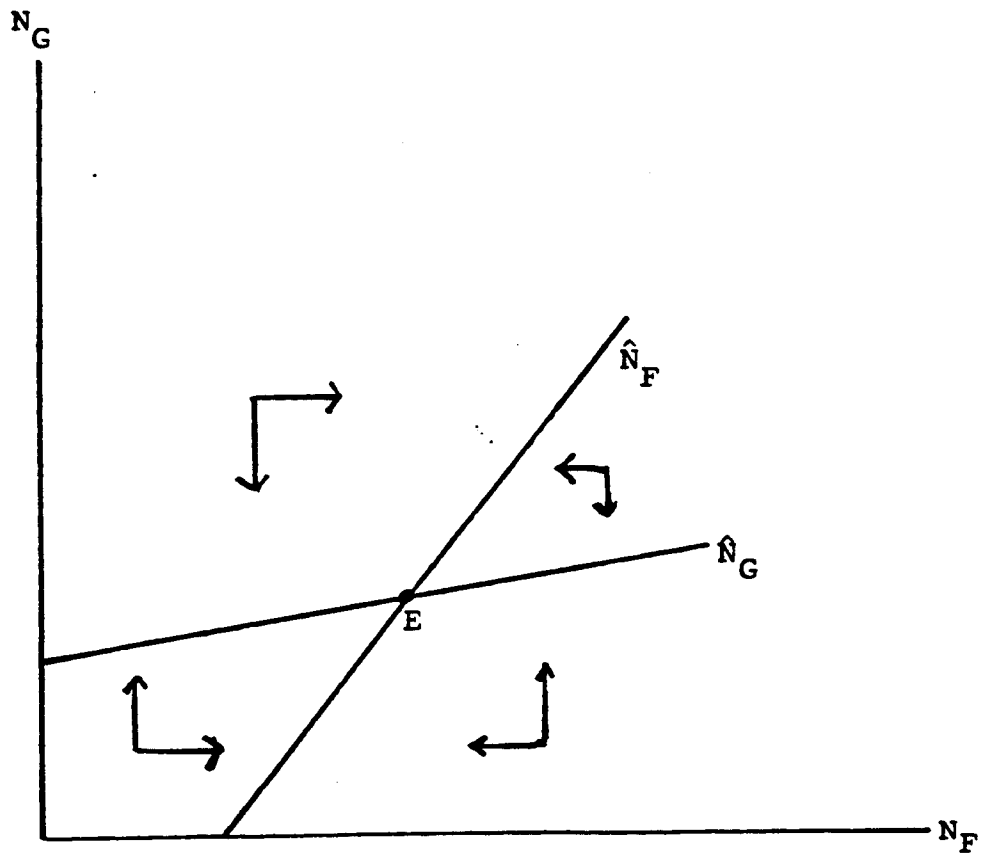
(Coexistence)

Figure 2

Stable Cooperative Equilibrium
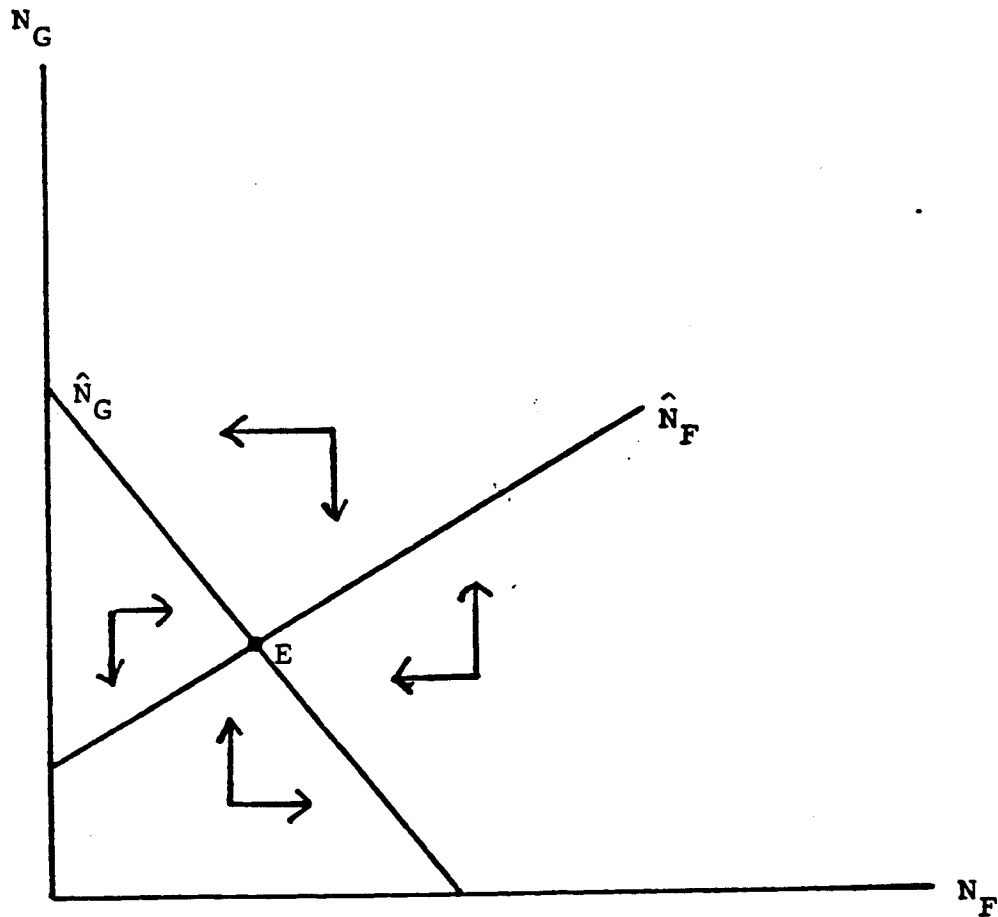
(Coexistence)

Figure 3

Asymmetrical Equilibrium
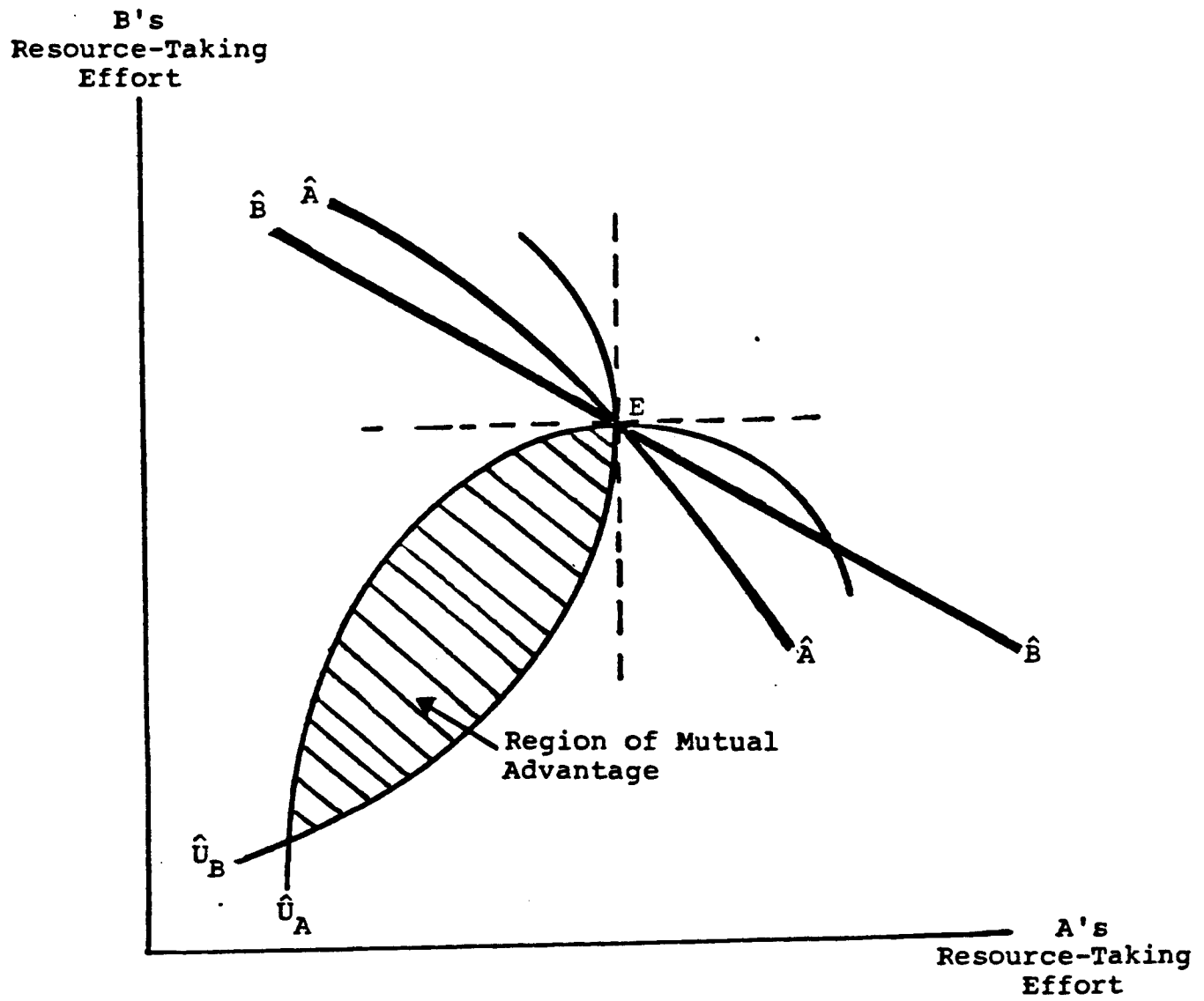
(Coexistence)

Figure 4
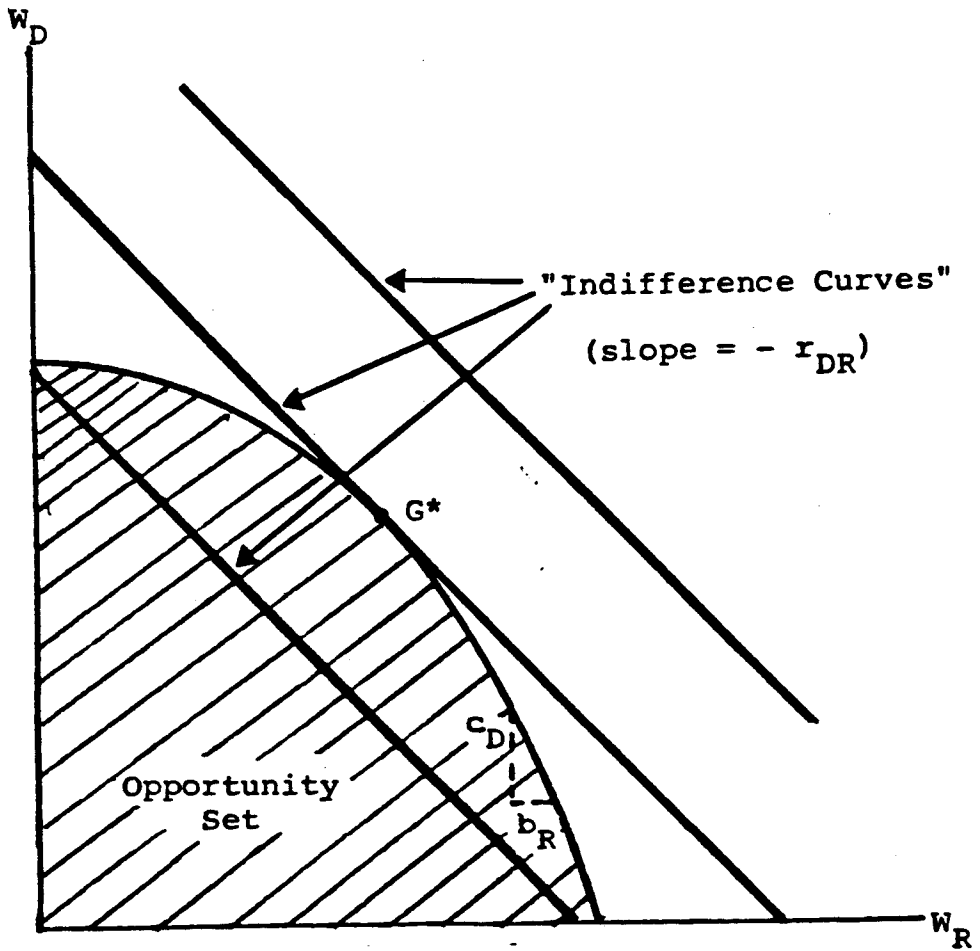
Nash Equilibrium for Preclusive Competition
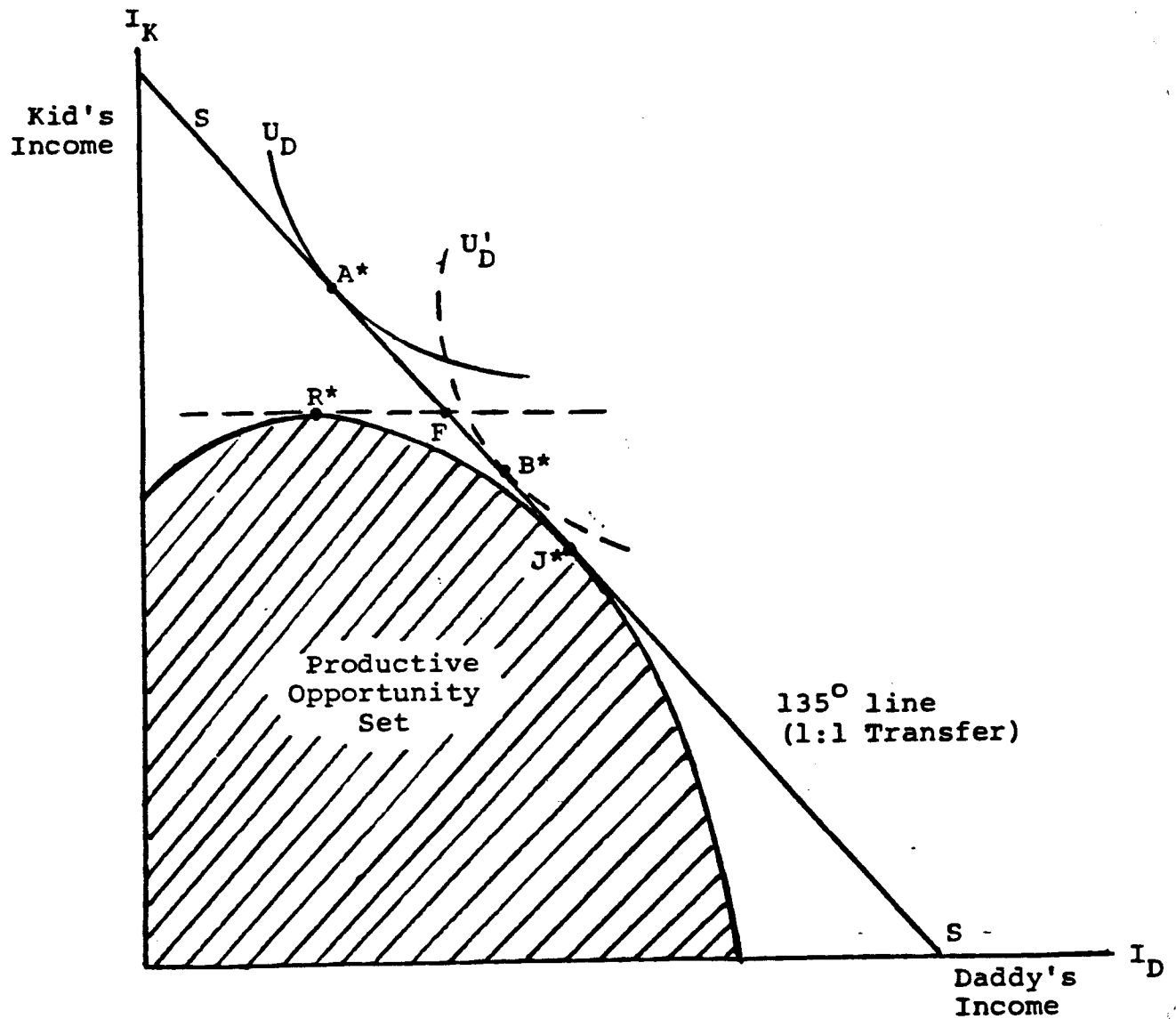
Figure 5

Maximization of "Inclusive Fitness"

Figure 6

Daddy vs. Kid:

Hard-Core vs. Pragmatic Cooperation