Conflictual intra-household allocations*

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We present a model in which there is potentially conflict within households about resource allocations. These conflicts are unlikely to be perfectly bargained out and hence there is some residual inefficiency associated with conflict which ought to increase with household size. We also show that individuals who contribute more than their fair share to household resources are likely to leave larger households and households riven with more conflicts sooner than smaller or more harmonious ones. These implications are testable in principle and we provide some evidence from South Africa which is consistent with the theory.

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> But the son, if he is wicked, will naturally avoid aiding his father, or not be zealous about it; for most people wish to get benefits, but avoid doing them, as a thing unprofitable. (Aristotle, Nicomachean Ethics, Book 8, Section 14.)

The idea that the family is a "haven in a heartless world" (Lasch 1977) is a prominent theme in popular accounts. Whereas the market-place is the domain of selfish individuals, given to taking maximum advantage of each other, the home is the domain of nurturing and care. This view is supported even in the writings of prominent economists. Becker (1991, Chapter 8) has provided arguments why the household would become the predominant site for altruism. Altruism, furthermore, has the effect that households become cooperative. The "Rotten Kid Theorem" implies that even selfish members of a household act as if they were intent on maximising overall household income. The overall distribution of income ends up reflecting the preferences of the altruistic head of the household - the person who transfers resources to all other members.

Nevertheless the distinction between the "private" domain of the household and the "public" domain of politics and the economy is a modern one. Indeed Aristotle founded his analysis of the polity on the household. As for the presumed harmony within households, there is a venerable literature about cheating and exploitation within them. In the bible, for instance there is the story of Jacob and Laban which provides several examples: Laban tricks Jacob into marrying Leah, and Jacob retaliates by engineering it so that he gets the predominant share of the off-spring of Laban's flocks. Laban's sons suspect intra-household theft, so they start plotting to get Jacob. Jacob, of course, was sheltering with Laban in the first place because he had previously cheated his brother Esau out of his rights as a first-born son.

Evidently conflicts within households about resources exist. Indeed Becker acknowledges the existence of allocational conflicts:

> families with both altruistic and selfish members have neither perfect harmony nor pervasive conflict, but harmony in production and conflict over distribution. (1991, p.292)

It seems clear, however, that allocational conflicts may have repercussions for productive effort. Individuals who contribute disproportionately to household income may eventually come to feel resentment at the "predation" that they are subjected to and come to feel that exit from the household is a much more profitable option. Indeed there is ample anecdotal evidence which suggests that conflicts about resources within households may have important consequences for how different members respond to incentives offered in the labour market. Some examples:

Firstly, prime-age males in South African households seem to reduce their work effort when other income, specifically an old-age pension, becomes available to the household (Bertrand, Miller, and Mullainathan 2000). This of course is compatible with the idea of altruism - that the recipient of the income is pleased to purchase additional leisure for other persons in the household. Direct interviews with pensioners seems to contradict this Panglossian reading. Pensioners in many cases complain about the "idle" young men that they have to support.

Secondly, in at least some cases it seems that individuals who acquire a well-paying job leave not only their household of origin, but also the neighbourhood in which they have grown up. The motivation seems to be to avoid "excessive" claims on their new-found fortune by other members of their extended household.

In this paper we will develop a model which views household allocations as occurring along a continuum from perfectly consensual to maximally dysfunctional. We will assume that the "norm" is that there is a moderate degree of conflict and we will seek to derive testable implications from this theory.

The plan of this paper is as follows. In Section 1 we briefly consider some of the literature dealing with intra-household allocations. The model is then presented in section 2. We discuss different ways of arriving at "efficient allocations" in section 3 and conclude that the hypothesis of perfect altruism is not necessary. In section 4 we consider the "benchmark" case - that of a household of completely selfish agents and we show in section 5 how some of the conclusions are softened by allowing for a degree of altruism. In section 6 we extend the model to households of more than two players. In section 7 we consider in more detail under what circumstances an individual might find it in their best interest to leave the household. In section 8 we consider how the model might be tested against empirical evidence and then implement some of these tests. Section 9 concludes.

1 Models of intra-household allocation

A number of very useful reviews of household allocation models have appeared in the last few years (Behrman 1997, Bergstrom 1997, Strauss and Thomas 1995, Weiss 1997). Our intention is not to duplicate these, but to sketch out the main contours of the debate. Traditional models of household allocation have assumed that the household maximises a single utility function. An initial defence of this position was provided by Samuelson (1956), although a more rigorous justification was only provided much later, by Becker (1974, 1991).

Becker's model relies on the actions of an altruistic household head to internalise, as it were, the conflicting preferences of household members. As long as the household head transfers resources to each household member, the household behaves *as though* it maximises a single utility function - that of the altruist. Some of the limits of this defence of the unitary household model were pointed out by Bergstrom (1989). He notes that Becker's proof relies on the existence of "conditional transferable utility", i.e. that conditional on each set of choices the utility possibilities frontier[1] is a simplex. If the head of the household chooses the final allocation on this frontier, then it is in the interests of every member of the household (however rotten) to push the frontier as far out as possible. Bergstrom notes that for a number of interesting applications of the theorem, it is also necessary that the head of the household be able to precommit to a particular allocation strategy, otherwise it may be possible for particular household members ("lazy rotten kids") to restrict the choices available to the head of household.

Clearly the model also relies on the fact that the head of the household distributes resources to every other household member. As Manser and Brown (1980, p.32) note, this in fact presupposes that the resource allocation issue has already been settled, because how else is the head free to distribute resources if he[2] does not have private rights to his money? Total household expenditure therefore reflects the preferences of the head of the household because he has control over a sufficiently large share of resources that he can effectively determine the final allocations. If the altruist does not have large enough resources, however, then

[1]for some representation of preferences

[2]This pronoun is used advisedly. Although Becker's model is theoretically neutral about the gender of the altruist, much of it can be seen as an idealised representation of the nuclear family, with the male head of the household as the breadwinner, who distributes resources to every other member of the family.

the final allocations need not reflect coherent preferences, even in a household of altruists (Stark 1995, Chapter 1).

Because the conditions under which the rotten kid theorem are applicable are restrictive, a number of authors have explored alternatives. In a series of articles Chiappori and his co-authors (Chiappori 1988, Chiappori 1992, Chiappori 1997, Browning and Chiappori 1994, Browning, Bourguignon, Chiappori, and Lechene 1994) have advanced the case that the model of the unitary household is flawed in theory and probably not applicable in practice. Instead, they posit that household allocations are efficient, i.e. they are such that intra-household redistribution cannot lead to a Pareto improvement. While these papers are agnostic about the mechanism through which such allocations are arrived at they show that the final allocations can be viewed as deriving from a "sharing rule" in which total income is allocated in the first phase to different members of the household and these members then in turn purchase consumption items in the second phase.

Manser and Brown (1980, p.32) and McElroy and Horney (1981) introduced the idea that the sharing rule is derived from a bargaining process in which the "threat point" is given by the payoff available to each member when single. Manser and Brown's presentation can best be interpreted as bargaining about the surplus generated within the household *prior* to household formation. The model has, however, been viewed (including by its authors) as bargaining about the sharing rule under the threat of divorce. As such it is held that changes in the "outside options" should lead to noticeable shifts in the allocation patterns of the household. Bergstrom (1996, p.1926) has noted, however, that the threat of divorce is rather extreme for a household bargaining model. The divorce option should be seen as a *constraint* on the feasible allocations, rather than as the threat point payoff, since divorce is irrevocable - it represents the breakdown of bargaining, rather than a position from where to hold out for a better deal. In that sense increases in the value of being divorced may not reflect themselves in increased bargaining power (on this point see also Chiu and Yang (1999)).

Lundberg and Pollak (1993, 1994, 1996) have presented a bargaining model in which the threat point is an "uncooperative household". In their model different household members specialise in the production of different public goods. In an uncooperative household these goods are underprovided. Unlike the models of Chiappori and of the "divorce bargaining" models, this account allows for a final allocation that is not efficient.

These different accounts have different empirical implications. In the unitary model, it should not matter who contributes the income, only total income matters. In the bargaining models, household demand depends also on who contributes. In the "separate spheres" model of Lundberg and Pollak income (such as transfers) that only accrues to married women (i.e. which does not change their outside options) will make a difference to household demand, provided that the household is in an uncooperative state.

None of these models, however, envisage the kinds of conflicts or predatory behaviour outlined at the beginning of this paper. Indeed, given perfect marriage markets and given the ability to make binding premarital state-contingent contracts, predation could never be a problem. The shares of resources belonging to each partner could be specified to any degree of accuracy. In practice, however, property rights within the household can only be imperfectly assigned and imperfectly monitored. This induces efficiency losses, as Udry (1996) has noted in relation to household production in Burkina Faso.

One way of thinking about these cases is to assume that the household has an ideal sharing rule $\mathbf{s}^*$ which prescribes how resources ought to be divided, if property rights could be perfectly assigned, i.e. individual i's share of household income y_i is such that we ought to see $y_i = s_i^* I$ where I is the household's total income. Due to the imperfect nature of property rights within the household, however, individuals can preemptively claim resources that don't really belong to them. The *actual* allocation $\mathbf{s}$ will therefore deviate from the sharing rule $\mathbf{s}^*$. Examples of such preemptive claiming would be the decision to consume all of the ice-cream in the freezer; or the decision by a "lazy rotten kid" that he really couldn't accept any of the jobs currently on offer. We will assume that such claims themselves require some effort, either in the act itself, or in brazening out the consequences. We also assume that this effort could, instead, have been put to more constructive use. Furthermore such behaviour is likely to elicit a response from other members of the household, keen to protect their shares of the resources. The outcome of such conflict is therefore likely to be some dissipation of the household's productive energy.

Unlike most of the other bargaining models, we therefore explicitly envisage outcomes that are non-efficient. The reason for the non-efficiency arises from the fact that if the shares s_i can be manipulated (even though at the expense of total income I), then it is no longer the case that every individual in the household necessarily has an interest in maximising I. In this case Becker's claim about unanimity in production and conflict in distribution no longer holds.

2 The model

We will formalise these intuitions, by adapting the Hirshleifer predation model (Hirshleifer 1988, Hirshleifer 1991, Skaperdas 1992, Wittenberg 2000) to the intra-household allocation problem. The basic idea is that individuals can exert effort at work or on appropriating some of the resources that other members bring into the household. This "predation" will occur around the theoretical set of allocations $\mathbf{s}^*$ which we assume will be derived from a household bargaining process. The outcome of these reallocations determines the utilities that individuals derive from membership of the household. If these utilities are too low, individuals may leave.

There are therefore three distinct "phases" of the model.

- Phase one is the negotiation about the constitution of power within the household. This is the kind of bargaining that Manser and Brown or McElroy and Horney had in mind. In our account these negotiations are about $\mathbf{s}^*$, although we only require that they determine a set of weights ω_i which characterise the influence that different individuals have on the spending decisions. We assume that the bargaining phase occurs on the assumption that these agreements will "stick", i.e. that there will be no predation within the household.

- Phase two is the day-to-day reality of life within the household, given the membership of the household, the weights ω_i derived in the previous phase and given the fact that property rights are only imperfectly defendable. This is the phase in which predation may, or may not, occur. The interactions result in the actual allocations $\mathbf{s}$.

- Phase three is where individuals compare the utilities that they have gained within the household s_i to the utilities that they could gain by leaving - and leave if they are excessively preyed upon.

Clearly very smart individuals would see that these phases are connected - that they are all part of a larger interaction. So smart predators in phase two might foresee that excessive predation would lead to the dissolution of a profitable arrangement and might therefore restrain themselves. This is certainly a possibility, although the ability of predators to coordinate such restraint is likely to be reduced the more members there are in the household. An even smarter "prey" would foresee at stage one that predation might be a problem and hence may not enter into households in which they might end up being exploited[3]. From our point of view it doesn't matter much whether the households which "dissolve" in phase 3 are thought of as never having been formed to start off with.

A perhaps more interesting question is whether individuals who would remain within the household might be able to push for a greater weight in the first phase on the assumption that they would be preyed upon in the second. We fail to see how such a negotiation would get off the ground. It is the problem of assigning and monitoring property rights that enables the predation to occur in the first place. More detailed bargaining is unlikely to get around this problem. Furthermore if the individual finds it advantageous to stay inside the household in phase three, despite being somewhat preyed upon, it is unclear where the additional bargaining power for phase one would come from.

The core of the model is the second phase - the predation phase. We will therefore defer an explicit discussion of the bargaining process and the possibilities of household dissolution to section 7 and turn to a discussion of the intra-household interactions, assuming a given membership and distribution of power.

There are four elements of this part of the model.

[3]This clearly might lead to a theory of assortative mating.

1. The household income function

   We assume that total household income is a function of the exertions of all members of the household. Individuals can earn a wage w_i per unit of effort expended at work so that

$$I = \sum_i w_i e_{iw} \tag{1}$$

2. The allocation of effort function

   Each individual has a total endowment of effort of one and has to decide how to allocate this between effort at work and appropriating resources at home.

$$e_{ic} + e_{iw} = 1 \tag{2}$$

   where e_{iw} is the effort expended at work and e_{ic} is the effort expended on claiming within the household.

3. A resource division function

   We assume that household resources are allocated between members according to the *actual* resource appropriation function ("sharing rule")

$$s_i = \frac{\omega_i e_{ic}^m}{\sum_j \omega_j e_{jc}^m} \tag{3}$$

   where s_i is i's share of resources, $e_{ic} \geq 0$ is the effort put into appropriating resources by individual i, $\omega_i \geq 0$ is the "weight" of individual i within the household and at least one of these weights is assumed to be strictly positive. m is a decisiveness parameter. This particular functional form is standard in the predation literature (see Skaperdas

(1996) for a theoretical treatment). It has the major advantage over the "difference" form (Hirshleifer 1989) that it is invariant to scale.

The decisiveness parameter m will turn out to be particularly important in our analysis. Note that if $m = 0$ we have $s_i = \frac{\omega_i}{\sum \omega_j}$, i.e. the allocations are set irrespective of any individual's lobbying effort. This provides an intuitively appealing way of characterising m: it is the degree to which allocation decisions are "up for grabs" within the household. If $m = 0$ then there is no dispute about how items ought to be allocated. The larger m is, the more sensitive household allocations become to individual acts of appropriation within the household.

This, in fact, provides the link to our theoretical entitlements, which we define as

$$s_i^* = \frac{\omega_i}{\sum \omega_j} \tag{4}$$

so that

$$s_i = \frac{\omega_i}{\sum \omega_j} \text{ if } e_{ic} = 0 \text{ for all } i \tag{5}$$

Another way of thinking about this is in terms of property rights to the joint household resources. If $m = 0$, then the sharing rule is completely well-defined and everyone knows exactly how much accrues to everyone else. The larger m is, the more indeterminate the rights are and the more resources become subject to preemptive claiming.

Since the weights ω_i are related to the sharing rule when outcomes are certain, we will think of these as being determined *inter alia* by the individual's threat point payoffs, in particular their earnings potential. Consequently they will be given by a function

$$\omega_i = f\left(w_1, \ldots w_n, \mathbf{x}_1, \ldots \mathbf{x}_n\right) \tag{6}$$

where w_i is individual i's wage rate (as above) and $\mathbf{x}_i$ is a vector of individual characteristics (such as strength, age, gender). Note that in general the weights will depend on the characteristics of *all* household members. We will provide a particular account of how these weights might be derived in section 7 below.

4. The utility function

We assume that individuals have preferences given by the utility function

$$U_i = y_i + \sum_{j \neq i} \alpha_{ij} y_j + V_{hi} \tag{7}$$

where the y_j are individual resource shares, the α_{ij} coefficients represent the degree of altruism felt by i to j. (which for most purposes will be assumed to be such that $\alpha_{ij} < 1$) and V_{hi} is the value to individual i of being in the *given* household h.

Note firstly that this utility function does not include the other individuals' *utilities* as argument, but their resource shares. This might be thought preferable for two reasons. Firstly agents may have a much better insight into some constituents that go into an individual's utility function rather than all of them, or indeed, the way in which they interact to produce utility. Secondly it avoids some of the particular types of conflicts considered by Stark (1995, Chapter 1). If these reasons are not persuasive, then we might consider the function to be a "reduced form" utility function, of the sort considered by Becker (1974, footnote 30, pp.1080-1081).

Secondly, the term V_{hi} is not modelled - we might think of it as a pure externality (e.g. companionship) or economies of scale achievable within the household.

Thirdly, this formulation assumes that we are in the domain of “transferable utility”, i.e. we have essentially only one commodity (“wealth”) in our model. This implies that e_{iw} should really be treated as “full work effort”, i.e. prior to any leisure that is “purchased” with the individual allocation y_i. Treating the leisure choice in this way is more easily defended if every member of the household supplies at least some labour to the market place, since then the valuation of leisure will be at the prevailing wage rate (Bergstrom 1989, Bergstrom 1997).

We leave the issue of how to extend the model to cases of non-transferable utility to future work.

Substituting $y_i = s_i I$ and $e_{ic} = 1 - e_{iw}$ into the utility function, we get

$$U_i = \frac{\omega_i \left(1 - e_{iw}\right)^m + \sum_{j \neq i} \alpha_{ij} \omega_j \left(1 - e_{jw}\right)^m}{\sum_j \omega_j \left(1 - e_{jw}\right)^m} \sum_j w_j e_{jw} + V_{hi} \tag{8}$$

We will in general now drop the subscript w on the level of effort, where this is unlikely to cause confusion, i.e. we now let e_i be the effort expended by individual i at work.

We make the Cournot assumption that players move simultaneously and take each other's responses as given.

3 The “Rotten Dad” theorem and other household fantasies

In order to get an initial feel for the nature of this model, we will consider situations in which this model corresponds to that of the unitary model of household decision-making. Consider first the case where only one individual in the household has a non-zero weight. Let the first individual (the head of the household) have sole say. In this case it is obvious that this individual ends up with all resources. The preferences of the household are therefore identical to the preferences of the head of the household.

We can, however, get practically indistinguishable results even if other individuals in the household have positive weights, provided that all individuals *except* the household head are perfect altruists. If we assume that individual i's altruism coefficients are $\alpha_{ij} = 1$ for all j then

$$U_i = w_i e_i + \sum_{j \neq i} w_j e_j + V_{hi}$$

which is maximised by setting $e_i = 1$.

If this is true for all $i > 1$, then

$$s_1 = \frac{\omega_1 (1 - e_1)^m}{\omega_1 (1 - e_1)^m}$$

This expression is equal to one if $e_1 < 1$ and is equal to $\frac{\omega_1}{\sum \omega_j}$ if $e_1 = 1$. If we let $\varepsilon > 0$ be the smallest positive claiming effort feasible, then setting $e_1 = 1 - \varepsilon$ will give the household head a utility of $w_1 (1 - \varepsilon) + \sum_{i > 2} w_i + V_{h1}$ which is the total of all resources available and certainly larger than $\frac{\omega_1}{\sum \omega_j} \sum w_i + V_{h1}$ which is the utility that he would obtain if he also abstained from claiming. So faced by a household of complete altruists the person who is *least* altruistic will perform the role of the dictator, the "rotten dad" of our theorem. This, of course, is a complete reversal of the altruistic head of Becker's "rotten kid" theorem.

The complete centralisation of resources under a less-than-altruistic head of household, can be usefully contrasted with the situation of a household of complete altruists. In this case every individual will have a utility function given by

$$U_i = w_i e_i + \sum_{j \neq i} w_j e_j + V_{hi}$$

which is again maximised by setting $e_i = 1$ for every i. This leads to the allocation

$$y_i = \frac{\omega_i}{\sum \omega_j} \sum_j w_j \tag{9}$$

It is easy to verify that such an allocation must also be an efficient allocation. Each household member works to maximum capacity and redistributions can be achieved only by making some individual worse off. In this case there is no assumption that the household has a common preference structure, because with different sharing rules (implicit in the weights) there would be different allocations and hence different expenditure patterns.

There is yet another route to efficient allocations. If $m = 0$ then equation 8 simplifies to

$$U_i = \frac{\omega_i + \sum_{j \neq i} \alpha_{ij}\omega_j}{\sum_j \omega_j} \sum_j w_j e_j + V_{hi}$$

This is maximised with respect to e_i by setting $e_i = 1$. Since this is true for every household member we get in the equilibrium the same allocation as in equation 9. In this case efficiency does not arise through the fact that household members completely internalise all conflicts through their preferences. Instead, all potential areas of disagreement have been "bargained out", so that there are no more gains to be made from claiming behaviour. The weights ω_i express the outcome of this bargaining process (which may, very well, be a Nash bargaining solution).

Since in general we are somewhat sceptical of the idea that many households contain only perfect altruists, we will assume that efficient allocations are more likely to be arrived at *via* the second route. We do not explicitly model the process through which the parameter m is driven down to zero. It would stand to reason, however, that the degree of uncertainty over allocations would diminish over time, provided that household income and composition was fairly stable. Since it is unlikely that incomes and composition are ever completely stable, we would expect in most situations to see some unresolved allocation conflicts, i.e. $m > 0$. In the remainder of this paper we will consider only situations with $m > 0$.

4 Allocations with completely selfish agents

We will consider for the moment two person households only. We will think of these as father and *adult* son, in order to avoid some of the complications arising from the existence of gender discrimination, the operations of the "marriage market" or from the need to consider educational investment decisions. If neither player is altruistic at all, i.e. $\alpha_{12} = \alpha_{21} = 0$, then the utility functions can be represented as

$$\begin{aligned} U_1 &= \frac{\omega_1 (1-e_1)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} (w_1 e_1 + w_2 e_2) + V_{h1} \\ U_2 &= \frac{\omega_2 (1-e_2)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} (w_1 e_1 + w_2 e_2) + V_{h2} \end{aligned}$$

This is a variant of the appropriation model considered by Wittenberg (2000). We can get an insight into the behaviour of the model for fixed weights ω_i by graphing the reaction functions as in Figure 1. It is evident that in each case the reaction curves start at a relatively high level. Indeed we can show that $e_i \geq \frac{1}{m+1}$ if $e_{-i} = 0$, where e_{-i} is short-hand for the effort level chosen by player i's opponent. The reason for such a high level of effort is that faced by a free-rider, one is compelled to produce if one wants a positive payoff. This compulsion gradually disappears as e_{-i} increases. There are two kinds of responses to this increased opportunity:

1. The first response is visible in the reaction curves of player 2, who in our diagram immediately increases his levels of claiming. This is due to two factors. At higher levels of e_1 Player 1 is earning positive amounts which adds to household income. This

increases the incentive for Player 2 to claim. On the other hand, as e_1 increases, Player 1's level of claiming activity goes down. This makes Player 2's claims relatively much more effective. The combination of increased incentive with increased effectiveness leads to the decrease in the reaction functions observed in the diagram. In all cases Player 2 again starts increasing his level of productive effort at high enough levels of e_1. Essentially at these levels, Player 1 is doing such little claiming that Player 2 is able to claim almost the entire share of income. In these situations it is in his interest to increase the total income.

2. The second response is evident in the reaction curve of player 1 when $w_1 = 10$. In this case player 1 just increases the level of his own effort, as the intensity of claims by player 2 diminish. The reason why player 1 is not tempted to increase his claiming activities, is that the opportunity costs are too high - given that he earns ten times what player 2 does, he has a much greater incentive to spend his time productively.

We also note that if the imbalance in earnings potential is too great, then one of the players has the incentive of becoming completely parasitic. In our case this happens to player 2 when player 1 has a relative wage ten times larger. It is no accident that in this case player 1's reaction curve is increasing in effort.

Indeed this is our first result:

Proposition 1 *There are three types of reaction curves:*

1. *Type one increases monotonically over the entire range* $[0, 1]$

2. *Type two is initially monotonically decreasing and then monotonically increasing with a turning point inside the interval* $[0, 1)$

3. *Type three has two kinks: it first decreases on an interval $[0,\delta_1]$ it is then zero on an interval $[\delta_1,\delta_2]$ and it then increases again on $[\delta_2,1)$*

Furthermore if one player has a type one reaction curve then his opponent has a type three reaction curve, and if a player has a type two reaction curve, then the opponent will also have a type two reaction curve.

There are therefore two types of Cournot equilibria: one in which both players are working and one in which only one player works and the other is completely parasitic. We can derive the properties of the equilibria. They are collected in the following theorem:

Theorem 2 *There are two types of Cournot equilibria: interior equilibria and corner equilibria. At any interior equilibrium we have*

$$\frac{s_1}{s_2} = \left(\frac{\omega_1}{\omega_2}\right)^{\frac{1}{m+1}}\left(\frac{w_2}{w_1}\right)^{\frac{m}{m+1}} \tag{10}$$

$$I = \frac{w_1+w_2}{m+1} \tag{11}$$

At a corner equilibrium where player 2 is completely parasitic we have

$$\frac{s_1}{s_2} = (1-e_1)^m\frac{\omega_1}{\omega_2} \tag{12}$$

$$I = e_1 w_1 \tag{13}$$

where e_1 is the solution to

$$(1-e_1)^{m+1}\frac{\omega_1}{\omega_2} = e_1(m+1)-1 \tag{14}$$

We will obtain a corner equilibrium with player 2 completely parasitic if, and only if

$$m\left[\left(\frac{w_1}{w_2}\right)^{\frac{1}{m+1}} - \left(\frac{\omega_2}{\omega_1}\right)^{\frac{1}{m+1}}\right] \geq \left(\frac{w_2}{w_1}\right)^{\frac{m}{m+1}} + \left(\frac{\omega_2}{\omega_1}\right)^{\frac{1}{m+1}} \tag{15}$$

Several conclusions follow from these results. Consider the interior equilibria first. The equation governing the equilibrium allocations (equation 10) indicates that an individual's share will increase with that individual's weight in the household sharing rule, but decrease with that individual's earning potential. The latter implication may seem somewhat puzzling at first, but it is actually what one would expect to see: if the household default entitlements stay constant when player 1's wage rate increases, then the incentives shift towards greater claiming by player 2. Furthermore the incentives for player 1 shift towards greater production. Since player 1 is around less to make his entitlements count, this tilts the actual allocations from the baseline more towards player 2. Increased earnings by player 1, without an attendant renegotiation of the household weights, would therefore leave player 1 with a smaller share (though of an admittedly larger total income).

Clearly, however, player 1's outside options would have improved, so an increase in w_1 would tend to increase player 1's weight. Below (section 7) we show that in some circumstances, ω_1 is almost proportional to w_1 so that we would find that player 1's shares will increase with his own wage rate.

Equation 11 is also highly revealing. It can be rewritten to yield

$$m = \frac{\max I - I}{I} \tag{16}$$

where we have used the fact that $w_1 + w_2$ is the maximum income that the household can attain, if every member works to full capacity. m is therefore the proportionate improvement possible in household income, if all inefficiencies due to household conflict were eliminated.

Of course the inefficiency may reach such a level that one player ceases to work altogether. In the case of corner equilibria, we can, however, show that

$$m \geq \frac{\max I - I}{I}$$

Paradoxically the percentage improvements possible at the corner will always be somewhat smaller than in the interior. The reason for this is evident when we consider the nature of these corner equilibria. Inequality 15 indicates that it is *impossible* to get a corner (with player 2 parasitic) if

$$\frac{w_1}{w_2} < \frac{\omega_2}{\omega_1}$$

A corner equilibrium is more likely if w_1 is much larger than w_2 and if ω_1 is large relative to ω_2. Considering the entire inequality, it is clear that one requires rather large excess of w_1 over w_2 in order to obtain a corner equilibrium. This, however, means that getting player 2 to produce will actually not increase aggregate household income by all that much. Furthermore inequality 15 also indicates that complete parasitism is more likely if ω_1 is large relative to ω_2. In this case player 1 is fairly effective in keeping the predations of player 2 in check.

In our model, the complete parasite is never a potentially highly productive individual with a reasonable weight within the household. It tends to be someone with low earnings potential.

We have seen how the parameters affect the equilibrium shares. It is less evident how the equilibrium levels of effort change. The main results are given in the following theorem:

Theorem 3 *Let* $(\overline{e}_1, \overline{e}_2)$ *be any Cournot equilibrium, then*

$$\frac{\partial \overline{e}_1}{\partial \left(\frac{w_1}{w_2}\right)} \geq 0, \frac{\partial \overline{e}_2}{\partial \left(\frac{w_1}{w_2}\right)} \leq 0$$

$$\frac{\partial \overline{e}_1}{\partial \left(\frac{\omega_1}{\omega_2}\right)} \geq 0, \frac{\partial \overline{e}_2}{\partial \left(\frac{\omega_1}{\omega_2}\right)} \leq 0$$

$$\frac{\partial \overline{e}_1}{\partial m} \lesseqqgtr 0 \quad as \ \frac{s_1}{s_2} \lesseqqgtr \zeta\left(\frac{\omega_1}{\omega_2}\right), \frac{\partial \overline{e}_2}{\partial m} \lesseqqgtr 0 \quad as \ \frac{s_2}{s_1} \lesseqqgtr \zeta\left(\frac{\omega_1}{\omega_2}\right)$$

where $\zeta(f)$ *is the solution to the equation* $1+x-x\ln x+x\ln f=0$*. We note that* $\zeta(1) \simeq 3.591$ *and that* $\zeta'(f) > 0$*.*

These results, with the exception perhaps of the last one, are not that surprising. The first indicates that work effort increases if one's earnings potential increases relative to the other player. The second indicates that work effort will go up if one's share according to the default sharing rule goes up.

The final result is more ambivalent. It indicates that the impact of a change in property rights within the household will depend on how unequal the actual shares are. If the actual shares are fairly equal then the ratio of these shares will almost definitely be below the critical value ζ, so that both players will spend more time claiming. If, however, power is so lopsided within the house that one player already takes a large portion of total household income then that player would benefit by the increased ease of appropriation - so much so that that individual would now find it in his interest to spend more effort on increasing the size of the overall pie.

5 Partial altruists and cooperation

We will now consider what happens if the agents care to some extent about the other player's resource shares. In Figure 2 we have graphed two sets of reaction curves for each player, one with altruism set at zero and one with α at 0.5. Note that each player's reaction function depends only on the level of effort of the other player, not on the other player's altruism. This means that Figure 2 depicts four potential equilibria. Equilibrium A occurs when both players are completely selfish, B and C occur when one player is completely selfish and the other player is altruistic and D occurs when both are somewhat altruistic.

Some interesting conclusions are immediately evident. Firstly, it is clear that altruism has the effect of shifting the reaction functions up. It is obvious that this must be the case, since with altruism, the player internalises some of the externalities that the additional effort creates for the other player.

The effect of this on a completely selfish player is also unambiguous. Since the altruist will increase his work effort and reduce his claiming effort, this cedes a larger portion of the pie to the selfish player. This player therefore now has an added incentive to increase the size of the pie and will therefore increase his work effort. In the diagram this is evident in the move from A to B or A to C.

If the player is already somewhat altruistic, however, then a shift by the other player towards altruism may paradoxically reduce effort somewhat, as we see in the shift from C to D. The reason for this is that some of the compulsion that players feel when facing a complete egoist is dissipated. This allows them to increase their own claiming. Nevertheless the overall picture is clear. Altruism has the effect of increasing work effort and reducing claiming within the household.

Even in the absence of altruism, more cooperative outcomes ought to be possible. The Folk Theorem would suggest that if members of the household interact over a sufficiently long horizon, then even if the agents are completely selfish there will be equilibria of the repeated game that will be Pareto superior to the simple repetition of the one-period Cournot equilibrium. A consideration of this possibility would take us beyond the scope of this paper.

6 Multiple players

The outcomes of the strategic interactions with more than two household members quickly become intractable. If none of the players are altruistic, we can derive expressions for the interior Cournot equilibria. They are contained in the following theorem:

Theorem 4 *At any interior Cournot equilibrium, the individual shares s_i are given by the solution to the set of equations*

$$\frac{s_j^{\frac{m+1}{m}} + s_j^{\frac{1}{m}} \sum_{k \neq i,j} s_k}{s_i^{\frac{m+1}{m}} + s_i^{\frac{1}{m}} \sum_{k \neq i,j} s_k} = \left(\frac{\omega_j}{\omega_i}\right)^{\frac{1}{m}} \frac{w_i}{w_j}, \textit{ for all } i, j \in \{1, \ldots, n\} \tag{17}$$

The income is given by

$$I = \frac{w_1 + w_2 + \cdots + w_n}{m\,(n-1) + 1} \tag{18}$$

Equation 17 has the same implication as in the two-player case: shares increase with one's weight ω_i and decrease with one's earning potential w_i.

The expression for the equilibrium income is, perhaps, more revealing. Except for the term $n - 1$ in the denominator, this is quite similar to equation 11. It is evident that the dissipation of income due to conflict is a bigger problem in large households than in smaller ones. Members of these household have to spend more energy on ensuring that they get their fair share than the members of smaller households have to. To keep such households functional would require either much tighter discipline (lower m) or a greater degree of altruism. The loss of efficiency due to conflict may, of course, be off-set to some extent by economies of scale.

One way of quantifying the impact of conflict is, as before, to look at the improvement possible on existing income, if everyone were to contribute to maximum capacity. The counterpart to equation 16 is now given by

$$m\,(n-1) = \frac{\max I - I}{I} \tag{19}$$

With the same m, larger households could make bigger improvements in efficiency than smaller ones. And the extent of the improvement goes up proportionately to $n-1$. This equation incidentally also provides the correct answer for one person households: they do not sustain efficiency losses due to intra-household conflicts.

All this of course assumes that we are at an interior equilibrium. With more household members, however, it is also more likely that at least some of them will be completely parasitic. The conditions for a corner equilibrium are less tractable, since we need to consider the responses of many more individuals.

7 Exit options

Thus far we have referred loosely to the idea that people might leave the household. In this section we will explore in some more detail how we might model this. We will assume for the sake of tractability that we have a household of non-altruistic individuals.

We assume that when the household is formed, these players engage in a bargaining game about the division of the surplus. We assume that when this bargaining occurs, players are under the impression that property rights to goods within the household can be perfectly assigned, so that there is no issue about effort at work, or about claiming at home. In this case the respective payoffs would be given by

$$U_i = s_i^* \left(w_1 + w_2 + \cdots + w_n\right) + V_{hi}$$

where s_i^* is the i'th person's negotiated share of total household income. We assume that if a person i leaves the household, he will get his wage w_i. The Nash bargaining solution will therefore be given by maximising

$$S = \prod_{i=1}^{n} \left(s_i^* W + V_{hi} - w_i\right)^{\beta_i}$$

with respect to the entitlements s_i^*, subject to $\sum s_i^* = 1$ and $\sum \beta_i = 1$, where $W = w_1 + w_2 + \cdots + w_n$. β_i represents the bargaining strength of player i. The solution to this problem is given by

$$s_i^* = \frac{w_i - V_{h_i} + \beta_i \sum_j V_{hj}}{W}$$

This solution fits the form of the weighting function given in equation 6 with weights

$$\omega_i = w_i - V_{h_i} + \beta_i \sum_j V_{hj} \tag{20}$$

If everyone had equal bargaining strength, i.e. $\beta_i = \frac{1}{n}$ and everyone valued membership in the household equally, then this would simply equate the weight to the wage rate. Note also that individual i's weight goes down with the importance of the household to him, but goes up with the value attached to household membership by others. Individuals that value household membership very highly will end up yielding more of their wage to other household members. The Nash solution yields an *anticipated* utility of

$$U_i = w_i + \beta_i \sum_j V_{hj}$$

or an anticipated surplus due to household membership of $\beta_i \sum_j V_{hj}$.

In *practice*, of course, property rights to household goods are only imperfectly assigned and hence the realised shares s_i are not equal to the entitlements s_i^*, but are as given in Theorem 2 or Theorem 4. We can now consider whether the realised utilities exceed the "reservation utility" w_i or not. Individual i will exit from the household if

$$s_i I + V_{hi} < w_i \tag{21}$$

It is evident that exit will never occur if $V_{hi} > w_i$. The interesting cases are therefore all given by situations where $w_i > V_{hi}$.

A useful baseline is given by the perfectly symmetrical situation, where all household members have identical characteristics. In this case $s_i = \frac{1}{n}$ for all i. Consequently the realised utility will be

$$U_i = \frac{w}{m\,(n-1)+1} + V_h$$

where w is the common wage rate and V_h the common value of household membership. Exit will be the less desirable option if

$$\frac{w}{m\,(n-1)+1} + V_h \geq w$$

(assuming that individuals that are indifferent will stay within the household). We can rearrange this to get the condition

$$n \leq 1 + \frac{V_h}{m\,(w - V_h)} \tag{22}$$

from which we can calculate the maximal household size: it is the largest n for which this inequality still holds (even if V_h is itself a function of n). This suggests that conflict (as proxied by m) is a limiting factor on household size, as is the ratio of w to V_h. So households that generate higher membership benefits at the prevailing wage rate can "afford" more conflict before they start losing members.

One immediate implication of this equation is that wealthier households should be smaller, unless the benefits of household membership also increase with wealth. The reason for smaller households in this case is a straight opportunity cost one: the inefficiencies due to conflict scale up with w, while the benefits associated with household membership (as we have modelled it here) do not. Hence exit should happen quicker from households with higher earnings potential.

8 Empirical evidence

8.1 Implications of the theory

In order to develop the implications of the theory, it is useful to combine equation 20 with equation 17. It follows that

$$s_i = s_i\left(w_1, \ldots w_n, V_{h1}, \ldots, V_{hn}, \beta_1, \ldots . \beta_n\right) \tag{23a}$$

$$\frac{\partial s_i}{\partial w_i} \geq 0, \text{ and } \frac{\partial s_i}{\partial w_j} \leq 0 \text{ if } m < 1 \text{ and } j \neq i \tag{23b}$$

$$\frac{\partial s_i}{\partial V_{hi}} \leq 0, \text{ and } \frac{\partial s_i}{\partial V_{hj}} \geq 0 \text{ for } j \neq i \tag{23c}$$

$$\frac{\partial s_i}{\partial \beta_i} \geq 0, \text{ and } \frac{\partial s_i}{\partial \beta_j} \leq 0 \text{ for } j \neq i \tag{23d}$$

Furthermore our discussion of altruism would suggest that $\frac{\partial s_i}{\partial \alpha_{ij}} \leq 0$ and $\frac{\partial s_i}{\partial \alpha_{ji}} \geq 0$. These implications are not in principle different from those obtainable from any of the other bargaining models. They do however, unlike the unitary model, suggest that it matters who the income is contributed by.

If we combine condition 23a with equation 18 we get some new implications. In particular we find that

$$y_i = y_i\left(w_1, \ldots w_n, V_{h1}, \ldots, V_{hn}, \beta_1, \ldots \beta_n, m, n\right) \tag{24a}$$

$$\frac{\partial y_i}{\partial m} < 0 \tag{24b}$$

$$\frac{\partial y_i}{\partial n} < 0 \tag{24c}$$

so that households in which property rights are less well defined should show a larger cost of predation and the household size should enter explicitly as an argument into the level of consumption of its members[4]. The converse of the last result is, of course, that members of larger households would be expected to spend less time productively and more time squabbling or preemptively claiming resources from each other. This will be the particular implication that we will seek to test.

One problem in implementing this test, however, is that we do not observe full work effort, we only observe work effort minus leisure, i.e. we observe

$$h_i = e_i - l_i$$

so that

$$\frac{\partial h_i}{\partial n} = \frac{\partial e_i}{\partial n} - \frac{\partial l_i}{\partial y_i}\frac{\partial y_i}{\partial n}$$

[4]This result would be attenuated somewhat if the V_{hi} terms were thought of as directly material benefits (e.g. economies of scale), in which case $y_i + V_{hi}$ would be the appropriate measure of consumption.

and it might be possible that the income effect on leisure demand of increasing household size might more than off-set the reduction of direct work effort. We can get a sense of how large this adjustment would have to be, by writing

$$y_i = \phi_i w_i e_i$$

so that ϕ captures the extent to which the individual is either preyed upon ($\phi < 1$) or preys on other household members ($\phi > 1$). We can then rewrite the expression above as

$$\frac{\partial h_i}{\partial n} = \frac{\partial e_i}{\partial n}\left[1 - \frac{\phi l_i}{e_i}\eta\right]$$

where η is the income elasticity of leisure demand and where we have assumed to a first approximation that $\frac{\partial \phi}{\partial n} = 0$. Increasing the household size should therefore reduce the observed hours worked provided that

$$\eta < \frac{e_i}{\phi l_i}$$

We need to add two important qualifications to this result. Firstly, in the data sets available to us we do not have a proper measure of home production. If we let

$$h_i = h_{wi} + h_{pi}$$

where h_w and h_p are hours devoted to work in the labour market and in home production respectively, then our empirical estimation will involve the equation

$$h_{wi} = f\left(\mathbf{x}_i, n_i\right) - h_{pi} + u_i$$

where $\mathbf{x}_i$ is a vector of personal and household characteristics and h_{pi} is only imperfectly observed.

Secondly, we have assumed that the direct effect of household size on leisure demand is zero, i.e.

$$\frac{\partial l_i}{\partial n} = 0$$

If this is not true, then the reduction in work effort that we observe in the data may simply be due to a greater taste for leisure in larger households (with the same level of "full work effort"). Our tests will not be able to distinguish between these hypotheses.

8.2 Specification and data issues

In our empirical work, we will make use of the data from the South African Project for Living Standards and Development. This data set contains information on about 8,800 households and about 44,000 individuals, collected in 1993. The survey was supervised by a team from the South African Labour and Development Research Unit, assisted by the World Bank. It collected a combination of socio-economic and anthropometric information, along the lines of the Living Standard Measurement Surveys of the World Bank.

Previous work using this data set has already suggested that some aspects of the unitary household model break down. Duflo (2000), for instance, has shown that receipt of a pension by a grandmother improves the nutritional status of the granddaughters, while pension receipts by grandfathers do not seem to have a similar impact. Bertrand *et al* (2000), also working with pension receipts, show that prime-age men in three-generational households seem to reduce their work effort if there is someone receiving a pension in the household. Women do not seem to reduce their work effort in a similar way. Indeed on finer examination, the authors suggest that it is the oldest prime age male in the household who seems to reap disproportionately much of the benefit. This suggests not only that the unitary model of the household is flawed, but that bargaining models may also be in trouble. After all most bargaining models assume that bargaining strength (and hence one's own share of household resources) depends on what one is able to bring to the household or command outside it. It is easier to explain the findings in the framework of "preemptive claiming" than in a model where the "idleness" is a consensually bargained outcome.

We will therefore take the Bertrand *et al* study as our point of departure. We will examine in addition the role of household size. Our general specification is given by

$$h_{wi} = \beta n_i + \gamma \mathbf{x}_i + u_i$$

and we will be concerned to test the hypothesis $\beta < 0$. In order to deal with the problem of home production we include among the individual variables indicator variables for whether an individual is involved in fetching water or wood for the household, and (in the case of women) whether the person is involved full-time in child-rearing. Since full-time housewives all come in with h_{wi} at zero, we have also presented some results with housewives excluded. Indeed we have re-run this particular regression (column 5 of Table 4) with a sample selection correction, with very similar results.

We note, however, that a proper test, both of the "unitary household" model as well as of the various alternatives, is rather difficult. These difficulties are both of an interpretive as well as of an econometric type. As far as the interpretation is concerned, cross-sectional studies do not investigate the same household under different circumstances. It is therefore always possible to spin explanations which rescue the unitary model. For example, one could posit that South African grannies just happen to have the very strong belief that the oldest son residing with them ought not to have to work very hard. This would square with the evidence, but seems to fall foul of Occam's razor. The more convoluted the household preferences have to be to be congruent with the observed patterns, the less attractive the unitary model becomes.

As far as the econometric issues are concerned, Strauss and Thomas (1995) in their review of intra-household allocation models, note that the estimation of the alternative models is bedevilled by the endogeneity of many of the variables. Furthermore a rejection of the pooling hypothesis, does not by itself prove that the bargaining models are superior. Similarly, Behrman (1997) has noted that measurement error and unobserved heterogeneity within the household can create major difficulties.

These are important points to note as they also apply to the results presented below. Our data do not allow us to deal with every possible source of endogeneity or measurement error. This means that we are presenting the results with a good deal of humility. All we intend to do at this stage is to show that our model is empirically testable and that some of the implications seem to hold up in the data. More thorough tests will come from future work.

8.3 Results

An initial look at the data is provided in Tables 1a and 1b. A more detailed explanation of the definition of the variables is provided in Table A1 of the Appendix. It is quite clear that different types of households seem to function in different ways. Three-generation households are larger on average than either nuclear or other extended households. Furthermore the probability of adult males or females in three-generation households working is lower than in the other types of households, markedly so in the case of males. The observed differences in hours worked is in a great measure also a reflection of this. We note also that individuals in these households also seem to have a lower probability of engaging in household production, whether it is fetching water, fetching wood or engaging in child-rearing. This is the first indirect evidence for our hypothesis: in these particular types of larger households there seems to be less effort of all kinds in evidence.

Three-generation households also are somewhat more rural and are much more likely to have a person eligible for a pension present within the household. By contrast the extended type of household seems to be relatively more of an urban phenomenon.

Interestingly, the average household size of "nuclear" households within which a prime-age male is resident is almost one person smaller than "nuclear" households within which a prime-age female is present. One reason for this is that there are many more single-person male households (which qualify as nuclear by our definition) than female ones. Undoubtedly part of the reason for this is that women are more likely to be expected to look after children born out of wedlock. Clearly gender roles play a part in the process of household formation. This process is therefore definitely more complicated than our model suggests.

We note also that there is clearly a strong gender household division of labour, with very few men involved in fetching water or wood. As a result of this we have in most of the regressions for men omitted the indicator variables for home production. Including them (as done in column 5 and 10 of Table 3) does not alter the interpretation at all, except that the coefficients on the indicator variables are somewhat puzzling.

In Tables 3 and 4 we present some regression results analogous to those of Bertrand *et al* (2000). The regression results in column 1 indicate the strong effect that the presence of a person who is eligible for the old age pension has on the labour supply of men. The effect on women is very much smaller. As column 2 shows, this effect is yet larger if we restrict our attention to men who are 25 to 49 years old, who presumably have less cause to be either ill or who may still be finding their way into the labour market. The effect persists when the sample is restricted only to men in three-generation households. Our findings (with slightly different specifications) therefore bear out the conclusion of Bertrand *et al*: some of the benefits of the pension are "diverted" (perhaps consensually) to support some unemployed prime-age males. There is no similar effect in the case of prime-age females.

Of course there may be other explanations for this behaviour - perhaps the pension money is used for small-scale own account businesses, or perhaps the males reduce their work effort to care for the ailing parents. Bertrand *et al* explore these and other potential explanations and rule them all out. The results look suspiciously like predation.

For our purposes we are just as interested in the coefficients on household size. Our model would lead us to expect that there should be a decline in work effort as household size increases. Indeed the OLS results for both men and women (columns 1 and 2 of Tables 3 and 4) record a statistically significant decrease in hours worked with household size[5]. The only coefficient not in accordance with our expectations is the coefficient on household size in three-generation households in Table 3. In column 4 we show that part of the reason for this is that the work effort in these households is lower to start off with. Indeed we would expect that household type is endogenous so that we tend to be suspicious of these results.

One of the problems with the OLS specification is that our theory suggests that household size is itself endogenous. High effort type of individuals are more likely to leave larger house-

[5]It might be thought that the predation model might be more applicable to the relationships between adults rather than to all members of the household. We have re-run these regressions using the number of adults not in formal education. The interpretation does not change and in fact the influence of this household size variable is stronger.

holds (such as the three-generation ones), so that household size would become correlated with the individual specific error terms in the hours regression.

Furthermore our theory suggests that the effect of household size is conditional on the effect of m, the degree of conflict within the household. If we write our regression as

$$h_i = \beta n_i + \gamma \mathbf{x}_i + u_i, \text{ and } u_i = \xi_i + \theta m_i$$

where ξ_i is an idiosyncratic error term, then $cov\,(n_i, u_i) \neq 0$. The effect of the omitted variable would be to increase the estimate on β, since $\theta < 0$ and $cov\,(n_i, m_i) < 0$.

In an attempt to control for these problems we have run instrumental variables regressions, in which we instrument for household size. The first stage regressions are given in Table 2. Two of the instruments are selected with inequality 22 in mind. We have included the maximum level of income contributed by any other member of the household and the maximum level of education obtained by any adult member of the household. We have also included the age gap between the oldest and the youngest member of the household. To the extent to which intra-household conflict is also a function of the generation gap, this may be a debatable choice.

Except in the case of three-generational households, the instruments performed well. In all cases the instruments were well correlated with household size (due in no small measure to the age gap variable). Furthermore the over-identification tests (implemented as suggested by Davidson and MacKinnon (1993, pp.234–236)) do not suggest that the instruments belong in the main regression. The Durbin-Wu-Hausman tests (done through an artificial regression as in Davidson and MacKinnon (1993, pp.237-240)) suggest that except in the case of three-generation households the IV results are significantly different from the

OLS ones. Interestingly enough, the effect of instrumenting household size was invariably to make the coefficient more negative, which would be consistent with the omitted variable interpretation.

Interestingly, the reduction of work effort by women seems somewhat smaller than the reduction in effort by men. Since we are more likely to mismeasure home production in the case of women, the real gap is likely to be even larger. This suggests that power within the household is an important factor in deciding final allocations.

9 Conclusion

The central theme of this paper has been that behaviour in households is unlikely to be completely different from behaviour in the rest of society. While altruism is likely to be a feature of household interactions, we would also expect selfishness and indeed even predation. To the extent to which the latter becomes an important feature of household behaviour, the outcomes are likely to be less efficient than suggested by bargaining models. We have presented a model within which we can examine both predation and altruism. The main prediction of this model is that predation should become more of a problem in larger and more diverse households. Our data suggest that this is, indeed, the case in South Africa.

The model also suggests that successful individuals should be more inclined to leave larger households, since these become a drain or burden on them. To the extent to which large households also have a negative impact on the accumulation of human capital within them, they may become traps for their members.

A major limitation of our analysis is that we have relied on transferable utility, so that we are not properly dealing with the provision of household public goods (for some of the difficulties associated with modelling this, see Apps and Rees (1997) and Chiappori (1997)). Similarly we may not be properly valuing the time of individuals who are not supplying any work to the labour market.

These are all important qualifications. Nevertheless we believe that all models of the household have to grapple with these problems. We believe that in this paper we have gone some way to presenting a framework which gets away from the straight-jacket of viewing household interactions through the lenses of altruism and efficiency only. This is not to denigrate the importance of altruism or of bargaining. Households are characterised by both altruism and selfishness. Of course, one might say the same thing of other institutions, such as the firm, the academic department or the state.

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A Appendix

A.1 Data

Table A1 - Definition of variables	
Age	Age in years
Education	Highest education level attained, converted to years of completed education. Grades 1 to 3 were not distinguished in the data and were coded as 2. All post-matric diplomas were coded as 14 years and University as 16.
Junior primary	Grades 1 to 3
Senior primary	Grades 4 to 7
Secondary	Grades 8 to 12
Post-secondary	Post-matric diplomas and University degrees
Employed	Dummy variable 1=Yes
Hours worked	Records with more than 90 hours were recoded as missing.
Log of wage	The wage was defined as income from regular work as well as cash income from casual work.
Household size	Only non-migrant members of the household were counted.
Pensioner present	Dummy variable, equal to one if a man older than 65 or a woman older than 60 was present in the household.
Log other income	This is the log of total household income minus own wage contribution. Where this difference was zero (as it was in many cases) it was reset to one, so that the log of the variable was zero. In these cases a dummy variable was included in the regression.
Water	Indicator variable, equal to one if the individual is involved with fetching water for the household.
Wood	Indicator variable, equal to one if the individual is involved with fetching wood for the household.
Housewife	Indicator variable equal to one if the reason for not looking for work is given as "Housewife/Child rearing".
Three-generation	A household which contained at least, either: i) The Head, children and grand-children; ii) the Head, children and the Head's parent(s) iii) the Head, the Head's parent(s) and grand-parent(s).
Nuclear	A household which did not contain any member other than the head, the head's spouse and the head's children, and possibly a domestic worker.
Extended	Any household which did not fit either the three-generation or nuclear model.

A.2 Proofs

A.2.1 Proof of Proposition 1

Proof. Differentiating the utility function U_1 we get that

$$\frac{\partial U_1}{\partial e_1} = \frac{\omega_1 (1-e_1)^{m-1}}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} \left[\frac{-m (w_1 e_1 + w_2 e_2) \omega_2 (1-e_2)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} + (1-e_1) w_1 \right] \tag{25}$$

The sign of this expression depends only on the term in square brackets. We deduce that

$$\frac{\partial U_1}{\partial e_1} \gtreqless 0 \text{ as } \frac{\omega_2 (1-e_2)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} (w_1 e_1 + w_2 e_2) \lesseqgtr \frac{(1-e_1) w_1}{m} \tag{26}$$

We note that

$$\frac{\omega_2 (1-e_2)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} (w_1 e_1 + w_2 e_2) = U_2 - V_{h2}$$

and this is monotonically increasing in e_1 while $\frac{(1-e_1)w_1}{m}$ is monotonically decreasing in e_1. There can therefore be at most one point at which $\frac{\partial U_1}{\partial e_1} = 0$. Furthermore such a point would be guaranteed to be a maximum. If at $e_1 = 0$ we have $\frac{\partial U_1}{\partial e_1} < 0$, then there is no solution to the equation $\frac{\partial U_1}{\partial e_1} = 0$ in the interval $[0, 1]$ and the maximum is reached at $e_1 = 0$.

The reaction function of player 1 will therefore be given by the solution to the equation $\frac{\partial U_1}{\partial e_1} = 0$ or by $e_1 = 0$.

We can write the conditions $\frac{\partial U_1}{\partial e_1} = 0$ and $\frac{\partial U_2}{\partial e_2} = 0$ respectively as

$$\frac{\omega_2 (1-e_2)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} (w_1 e_1 + e_2 w_2) = \frac{(1-e_1) w_1}{m} \tag{27a}$$

$$\frac{\omega_1 (1-e_1)^m}{\omega_1 (1-e_1)^m + \omega_2 (1-e_2)^m} (w_1 e_1 + e_2 w_2) = \frac{(1-e_2) w_2}{m} \tag{27b}$$

If we apply the implicit function theorem to equation 27a, (again noting that the left hand side is $U_2 - V_{h2}$) it is easy to show that the slope of Player 1's reaction function $e_1 = r_1(e_2)$ at any interior point will be given by

$$\frac{\partial e_1}{\partial e_2} = -\frac{\frac{\partial U_2}{\partial e_2}}{\frac{\partial U_2}{\partial e_1} + \frac{w_1}{m}} \tag{28}$$

and that

$$\frac{\partial e_1}{\partial e_2} \lesseqgtr 0 \text{ as } \frac{\partial U_2}{\partial e_2} \gtreqless 0$$

We can now characterise the different types of reaction functions.

Firstly we note (by substitution into equation 25) that if $e_2 = 0$ then $\frac{\partial U_1}{\partial e_1} > 0$ at $e_1 = 0$, i.e. player one will produce a positive amount. Indeed the solution to the resulting equation

$$\frac{\omega_1}{\omega_2}(1-e_1)^{m+1} = e_1(m+1) - 1$$

must be in the interval $\left(\frac{1}{m+1}, 1\right)$.

We also note (by substitution) that for e_2 close to one, we must have $\frac{\partial U_1}{\partial e_1} > 0$ at $e_1 = 0$ so again we will have well-defined interior solutions. Consideration of equation 27a shows that this interior maximum must approach 1 as $e_2 \to 1$.

Secondly we observe that if player one's reaction curve slopes upwards at any point, it will continue to do so the right of that point. This follows by combining equation 28 with condition 26 (transposed for player two). So if $\frac{de_1}{de_2} > 0$, then $\frac{\partial U_2}{\partial e_2} < 0$. This implies that $U_1 > \frac{(1-e_2)w_2}{m} + V_{h1}$. But along player one's reaction function U_1 is increasing (we can show this by totally differentiating). So if at any point e_2^* we have $U_1 > \frac{(1-e_2)w_2}{m} + V_{h1}$ then it must be true at every $e_2 > e_2^*$, since the right hand side of this inequality is independent of e_1 and decreasing in e_2. It follows that if $\frac{de_1}{de_2} > 0$ at (e_1^*, e_2^*) then it will stay positive for $e_2 > e_2^*$.

It follows that if player one's reaction function is positive at $e_2 = 0$, it will be monotonically increasing on $[0, 1]$, i.e. it is a type one reaction function.

If the reaction function has a negative slope at $e_2 = 0$, then two possibilities are open (given that we know that as $e_2 \to 1$ we must have $e_1 \to 1$). The reaction function could have an interior turning point. From equation 28 it is clear that this turning point is also the point of intersection with player two's reaction function. It follows that both players have a type two reaction function. It is also immediately apparent that a type one or a type three reaction function could never be paired with a type two reaction function.

If the reaction function does not have an interior turning point, then it must eventually reach the boundary. At this point the equation $\frac{\partial U_1}{\partial e_1} = 0$ ceases to have a solution and the optimal response for player one is $e_1 = 0$. At high enough values of e_2, however, the equation $\frac{\partial U_1}{\partial e_1} = 0$ will again have solutions, i.e. we have a type three reaction function.

It remains to show that a type one reaction function will always be paired with a type three reaction function. We note that if player one has a type one reaction function, then at $e_2 = 0$ we must have $\frac{de_1}{de_2} > 0$. Let e_1^* be the optimal response to $e_2 = 0$. We must have (by equation 28) that $\frac{\partial U_2}{\partial e_2} < 0$ at $(e_1^*, 0)$. Now this implies that the optimal response by player two to e_1^* must be $e_2 = 0$, i.e. player two's reaction function must have reached the boundary and is therefore of type three. Similarly if player one has a type three reaction function then we can show that at player two's optimal response to $e_1 = 0$ we will have $\frac{\partial U_1}{\partial e_1} < 0$ and player two's reaction function will have a positive slope, i.e. it will be of type one. ■

A.2.2 Proof of Theorem 2

Proof. Assume initially that we have an interior equilibrium. In this case both equation 27a and equation 27b must hold. Adding them yields

$$w_1 e_1 + w_2 e_2 = \frac{(1-e_1)\,w_1}{m} + \frac{(1-e_2)\,w_2}{m} \tag{29}$$

Rearranging this expression and using the definition of I gives

$$I = \frac{w_1 + w_2}{m+1}$$

which is equation 11 of the theorem.

Dividing the second equation by the first gives

$$\frac{\omega_1 (1-e_1)^{m+1}}{\omega_2 (1-e_2)^{m+1}} = \frac{w_2}{w_1} \tag{30}$$

which implies that

$$\frac{\omega_1 (1-e_1)^{m}}{\omega_2 (1-e_2)^{m}} = \frac{\omega_1^{\frac{1}{m+1}}}{\omega_2^{\frac{1}{m+1}}} \left(\frac{w_2}{w_1}\right)^{\frac{m}{m+1}}$$

The left hand side of this is just $\frac{s_1}{s_2}$. This proves equation 10 of the theorem.

Since we will require the results later, we will at this stage derive explicit expressions for e_1 and e_2 at an interior equilibrium. From equation 30 we get (after rearrangement) that

$$e_1 = 1 - \left(\frac{\omega_2 w_2}{\omega_1 w_1}\right)^{\frac{1}{m+1}} + \left(\frac{\omega_2 w_2}{\omega_1 w_1}\right)^{\frac{1}{m+1}} e_2$$

We can substitute this expression for e_1 into equation 11, noting that $I = e_1 w_1 + e_2 w_2$. Solving for e_2 and then substituting back to get the solution for e_1, we get the following equilibrium values:

$$e_1 = 1 - \frac{m}{m+1}\left(\frac{\omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}}}{\omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}} + \omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}}}\right)\left(\frac{w_1 + w_2}{w_1}\right) \tag{31a}$$

$$e_2 = 1 - \frac{m}{m+1}\left(\frac{\omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}}}{\omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}} + \omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}}}\right)\left(\frac{w_1 + w_2}{w_2}\right) \tag{31b}$$

We turn now to consider the corner equilibrium where player 2 is parasitic. This means that $e_2 = 0$ and it immediately follows (by substitution) that

$$\begin{aligned} \frac{s_1}{s_2} &= (1-e_1)^m \frac{\omega_1}{\omega_2} \\ I &= e_1 w_1 \end{aligned}$$

which are equations 12 and 13 of the theorem respectively.

The optimal level of e_1 still has to satisfy equation 27a. Simplifying this we get the condition given in equation 14.

In order to establish condition 15 of the theorem, we proceed by first considering under which conditions it will be optimal for player two to be a parasite and we show that in this case the condition must hold. We then show that if player two is not parasitic the inequality cannot hold. To show the former, we note that in order for parasitism to be optimal we must have $\frac{\partial U_2}{\partial e_2} < 0$ at $e_2 = 0$ and at e_1 as given in equation 14. The former condition will hold only if

$$\frac{\omega_1 (1-e_1)^m}{\omega_1 (1-e_1)^m + \omega_2} (w_1 e_1) > \frac{w_2}{m} \tag{32}$$

and e_1 must satisfy

$$\frac{\omega_2}{\omega_1 (1-e_1)^m + \omega_2} (w_1 e_1) = \frac{(1-e_1) w_1}{m}$$

Dividing 32 by this, we get

$$\frac{\omega_1 (1-e_1)^m}{\omega_2} > \frac{w_2}{(1-e_1) w_1}$$

and hence

$$\frac{\omega_1}{\omega_2} (1-e_1)^m > \frac{\omega_1^{\frac{1}{m+1}}}{\omega_2^{\frac{1}{m+1}}} \left(\frac{w_2}{w_1}\right)^{\frac{m}{m+1}} \tag{33}$$

From equation 14 we get that $\frac{\omega_1}{\omega_2} (1-e_1)^m = \frac{e_1(m+1)-1}{1-e_1}$. Substituting this in for the left hand side and simplifying, we can show that

$$\frac{1}{1-e_1} > \frac{(m+1)\, \omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}} + \omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}}}{m \omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}}}$$

We can manipulate inequality 33 in yet another way, to yield the condition

$$\left(\frac{\omega_1 w_1}{\omega_2 w_2}\right)^{\frac{1}{m+1}} > \frac{1}{1-e}$$

Combining the last two inequalities we get

$$\left(\frac{\omega_1 w_1}{\omega_2 w_2}\right)^{\frac{1}{m+1}} > \frac{(m+1)\,\omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}} + \omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}}}{m\omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}}}$$

which, on simplification and rearrangement yields inequality 15 in the Theorem. We have shown that at a corner where player 2 is parasitic, this inequality holds. To show the converse we need to show that at an interior solution (or at the opposite corner) the inequality does not hold. For the interior solution we note that in any valid interior solution we must have $e_2 > 0$. Using equation 31b this becomes

$$1 - \frac{m}{m+1}\left(\frac{\omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}}}{\omega_1^{\frac{1}{m+1}} w_2^{\frac{m}{m+1}} + \omega_2^{\frac{1}{m+1}} w_1^{\frac{m}{m+1}}}\right)\left(\frac{w_1 + w_2}{w_2}\right) > 0$$

Manipulating this condition, it follows that the inequality holds. If we are at a corner where player 1 is parasitic, it follows from the argument for the other corner (by simply switching subscripts) that we must have

$$m\left[\left(\frac{w_2}{w_1}\right)^{\frac{1}{m+1}} - \left(\frac{\omega_1}{\omega_2}\right)^{\frac{1}{m+1}}\right] \geq \left(\frac{w_1}{w_2}\right)^{\frac{m}{m+1}} + \left(\frac{\omega_1}{\omega_2}\right)^{\frac{1}{m+1}}$$

In order for this to hold, the expression in square brackets must be positive. It will be so only if

$$\left(\frac{\omega_2}{\omega_1}\right)^{\frac{1}{m+1}} > \left(\frac{w_1}{w_2}\right)^{\frac{1}{m+1}}$$

which implies that inequality 15 cannot hold. ■

A.2.3 Proof of Theorem 3

Proof. In order to prove Theorem 3 we need to consider separately the interior from the corner Cournot equilibria.

Starting with the interior equilibria, $\overline{e}_1$ will be given by equation 31a. We can rewrite this as

$$\overline{e}_1 = 1 - \frac{m}{m+1}\left(\frac{p^{\frac{m}{m+1}}}{p^{\frac{m}{m+1}} + f^{\frac{1}{m+1}}}\right)\left(\frac{p+1}{p}\right), \text{ where } p = \left(\frac{w_1}{w_2}\right) \text{ and } f = \left(\frac{\omega_1}{\omega_2}\right)$$

Differentiating this with respect to p and (and rearranging) we get

$$\frac{\partial e_1}{\partial p} = \frac{m}{m+1} \frac{p^{\frac{m}{m+1}}}{p^2 \left(p^{\frac{m}{m+1}} + f^{\frac{1}{m+1}}\right)} e_2 \geq 0$$

where e_2 is the equilibrium value as given in equation 31b, which at an interior equilibrium is guaranteed to be positive.

Differentiating with respect to f we get

$$\frac{\partial e_1}{\partial f} = \frac{m}{(m+1)^2} \frac{p^{\frac{m}{m+1}}}{f^{\frac{m}{m+1}} \left(p^{\frac{m}{m+1}} + f^{\frac{1}{m+1}}\right)^2} \frac{(p+1)}{p} > 0$$

The derivative with respect to m is a bit more messy. We get

$$\frac{\partial e_1}{\partial m} = -(p+1) \frac{p^{\frac{m}{m+1}} \left\{p^{\frac{m}{m+1}} (m+1) + f^{\frac{1}{m+1}} (m+1) + m f^{\frac{1}{m+1}} (\ln pf)\right\}}{(m+1)^3 p \left(p^{\frac{m}{m+1}} + f^{\frac{1}{m+1}}\right)^2}$$

The sign of the expression therefore depends on the term in braces in the numerator. We can rearrange this term to yield

$$p^{\frac{m}{m+1}} (m+1) \left[1 + \frac{f^{\frac{1}{m+1}}}{p^{\frac{m}{m+1}}} - \frac{f^{\frac{1}{m+1}}}{p^{\frac{m}{m+1}}} \ln\left(\frac{f^{\frac{1}{m+1}}}{p^{\frac{m}{m+1}}}\right) + \frac{f^{\frac{1}{m+1}}}{p^{\frac{m}{m+1}}} \ln f\right]$$

The expression in square brackets is of the form $1 + x - x\ln x + x\ln f$. It is easy to show that this expression is initially positive and increasing, but is eventually monotonically decreasing. This guarantees that there is precisely one value at which it is zero. Let the root of the equation $1 + x - x\ln x + x\ln f = 0$ be $x = \zeta(f)$.Then we have $\frac{\partial e_1}{\partial m} \lesseqgtr 0$ as $x \lesseqgtr \zeta(f)$. Noting that $\frac{s_1}{s_2} = x$, the result follows.

Solving numerically we get that $\zeta(1) \simeq 3.591\,121\,477$. Implicitly differentiating the equation we can show that $\zeta'(f) > 0$ so that as the weights change in favour of player 1 the critical threshold at which $\frac{\partial e_1}{\partial m}$ becomes positive increases.

For the corner solution, we proceed by implicit differentiation. We assume that **B** is parasitic, so that the optimal e_1 is given by the solution to the equation

$$(1 - e_1)^{m+1} \frac{\omega_1}{\omega_2} = e_1 (m+1) - 1$$

Using the same notation as above, we let $q(e_1) = (1 - e_1)^{m+1} f - e_1 (m+1) + 1$. Then $\overline{e}_1$ is defined implicitly by $q(e_1) \equiv 0$. We can get the comparative statics on $\overline{e}_1$ from the implicit function theorem provided that $q_{e_1} \neq 0$. We have $q_{e_1} = -(m+1)(1 - e_1)^m f - (m+1) < 0$, so that the numerator will determine the sign.

$q_f = (1-e_1)^{m+1} > 0$, i.e. $\frac{\partial \overline{e}_1}{\partial f} > 0$.

In the case of m we have $q_m = (1-e_1)^{m+1} f \ln(1-e_1) - e_1$. It helps to rewrite this. Let $y = (1-e_1)^m$, then $q_m = (1-e_1) fy \ln y^{\frac{1}{m}} - e_1$, i.e. $q_m = \frac{1-e_1}{m}\left[fy\ln y - \frac{e_1 m}{1-e_1}\right]$. This expression has to be evaluated at a solution to $q(e_1) = 0$. At such a solution we have $e_1 m = (1-e_1)^{m+1} f + (1-e_1)$. Substituting this into the expression for q_m we get $q_m = \frac{1-e_1}{m}[fy\ln y - fy - 1]$, i.e. $q_m = -\frac{(1-e_1)}{m}[1 + fy - fy\ln fy + fy\ln f]$. This is again of the form $1 + x - x\ln x + x\ln f$, So $q_m \lesseqqgtr 0$ as $(1-\overline{e}_1)^m f \lesseqqgtr \zeta(f)$. The left-hand side of this final expression, however, is just $\frac{s_1}{s_2}$ when $e_2 = 0$. ■

A.2.4 Proof of Theorem 4

Proof. The proof is a simple extension of the proof for the two-player game. First we need to derive an expression for the reaction curve of the i-th player. We set $\alpha_{ij} = 0$ in equation 8 to get

$$U_i = \frac{\omega_i (1-e_i)^m}{\sum_j \omega_j (1-e_j)^m} \sum_j w_j e_j + V_{hi}$$

and then differentiate this expression with respect to e_i. After some rearrangement, this derivative can be written as

$$\frac{\partial U_i}{\partial e_i} = \frac{\omega_i (1-e_i)^{m-1}}{\sum_j \omega_j (1-e_j)^m}\left(-\frac{\sum_{k\neq i}\omega_k (1-e_k)^m}{\sum_j \omega_j (1-e_j)^m} m \sum_j w_j e_j + (1-e_i) w_i\right)$$

So that Player i's reaction curve is implicitly defined (at an interior solution) by

$$\frac{\sum_{k\neq i}\omega_k (1-e_k)^m}{\sum_j \omega_j (1-e_j)^m}\sum_j w_j e_j = \frac{(1-e_i) w_i}{m} \tag{34}$$

At the multi-player Cournot equilibrium we will have n equations like this. Summing up these up over all i we get

$$\frac{\sum_j w_j e_j}{\sum_j \omega_j (1-e_j)^m}\sum_i \sum_{k\neq i}\omega_k (1-e_k)^m = \sum_i \frac{(1-e_i) w_i}{m}$$

Now

$$\sum_i \sum_{k\neq i}\omega_k (1-e_k)^m = (n-1)\sum_j \omega_j (1-e_j)^m$$

so that

$$(n-1)\sum_j w_j e_{jw} = \frac{1}{m}\sum w_i - \frac{1}{m}\sum_j w_j e_j$$

which on rearrangement gives equation 18.

Taking the versions of equation 34 for player i and player j and dividing the former by the latter we get

$$\frac{\sum_{k\neq i}\omega_k\left(1-e_k\right)^m}{\sum_{k\neq j}\omega_k\left(1-e_k\right)^m}=\frac{\left(1-e_i\right)w_i}{\left(1-e_j\right)w_j}$$

Now the left hand side of this expression can be written as

$$\frac{s_j+\sum_{k\neq i,j}s_k}{s_i+\sum_{k\neq i,j}s_k} \tag{35}$$

while the right hand side is equal to

$$\frac{s_i^{\frac{1}{m}}\omega_j^{\frac{1}{m}}w_i}{s_j^{\frac{1}{m}}\omega_i^{\frac{1}{m}}w_j} \tag{36}$$

Substituting these expressions in and rearranging we get equation 17 of the Theorem. ■

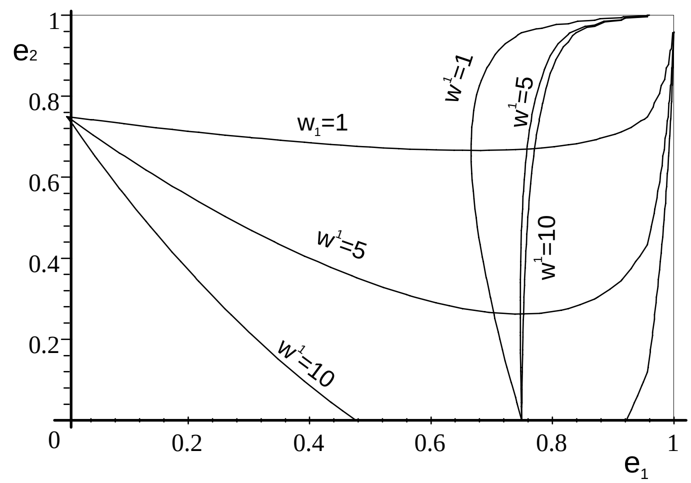

Figure 1: Reaction functions for the case $w_2 = 1$, $\omega_1 = \omega_2 = 1$, $m = 0.5$

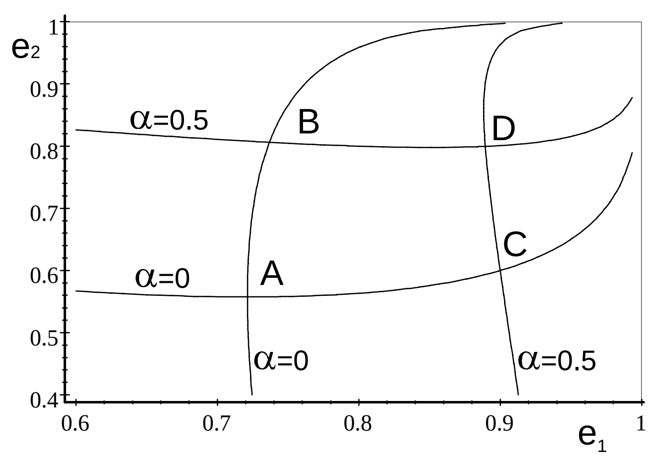

Figure 2: Altruism shifts the reaction curves upwards. Simulation: $w_1 = 2$, $w_2 = 1$, $m = 0.5$. $\omega_1 = \omega_2 = 1$. Only those portions of the reaction curves near the Cournot equilibria are shown.

Table 1a: Descriptive Statistics - African men					
	(1)	(2)	(3)	(4)	(5)
Age	**35.07417**	**34.98657**	**33.63592**	**35.93196**	**34.47751**
s.e.	(.2112759)	(.1529958)	(.2263524)	(.2585242)	(.2845236)
s.d.	12.19351	6.963463	7.062644	6.819849	6.791667
Education	**6.523085**	**6.783693**	**7.115115**	**6.533574**	**6.962704**
s.e.	(.1233333)	(.1386808)	(.1738485)	(.1813135)	(.2012537)
s.d.	3.985824	3.920339	3.780908	4.005087	3.853116
Employed (1=yes)	**.6063083**	**.6979442**	**.487049**	**.8326675**	**.6565234**
s.e.	(.0175703)	(.0167952)	(.0209197)	(.0160492)	(.0216803)
Hours worked	**26.79312**	**31.06758**	**21.3931**	**37.27871**	**29.09292**
s.e.	(.8788848)	(.849481)	(.9804992)	(.8934441)	(1.13772)
s.d.	24.43991	23.65115	24.26859	21.07286	23.98686
Household size	**5.738821**	**5.375159**	**8.883137**	**3.361644**	**5.379446**
s.e.	(.1896543)	(.2046472)	(.1865262)	(.1792366)	(.1753172)
s.d.	3.746127	3.757164	3.67392	2.264424	2.977013
Pensioner present	**.1938179**	**.1990539**	**.542296**	**.0324321**	**.1088333**
s.e.	(.0118543)	(.0140952)	(.0212519)	(.0060006)	(.0161912)
Log other income	**5.89544**	**5.776854**	**6.595732**	**5.20274**	**6.088293**
s.e.	(.0544965)	(.0628882)	(.0627261)	(.0839711)	(.0918148)
s.d.	1.697879	1.782395	1.28693	1.825469	1.759573
Fetches water	**.069053**	**.0541356**	**.0277975**	**.070519**	**.0503286**
s.e.	(.0072935)	(.007152)	(.0057657)	(.011287)	(.0104071)
Fetches wood	**.0461391**	**.0429151**	**.0353213**	**.0501652**	**.0342833**
s.e.	(.0078257)	(.0088418)	(.0083296)	(.0132037)	(.0112643)
Rural	**.5685295**	**.5322693**	**.5844256**	**.5328915**	**.4411974**
s.e.	(.0365255)	(.0384473)	(.0412564)	(.2147357)	(.0464147)
Urban	**.1920006**	**.2109895**	**.1934291**	**.2147357**	**.229855**
s.e.	(.0281987)	(.0311829)	(.0330045)	(.037401)	(.0397303)
Metropolitan	**.23947**	**.2567413**	**.2221454**	**.2523728**	**.3289477**
s.e.	(.0336301)	(.0359101)	(.0374227)	(.0418022)	(.0519908)
Three-generations	**.3531324**	**.3004747**			
s.e.	(.0176047)	(.0182203)			
Nuclear household	**.4768955**	**.523866**			
s.e.	(.0208568)	(.0230132)			
Extended household	**.169972**	**.1756593**			
s.e.	(.0104324)	(.0116256)			
Prime aged (1=yes)	**.6178388**				
s.e.	(.0095672)				
N	5483	3375	1037	1750	588

Notes:

Sample includes men aged 16 to 64 who were not in the formal education system and who were not out of the labour force due to mental or physical incapacity. Summary statistics are given for the samples used in the regressions given in tables 2,3 and 4. Very similar statistics are obtained if all possible observations are used on every variable.

s.e. standard error of the mean, corrected for sample design.

s.d. (weighted) sample standard deviation.

"Prime aged" is defined as age 25 to 49 (inclusive).

(1) All African men
(2) African men aged 25 to 49
(3) Prime age African men in three-generational households
(4) Prime age African men in nuclear households
(5) Prime age African men in extended households (but not three-generational ones).

Table 1b: Descriptive Statistics - African women

	(1)	(2)	(3)	(4)	(5)	(6)
Age	**34.25606**	**35.2921**	**35.42096**	**35.44638**	**34.55602**	**35.1555**
s.e.	(.148996)	(.1260306)	(.1649498)	(.2045996)	(.2421495)	(.1418485)
s.d.	11.32148	6.948566	7.538153	6.577187	6.424189	6.913232
Education	**6.440833**	**6.425512**	**6.699258**	**6.090499**	**6.699855**	**6.900243**
s.e.	(.123496)	(.1384486)	(.1720552)	(.1671415)	(.2004703)	(.1399815)
s.d.	4.040957	4.027612	3.987742	4.040184	4.023061	4.027482
Employed (1=yes)	**.3507402**	**.4150174**	**.3815572**	**.4357894**	**.4374399**	**.5691058**
s.e.	(.0120691)	(.0138154)	(.0173781)	(.0174197)	(.0223493)	(.0141778)
Hours worked	**13.82098**	**16.39779**	**14.92475**	**17.27909**	**17.47686**	**22.66306**
s.e.	(.5289453)	(.6056067)	(.7468569)	(.7981223)	(.9781674)	(.6536886)
s.d.	21.03612	22.01582	21.45031	22.41683	22.0669	23.01616
Household size	**6.528532**	**6.306316**	**8.727875**	**4.280379**	**6.133005**	**6.230662**
s.e.	(.1102096)	(.1192738)	(.1685664)	(.0850448)	(.1697624)	(.1340836)
s.d.	3.659902	3.644323	3.786373	2.200787	2.956242	3.763214
Pensioner present	**.2192914**	**.2113698**	**.4649538**	**.0220047**	**.1300194**	**.2329245**
s.e.	(.0091566)	(.0101424)	(.0167098)	(.0039212)	(.0167413)	(.0125735)
Log other income	**6.191633**	**6.184327**	**6.522791**	**5.880629**	**6.217038**	**6.165209**
s.e.	(.0380908)	(.0423461)	(.0513603)	(.0550435)	(.0743114)	(.0490369)
s.d.	1.510746	1.537391	1.317545	1.639571	1.562075	1.625303
Fetches water	**.3920058**	**.3726897**	**.3217155**	**.4229529**	**.3552141**	**.301817**
s.e.	(.0204349)	(.0216803)	(.0211279)	(.027254)	(.0304209)	(.0218228)
Fetches wood	**.2663239**	**.253452**	**.2408024**	**.2726234**	**.2305396**	**.1933336**
s.e.	(.0190563)	(.0194047)	(.0202849)	(.023578)	(.0240614)	(.0175484)
Housewife	**.2961471**	**.2894519**	**.2392174**	**.3394889**	**.2708347**	
s.e.	(.0109985)	(.0127437)	(.0150867)	(.0160738)	(.0216647)	
Rural	**.6229339**	**.5906791**	**.6369036**	**.5680159**	**.5429729**	**.517584**
s.e.	(.0326528)	(.0337643)	(.036805)	(.0359663)	(.0433334)	(.0357948)
Urban	**.1738467**	**.1880098**	**.1788462**	**.1907442**	**.2023439**	**.2151669**
s.e.	(.0252833)	(.0268456)	(.0288976)	(.0293324)	(.0338383)	(.0302543)
Metropolitan	**.2032194**	**.221311**	**.1842502**	**.24124**	**.2546831**	**.2672492**
s.e.	(.0282118)	(.0301926)	(.0311988)	(.0327208)	(.0438035)	(.0346064)
Three-generations	**.462575**	**.3879554**				**.4153831**
s.e.	(.0116999)	(.0120753)				(.0145213)
Nuclear household	**.3760982**	**.4498384**				**.4181607**
s.e.	(.0106634)	(.0122657)				(.0143719)
Extended household	**.1613268**	**.1622062**				**.1664562**
s.e.	(.0071305)	(.0080324)				(.0098066)
Prime aged (1=yes)	**.6339598**					
s.e.	(.0071826)					
N	6826	4313	1689	1928	696	3039

Notes:

Sample includes women aged 16 to 59 who were not in the formal education system and who were not out of the labour force due to mental or physical incapacity. Summary statistics are given for the samples used in the regressions given in tables 2,3 and 4. Very similar statistics are obtained if all possible observations are used on every variable

s.e. standard error of the mean, corrected for sample design.

s.d. (weighted) sample standard deviation.

"Prime aged" is defined as age 25 to 49 (inclusive).

(1) All African women
(2) African women aged 25 to 49
(3) Prime age African women in three-generational households
(4) Prime age African women in nuclear households
(5) Prime age African women in extended households (but not three-generational ones)
(6) Prime age African women who are not full-time housewives.

Table 2: First stage regressions - Household size

Dep. Variable: Household size	Men (1)[a]	(2)[b]	(3)[c]	(4)[b]	(5)[b]	Women (6)[a]	(7)[b]	(8)[c]	(9)[b]	(10)[d]
Maxinc	0.00019+	0.00021+	-0.00006	0.00021+	0.00022+	-0.00012	-0.0001	-0.00021	-0.00002	-0.00006
	(0.0001)	(0.00011)	(0.00024)	(0.00011)	(0.00011)	(0.00009)	(0.00009)	(0.00023)	(0.00008)	(0.00009)
Maxed	0.16111***	0.1606***	0.29575***	0.14504***	0.15735***	0.21559***	0.21059***	0.25226***	0.17315***	0.21099***
	(0.01934)	(0.02595)	(0.05606)	(0.02472)	(0.02575)	(0.01942)	(0.02304)	(0.04164)	(0.02255)	(0.02487)
Agegap	0.12572***	0.13022***	0.07442***	0.10994***	0.12963***	0.12757***	0.13036***	0.09329***	0.10422***	0.12911***
	(0.0023)	(0.00273)	(0.01511)	(0.00284)	(0.0028)	(0.00318)	(0.00372)	(0.01304)	(0.00382)	(0.00396)
Age	0.03985+	0.03556	0.18107	0.12682+	0.03389	0.05898**	0.13583*	0.25867*	0.26005***	0.09955
	(0.02096)	(0.06742)	(0.19551)	(0.0706)	(0.06719)	(0.02044)	(0.06224)	(0.1177)	(0.06229)	(0.07821)
Age squared	-0.00096***	-0.0009	-0.003	-0.00194*	-0.00088	-0.00147***	-0.00247**	-0.00445**	-0.00411***	-0.00203+
	(0.00027)	(0.00092)	(0.0027)	(0.00096)	(0.00092)	(0.00027)	(0.00086)	(0.00161)	(0.00086)	(0.00109)
Junior primary	-0.14201*	-0.13816+	-0.23668	-0.15781*	-0.145+	-0.04053	-0.06801	0.19074	-0.0621	-0.00796
	(0.05471)	(0.07714)	(0.20983)	(0.07548)	(0.07742)	(0.06186)	(0.08082)	(0.1799)	(0.07859)	(0.08898)
Senior primary	-0.09501*	-0.11944*	-0.17902	-0.09299*	-0.11556*	-0.22394***	-0.2082**	-0.46097**	-0.18933**	-0.17778*
	(0.03815)	(0.04681)	(0.11193)	(0.04603)	(0.04689)	(0.05227)	(0.07061)	(0.14539)	(0.06776)	(0.07464)
Secondary	-0.2154***	-0.17956***	-0.29825**	-0.15203**	-0.1794***	-0.23747***	-0.21166***	-0.25258**	-0.18683***	-0.22139***
	(0.03503)	(0.04604)	(0.109)	(0.04515)	(0.04592)	(0.0375)	(0.04791)	(0.0905)	(0.04622)	(0.0562)
Post Secondary	-0.22303*	-0.30307**	-0.3292	-0.26098**	-0.30125**	-0.54806***	-0.57554***	-0.7882***	-0.50604***	-0.59517***
	(0.09535)	(0.10576)	(0.2776)	(0.09841)	(0.10551)	(0.09288)	(0.10389)	(0.20365)	(0.09636)	(0.11361)
Pensioner	-1.33334***	-1.36703***	-1.09901**	-1.67197***	-1.35436***	-1.29114***	-1.21702***	-1.21989***	-1.39576***	-1.25113***
	(0.20956)	(0.25499)	(0.38282)	(0.26431)	(0.25428)	(0.19687)	(0.24247)	(0.34316)	(0.24078)	(0.28016)
Fetches water					-0.41371**	-0.48093***	-0.55752***	-0.73914**	-0.48544***	-0.62672***
					(0.13708)	(0.09715)	(0.11479)	(0.24688)	(0.11103)	(0.12724)
Fetches wood					-0.32511	0.05048	0.10491	0.2838	0.18328	0.09705
					(0.22067)	(0.10801)	(0.12435)	(0.23455)	(0.11753)	(0.14372)
Log other income	0.25208***	0.19851***	0.67655***	0.13771***	0.19502***	0.36547***	0.2949***	0.73356***	0.26571***	0.28833***
	(0.03629)	(0.03876)	(0.18013)	(0.03559)	(0.03889)	(0.04918)	(0.05015)	(0.14333)	(0.04645)	(0.05484)
Housewife						-0.04435	-0.00441	0.2916	0.16516	
						(0.09403)	(0.11741)	(0.25223)	(0.11737)	
Threegen				1.85861***					1.89374***	
				(0.23441)					(0.18529)	
Extended				0.74609***					0.94306***	
				(0.12918)					(0.12357)	
N	5483	3375	1037	3375	3375	6826	4313	1689	4313	3039
F[e]	304.19	258.52	11.4	259.91	220.47	149.31	130.02	11.24	125.25	135.21
F[f]	1102.29	886.82	18.74	607.66	849.18	580.11	436.99	26.47	260.92	378.71
R^2	0.5834	0.6052	0.1395	0.6255	0.6062	0.4443	0.4606	0.1738	0.4899	0.478

Notes

a) Entire subsample b) Individuals aged 25 to 49 c) Individuals aged 25 to 49 in three generational households

d) Individuals aged 25 to 49 who are not full-time housewives e) F test is of the null hypothesis that all regressors are zero f) F test is of the null hypothesis that maxinc, maxed and agegap are jointly zero. All F statistics are significant at the 0.1% level

+significant at 10% level * significant at 5% level ** significant at 1% level *** significant at 0.1% level

The male subsample includes African men aged 16 to 64 and the female subsample includes African women aged 16 to 59. We have included individuals who were not in the formal education system and who were not out of the labour force due to mental or physical incapacity.
All regressions include geographical dummies for rural/urban/metro. The regressions also contain a dummy for individuals where “other income” was zero. The education variables are linear splines of education completed, with knots at 3 years, 7 years and 12 years.
The regressions were run using the Stata svyreg command, weighting the data, correcting for clustering and adjusting the standard errors for the fact that the subpopulation size is itself a variable.
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Table 3: Hours worked by African Men

Dep. Variable: Hours worked	OLS					IV				
	(1)[a]	(2)[b]	(3)[c]	(4)[b]	(5)[b]	(6)[a]	(7)[b]	(8)[c]	(9)[b]	(10)[b]
Age	2.9804***	1.66541*	-0.55384	1.25709+	1.56652*	2.78664***	1.4428*	-0.47579	1.34356+	1.3194+
	(0.19296)	(0.68555)	(1.19456)	(0.68066)	(0.67938)	(0.19362)	(0.69632)	(1.23658)	(0.69188)	(0.68965)
Age squared	-0.03625***	-0.01854*	0.01579	-0.0136	-0.0175+	-0.03375***	-0.01548	0.01448	-0.01442	-0.01413
	(0.00242)	(0.00933)	(0.01663)	(0.00926)	(0.00923)	(0.00244)	(0.00949)	(0.0173)	(0.00943)	(0.00939)
Junior primary	-0.80937	-0.22762	-0.37079	-0.05967	-0.13399	-0.76646	-0.21241	-0.39684	-0.1347	-0.13195
	(0.5137)	(0.70145)	(1.26964)	(0.70196)	(0.68553)	(0.51835)	(0.70236)	(1.24137)	(0.70724)	(0.68947)
Senior primary	0.6585+	0.49618	0.85186	0.39416	0.5941	0.58669+	0.41562	0.81396	0.36733	0.51729
	(0.36166)	(0.44875)	(0.8224)	(0.44652)	(0.43167)	(0.3545)	(0.44439)	(0.82999)	(0.44189)	(0.42706)
Secondary	0.25373	0.8843**	1.30376*	0.85055**	0.87559**	0.21941	0.89768**	1.23799*	0.87756**	0.88478**
	(0.25232)	(0.30415)	(0.54046)	(0.29783)	(0.30036)	(0.2489)	(0.30148)	(0.55911)	(0.29725)	(0.29734)
Post-secondary	2.38355**	1.35086+	3.97723*	1.20176	1.46998+	2.16844**	1.14973	3.95649*	1.06542	1.2591
	(0.70882)	(0.79246)	(1.54527)	(0.79906)	(0.80334)	(0.74228)	(0.80894)	(1.53769)	(0.80869)	(0.82286)
Household size	**-1.08817*** **	**-1.06769*** **	**0.00585**	**-0.67148*** **	**-1.13188*** **	**-2.16171*** **	**-1.84807*** **	**-0.43456**	**-1.65435*** **	**-1.98144*** **
	(0.17212)	(0.16391)	(0.1877)	(0.164)	(0.15997)	(0.22878)	(0.23086)	(0.85011)	(0.29528)	(0.22044)
Pensioner	-9.44397***	-11.27015***	-7.29516***	-8.97971***	-11.06464***	-6.78603***	-8.91305***	-7.26715***	-8.61616***	-8.518***
	(0.98492)	(1.31275)	(1.72641)	(1.45147)	(1.29706)	(1.0881)	(1.46424)	(1.76519)	(1.56585)	(1.44832)
Fetches water					-10.15383***					-11.60725***
					(2.11005)					(2.05637)
Fetches wood					9.07749**					8.91238**
					(3.11176)					(2.99196)
Log of other income	-0.36336	-0.17864	1.44816	0.16088	-0.26074	0.45979	0.35746	1.8488	0.51217	0.30414
	(0.29836)	(0.35987)	(0.9219)	(0.35809)	(0.35643)	(0.31941)	(0.36877)	(1.19626)	(0.36719)	(0.36484)
Three generation household				-7.31559***					-2.47008	
				(1.53082)					(1.90097)	
Other extended household				-5.92518***					-4.20215**	
				(1.33549)					(1.30867)	
N	5483	3375	1037	3375	3375	5483	3375	1037	3375	3375
F	58.23	24.75	8.21	23.44	23.87	64.95	25.16	8.95	22.98	24.78
R^2	0.1526	0.1113	0.0783	0.1225	0.1236	0.1314	0.0996	0.0742	0.1088	0.1099
Over identifying restrictions $\chi^2(2)$						1.667	4.738	0.725	4.2644	3.346
Hausman						58.8	26.82	0.29	18.05	31.61

Notes

a) Entire subsample b) Men aged 25 to 49 c) Men aged 25 to 49 in three generational households

+significant at 10% level * significant at 5% level ** significant at 1% level *** significant at 0.1% level

The subsample includes African men aged 16 to 64 who were not in the formal education system and who were not out of the labour force due to mental or physical incapacity. All regressions include geographical dummies for rural/urban/metro. The regressions also contain a dummy for individuals where "other income" was zero.

The education variables are linear splines of education completed, with knots at 3 years, 7 years and 12 years.

The regressions were run using the Stata svyreg and svyivreg commands, weighting the data, correcting for clustering and adjusting the standard errors for the fact that the subpopulation size is itself a variable.

Table 4: Hours worked by African Women

Dep. Variable: Hours worked	OLS					IV				
	(1)[a]	(2)[b]	(3)[c]	(4)[b]	(5)[d]	(6)[a]	(7)[b]	(8)[c]	(9)[b]	(10)[d]
Age	1.87748***	2.05502***	1.20513	1.9108***	2.57095***	1.81393***	1.95476***	1.21895	2.08527***	2.43005***
	(0.133)	(0.45298)	(0.76786)	(0.45976)	(0.64376)	(0.13339)	(0.45031)	(0.76584)	(0.45767)	(0.64391)
Age squared	-0.02276***	-0.02537***	-0.01378	-0.02333***	-0.03188***	-0.02203***	-0.02396***	-0.01428	-0.02579***	-0.03**
	(0.00175)	(0.0063)	(0.0105)	(0.00639)	(0.00894)	(0.00174)	(0.00626)	(0.01049)	(0.00638)	(0.00894)
Junior primary	0.21347	0.16581	-0.16786	0.17643	0.38277	0.26238	0.21029	-0.03459	0.20639	0.47201
	(0.35548)	(0.44949)	(0.71897)	(0.44832)	(0.69475)	(0.35432)	(0.44912)	(0.73227)	(0.45111)	(0.68389)
Senior primary	0.27823	0.10489	0.1776	0.11109	0.01564	0.22479	0.0478	0.03901	0.03036	-0.01943
	(0.26235)	(0.34352)	(0.54038)	(0.34199)	(0.49833)	(0.26624)	(0.34563)	(0.56312)	(0.34831)	(0.4944)
Secondary	0.03277	0.38132	0.11536	0.39054	0.48116	0.00644	0.36448	0.0816	0.35296	0.45884
	(0.19592)	(0.25857)	(0.37923)	(0.25772)	(0.32596)	(0.19913)	(0.26248)	(0.38431)	(0.26403)	(0.33099)
Post-secondary	4.7382***	3.68572***	5.83633***	3.65091***	3.19549***	4.35719***	3.30458***	5.58242***	3.27321***	2.79295**
	(0.70051)	(0.79032)	(1.17955)	(0.79049)	(0.85444)	(0.69948)	(0.78873)	(1.22712)	(0.79032)	(0.8513)
Household size	**-0.57533*** **	**-0.64363*** **	**-0.41766** **	**-0.56389*** **	**-0.86391*** **	**-1.13649*** **	**-1.20555*** **	**-0.79771+**	**-1.38096*** **	**-1.42379*** **
	(0.08439)	(0.10781)	(0.14093)	(0.1185)	(0.14026)	(0.15389)	(0.1777)	(0.44854)	(0.25933)	(0.21631)
Pensioner	-1.77505**	-2.42359**	-1.99582+	-1.83376*	-3.5274**	-0.5367	-0.92205	-1.83345+	-1.29621	-2.06249+
	(0.67914)	(0.86156)	(1.02804)	(0.86737)	(1.09007)	(0.72396)	(0.9355)	(1.07551)	(0.90747)	(1.16789)
Fetches water	-4.83559***	-5.76686***	-4.92337***	-5.80204***	-8.99203***	-5.24451***	-6.2597***	-5.25555***	-6.29515***	-9.49304***
	(0.64183)	(0.81833)	(1.14398)	(0.8215)	(1.18392)	(0.65456)	(0.84465)	(1.2004)	(0.8475)	(1.19832)
Fetches wood	-2.27252**	-3.47491***	-3.32159**	-3.52775***	-5.82035***	-2.20686**	-3.32088***	-3.2395*	-3.23998**	-5.70604***
	(0.72119)	(0.91491)	(1.23362)	(0.90804)	(1.42271)	(0.72358)	(0.93273)	(1.24613)	(0.94044)	(1.43289)
Log of other income	-0.21061	-0.1086	0.87618+	-0.09976	0.0069	0.18664	0.25192	1.22323*	0.29302	0.38771
	(0.23587)	(0.27409)	(0.49841)	(0.27331)	(0.34613)	(0.25717)	(0.29112)	(0.59992)	(0.3019)	(0.36875)
housewife	-16.039***	-19.219***	-16.713***	-19.333***		-15.965***	-19.109***	-16.590***	-18.959***	
	(0.69249)	(0.81769)	(0.95504)	(0.8272)		(0.69454)	(0.82416)	(0.99324)	(0.84006)	
Three generation household				-1.50099+					1.66694	
				(0.90221)					(1.2707)	
Other extended household				-0.38822					0.98248	
				(0.95252)					(1.02125)	
N	6826	4313	1689	4313	3039	6826	4313	1689	4313	3039
F	101.2	100.68	42.46	90.22	24.56	97.73	98.46	41.95	86.46	25.85
R^2	0.2417	0.258	0.1941	0.2586	0.1031	0.2339	0.2511	0.1901	0.247	0.0964
Over identifying restrictions $\chi^2(2)$						3.394	2.033	1.641	1.961	1.332
Hausman						25.27	18.87	0.8	15.07	12.7

Notes a) Entire subsample b) Women aged 25 to 49 c) Women aged 25 to 49 in three generational households d) Women aged 25 to 49 who are not housewives.
+significant at 10% level * significant at 5% level ** significant at 1% level *** significant at 0.1% level
The subsample includes African women aged 16 to 59 who were not in the formal education system and who were not out of the labour force due to mental or physical incapacity. All regressions include geographical dummies for rural/urban/metro. The regressions also contain a dummy for individuals where "other income" was zero. The education variables are linear splines of education completed, with knots at 3 years, 7 years and 12 years.
The regressions were run using the Stata svyreg and svyivreg commands, weighting the data, correcting for clustering and adjusting the standard errors for the fact that the subpopulation size is itself a variable.