Are Better–off Households More Unequal or Less Unequal?

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Within the framework of intrahousehold bargaining, it is argued that (1) targeting of transfers to disadvantaged members of the household is important, (2) structural adjustment that favors cash crops over food crops may end up worsening intrahousehold inequality, and (3) as households become better-off, intrahousehold inequality may first increase and then decrease (in other words, there may exist a Kuznets curve for intrahousehold inequality).

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In many parts of the world, resources within a household are apparently not distributed according to need.

Using a model of intrahousehold bargaining, Haddad and Kanbur first try to answer the question: As households become better-off, does intrahousehold increase or decrease? This is the household-level counterpart to a classic question Kuznets (1955) posed at the level of the economy as a whole. They find that under certain conditions intrahousehold inequality first increases and then decreases, in other words, a Kuznets-type "inverse-U" curve.

The debate on intrahousehold inequality is entwined with policy questions about the efficacy of targeting individual disadvantaged members of a household, as opposed to poor households in general. Haddad and Kanbur

found that an intrahousehold bargaining view (more than a household welfare maximization perspective) tends to support targeting to disadvantaged members of the household, because of bargaining power effects.

The bargaining framework also gives support for the concern that some observers have expressed about the impact of structural adjustment on intra-household inequality. When cash crops are predominantly under male control and food crops are primarily a female preserve, improving the relative price of cash crops can worsen intrahousehold inequality.

According to Haddad and Kanbur, the policy implications of applying intrahousehold bargaining theory to social policy questions are important enought that this work should continue at an accelerated pace.

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1. Introduction

The comfortable (and perhaps comforting) assumption of the unitary household has come under increasing attack in recent years. In many parts of the world, it would appear that resources within a household are not distributed in proportion to need (for a recent survey, see Behrman, 1989). There appears to be sufficient intra-household inequality to throw out standard estimates of overall inequality by an order of 30 to 40 percent (Haddad and Kanbur, 1989a). While the evidence is by no means uniform (see Deaton, 1989), there is enough of it to warrant attempts at an analysis of the phenomenon of intra-household inequality.

Many authors have adopted the framework of a household maximizing a modified Utilitarian Welfare Function with a distribution of weights on different individual utilities (e.g. Behrman, 1988). Others have taken an explicit bargaining approach, relying on modifications of two person cooperative bargaining theory (e.g., Manser and Brown, 1980). This latter approach has been criticized by some (e.g. Ulph, 1988) for failing to specify rational behaviour in the event of a breakdown in bargaining, while others have pointed out the difficulties of distinguishing empirically between the two approaches of household welfare maximization and cooperative bargaining. In this context, the approach of non-cooperative bargaining seems a fruitful avenue to be explored.

The literature has attempted to identify several determinants of intra-household allocation of resources and its inequality. However, in this paper our focus is on scale effects. As households become better off (in a sense still to be made precise) does intra-household inequality increase or decrease? It will be recognized at once that this is, in many ways, the micro counterpart to a classic question posed by Kuznets (1955) at the level of an economy as a whole. Kuznets directed our attention to the issue of whether inequality increases or decreases as the economy grows. A vast literature has grown up around this issue. The policy relevance of the question is clear when we consider the "trickle down" hypothesis and its critics. The latter argued that if growth is accompanied by increased

inequality, the benefits of growth may in fact not trickle down at all.

There is an analogous reason as to why we should be interested in possible "Kuznets effects" at the very micro level of intra-household allocations. As Sen (1984) notes, "The food consumption of a person depends, among other things, on (1) the power of the family to command food, and (2) the division of food within the family." Clearly, the same point applies to resources in general. But if there is a systematic relationship between the total resources available to a household and its distribution within the household, then it needs to be investigated, so that policy can be informed as to if and how any increase in total household resources will in fact "trickle down" to individuals within the household.

Our object in this paper is to begin an inquiry into Kuznets effects at the intra-household level within the framework of bargaining. Section 2 lays out the basic theory of scale effects on inequality in the context of simple Nash Bargaining and Non-Cooperative Bargaining. Section 3 uses these results to trace out the behavior of inequality as a household becomes better off. Section 4 presents further applications of the framework, to two recent policy concerns. Section 5 concludes the paper.

2. Bargaining, Inequality and Scale Effects

2.1 Two-Person Nash Bargaining

Consider a two person household that has to divide a cake of size X. Let the proposed division be $\chi_1 + \chi_2$ to the two individuals. Clearly, it is natural to suppose that

$$(1) \qquad\qquad \chi_1 + \chi_2 - X$$

But which of the several combinations of $\chi_1 + \chi_2$ will actually arise? In his classic paper, Nash (1950) axiomatized an appealingly simple answer to this question (see Friedman, 1986,

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for a modern treatment). If s_1 and s_2 are the fall back positions the two individuals have access to in the absence of the bargain (with $s_1 + s_2 < X$, so that bargaining is worthwhile) then the outcome of the bargain should depend on the relative values of s_1 and s_2, with the simple intuition that the better is an individual's fall back option, the better should be his bargaining outcome. Nash's axioms lead to a solution to the bargaining problem which can be shown to be a solution to the following problem:

(2)
$$Max \quad (\chi_1 - s_1)(\chi_2 - s_2)$$
$$\chi_1, \chi_2$$
$$s \cdot t \cdot \chi_1 + \chi_2 = X$$

The solution is easily shown to be:

(3)
$$\chi_1 = \frac{1}{2}(s_1 - s_2) + \frac{1}{2}X$$
$$\chi_2 = \frac{1}{2}(s_2 - s_1) + \frac{1}{2}X$$

More complicated structures can be built on to this simple framework. For example, some writers introduce a "bargaining strength" parameter, α, which modifies (2) as follows

$$Max \quad (\chi_1 - s_1)^\alpha (\chi_2 - s_2)^{1-\alpha}$$
$$\chi_1, \chi_2$$
$$s \cdot t \cdot \chi_1 + \chi_2 = X$$

However, for our purposes (2) and (3) will suffice. As can be seen from (3), any deviation from equal shares is explained by the difference in the "threat points" s_1 and s_2. Quite simply, the larger the difference, the greater the inequality. Without loss of generality, suppose $s_1 > s_2$. Then an obvio measure of inequality in this two person world is the deviation, from half, of the better off individual's share of the cake.

(4)
$$I - \frac{x_1}{X} - \frac{1}{2} - \frac{1}{2} \cdot \frac{s_1 - s_2}{X}$$

Equation (4) provides a basic insight into the impact of scale effects on the inequality of a distribution arising out of Nash bargaining.

(5)
$$d\ln I - d\ln(s_1 - s_2) - d\ln X$$

As scale increases then, ceteris paribus, inequality falls. For given values of threat points, as the size of the cake grows bargaining itself becomes less important and the allocation tends to equal shares. In general, of course, the threat points will also change and our task is to model the relative strengths of these two forces. This task is taken up in Section 3.

2.2 Non-Cooperative Bargaining

Nash's use of the threat points, motivated as "outside options" available to the two players, has been criticized. Suppose, for example, that although s_1 and s_2 are different, they are each of them less than $\frac{1}{2}x$. Consider a candidate allocation of $\frac{1}{2}x$ to each of the two players. Then a threat from individual 1 to disrupt the bargaining process unless allocation (3) is agreed to is an empty threat. It is not credible since without the bargain individual 1 will have s_1, which is less than the current candidate allocation of $\frac{1}{2}x$.

Moreover, some of the motivation for the Nash solution is given in terms of the individual with the larger security level being able to "hold out" for longer until a bargain is struck. But such an intertemporal waiting process should be made explicit. Recently Rubinstein (1982) has put forward a framework of two-person bargaining in an intertemporal framework that can be used to advantage in assessing the role of the "outside options" s_1 and s_2 in determining the outcome of the bargaining process. Sutton (1986) provides a good discussion of the "outside option principle," and we rely on his exposition.

Consider the following game. At the start, one of the players, say Player 1, proposes a division of the cake: χ_1 and $X-\chi_1$. Player 2 can (i) accept this offer, in which case the game ends; (ii) reject the offer but make a counter-offer X_2 and $X-\chi_2$; (iii) reject the offer and terminate the bargaining process by taking up his outside option, s_2. If player 2 chooses (ii) and makes a counteroffer, then Player 1 faces the same three categories of choices, and so on. We suppose the individuals are infinitely lived and have the same discount rate. We can also make the time period between offer and counter-offer infinitesimally small in order to remove any "first player" advantage that accrues to Player 1. Following Rubinstein (1982) and Sutton (1986), it can be shown that this non-cooperative bargaining game has a Perfect Equilibrium with the following allocations:

(6)

$$s_1 < \frac{1}{2}X \; ; s_2 < \quad \frac{1}{2}X \; ; \quad \rightarrow \quad \chi_1 - \frac{1}{2}X$$

$$\chi_2 - \frac{1}{2}X$$

$$s_1 \geq \frac{1}{2}X \; ; s_2 < \frac{1}{2}X \; ; \quad \rightarrow \quad \chi_1 - s_1$$

$$\chi_2 - X - s_1$$

Notice that we are still assuming that $s_1 + s_2 < X$, so that there are gains from reaching a bargain, and that $s_1 > s_2$ (without loss of generality).

The intuitive argument behind (6) is straightforward. If s_1 exceeds ½X, then Player 2 needs to offer Player 1 at least s_1 to keep him in the game. There is no point offering more since by offering s_1 (plus "ε") he could keep him in the game. On the other hand, Player 1 demanding more than s_1 does not pose a credible threat, since his outside option is equal to his gain from the ge. If, on the other hand, s_1 is less than ½X, so that s_2 is also less than ½X. (recall that $s_1 > s_2$), then these outside options do not pose a credible threat to the

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allocation $\chi_1 = \frac{1}{2}X$; $\chi_2 = \frac{1}{2}X$. We thus arrive at (6) as the only equilibrium allocation outcome of the bargaining process.

With this allocation, the inequality measure I is as follows:

$$(7) \qquad I = \frac{\chi_1}{X} - \frac{1}{2} = \begin{cases} \dfrac{s_1}{X} - \dfrac{1}{2} & ; \quad X < 2s_1 \\ \\ 0 & ; \quad X \geq 2s_1 \end{cases}$$

Thus as X increases from $s_1 + s_2$ (the minimum value necessary for the bargaining to be worthwhile to both parties), with given values of s_1 and s_2, the inequality measure falls to zero till X reaches $2s_1$. After that it stays at zero.

$$(8) \qquad dlnI = \left[\frac{1}{\dfrac{s_1}{x} - \dfrac{1}{2}}\right] [dlnS_1 - dlnX]$$

Equation 8 shows us once again the balance between "scale effects" as reflected in X and "bargaining strength effects" as reflected in s_1. The basic insight is that scale effects tend to lead to lower inequality. The question is whether they dominate the bargaining strength effects. For this we need a specific model, and the next section attends to this task.

3. Is There an Intra-Household Kuznets Curve?

We suppose a household of two agents, each of whom has access to a production function $f(n;\theta)$, where n is a parameter specific to each individual, taking on values n_1 and n_2, and θ is a parameter common to the household. We suppose that

$$(9) \qquad f_n > 0 \; ; f_\theta > 0$$

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The difference in n_1 and n_2 is the cause of asymmetry and inequality. Without loss of generality, we assume $n_1 > n_2$. This can be interpreted as differences in ability, access to different sized plots of land, etc. The parameter θ is interpreted as a scale variable that improves production for both agents: improvement in technology (e.g. the high yielding varieties of the Green Revolution), irrigation, general wage rates (where n is interpreted as ability) etc.

We assume that

$$(10) \qquad f(n_1 ; \theta) + f(n_2 ; \theta) < f(n_1 + n_2 ; \theta)$$

Hence, there are gains from cooperation. But how will these gains be divided? If we suppose that in the absence of cooperation each individual has the fall back option of operating his own production function, then in terms of the terminology of the previous sections we have

$$(11) \qquad \begin{aligned} s_1 &= f(n_1 ; \theta) \\ s_2 &= f(n_2 ; \theta) \\ X &= f(n_1 + n_2 ; \theta) \end{aligned}$$

In the Nash bargaining model the measure of inequality becomes

$$(12) \qquad I_N = \frac{1}{2} \cdot \frac{f(n_1 ; \theta) - f(n_2 : \theta)}{f(n_1 + n_2 ; \theta)}$$

while in the Rubinstein model it is

$$(13) \qquad I_R = \begin{cases} \dfrac{f(n_1 ; \theta)}{f(n_1 + n_2 ; \theta)} - \dfrac{1}{2} & ; \quad f(n_1 + n_2 ; \theta) < 2f(n_1 ; \theta) \\ 0 & ; \quad f(n_1 + n_2 ; \theta) \geq 2f(n_1 ; \theta) \end{cases}$$

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We are now in a position to investigate how inequality behaves as a function of the scale effects parameter, θ for different types of production functions. Consider first of all the multiplicatively separable form

(14)
$$f(n \; ; \; \theta) = g(\theta)h(n)$$

Using this in (12) and (13) we get

(15)
$$I_N = \frac{1}{2} \cdot \frac{h(n_1) - h(n_2)}{h(n_1 + n_2)}$$

and

(16)
$$I_R = \begin{cases} \dfrac{h(n_1)}{h(n_1 + n_2)} - \dfrac{1}{2} & \text{if } h(n_1 + n_2) < 2h(n_1) \\\\ 0 & \text{if } h(n_1 + n_2) \geq 2h(n_1) \end{cases}$$

Notice, therefore, that <u>if output is multiplicatively separable in θ and n, then scale has no effect on inequality in either of the two bargaining models</u>.

Consider now the case where output is additively separable in θ and n:

(17)
$$f(n \; ; \; \theta) = g(\theta) + h(n)$$

In this case, again substituting in (12) and (13), we get

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(18)
$$I_N = \frac{1}{2} \cdot \frac{h(n_1) - h(n_2)}{h(n_1 + n_2) + g(\theta)}$$

(19)
$$I_R = \begin{cases} \dfrac{h(n_1) + g(\theta)}{h(n_1 + n_2)g(\theta)} - \dfrac{1}{2} & ; \quad h(n_1 + n_2) - 2h(n_1) < g(\theta) \\[2mm] 0 & ; \quad h(n_1 + n_2) - 2h(n_1) \geq g(\theta) \end{cases}$$

Notice first of all that for the production function (17), condition (10) requires that $h_{nn} > 0$. For low enough values of θ there are gains to cooperation. As θ increases the size of the cake increases, but so does the fall back option to each individual. However, as (18) shows, since the increments are identical for each individual they cancel each other out in their effects on threat points. What is left is the scale effect, so that inequality decreases with θ. Once θ becomes so large that bargaining is no longer worthwhile, each individual sticks to his fall back option and inequality is given by

$$I_N = \frac{h(n_1) + g(\theta)}{h(n_1) + h(n_1) + h(n_2) + 2g(\theta)} \quad ; \quad g \geq h_{12} - h_1 - h_2$$

where $h_{12} = h(n_1 + n_2)$; $h_1 = h(n_1)$; $h_2 = h(n_2)$. Thus inequality continues to decline as θ increases. Figure 1 depicts I_N as a function of g.

The story in the non-cooperative game is quite different. While there are gains to cooperation, for small θ the fall back options are so small relative to equal division of cooperative output that the latter is indeed the equilibrium outcome. Once θ becomes so large that the fall back option of individual 1 exceeds half the cooperative output, then he begins to get exactly his fall back option. But each increase in θ adds proportionately more to his fall back option than to the cooperative output so that, as can be seen by differentiating the first part of (19), inequality increases. When θ is so large that, $g \geq h_{12}-h_1-h_2$ cooperation ceases to be valuable and individuals revert to their own devices. Then inequality is given by

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$$I_R = \frac{h(n_1) + g(\theta)}{h(n_1) + h(n_2) + 2g(\theta)} \quad ; \quad g(\theta) \geq h_{12} - h_1 - h_2$$

and this <u>declines</u> with θ. Thus we get Figure 2, where inequality first increases and then decreases as the household gets better off--the Kuznets "inverse-U" relation!

The above illustrations take the case where cooperation is valuable at low values of θ. Let us now consider the opposite case, where cooperation only becomes valuable at high levels of productivity. Suppose:

(20)
$$f(n ; \theta) = e^{n\theta}$$

Now cooperation is not valuable till θ exceeds θ^*, where

(21)
$$e^{n_1\theta^*} + e^{n_2\theta^*} = e^{(n_1 + n_2)\theta^*}$$

While cooperation does not take place, inequality is simply:

$$I_R = I_N = \frac{e^{n_1\theta}}{e^{n_1\theta} + e^{n_2\theta}} - \frac{1}{2} \quad ; \quad \theta \leq \theta^*$$

It can be checked that this <u>increases</u> with θ. Beyond θ^*, the two bargaining models give different allocations, leading to inequalities:

(22)
$$I_N = \frac{1}{2} \frac{e^{n_1\theta} - e^{n_2\theta}}{e^{(n_1 + n_2)\theta}}$$

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$$
(23) \qquad I_R = \begin{cases} e^{-n_2\theta} - \dfrac{1}{2} & ; \quad \theta \le \dfrac{ln2}{n_2} \\[3mm] 0 & ; \quad \theta \ge \dfrac{ln2}{n_2} \end{cases}
$$

The shapes of I_N and I_R as functions of θ are depicted in Figures 3 and 4. We see that in both cases as the household becomes better off inequality first increases and then decreases-- the Kuznets inverse-U once again.

Thus, while in general there is no guarantee that the opposing forces of scale effects and bargaining strength effects will go together to produce an inverse-U shape, we have demonstrated cases where there is indeed a Kuznets curve at the micro level of intra-household inequality. It remains for empirical work to test this prediction with actual data.

4. Further Applications of the Framework

4.1 Intra-Household Targeting

The debate on intra-household inequality is entwined with the policy question of the efficacy of targeting individual, disadvantaged, members of a household. These concerns are reflected in the discussions in developed countries on whether child benefit should be paid through the father's pay cheque, or whether it should be an allowance that the mother picks up at a government office. They are also reflected in the discussions in developing countries on the efficacy of instituting special supplementary feeding programs for mothers and children. One argument is that this is the best way of making sure that some nourishment does indeed reach the disadvantaged within a household. Another argument is that this is a naive view of intra-household allocation--might there not be a reduction in the nourishment provided within the household to those who go to the supplementary feeding station? A counter to this is that so long as the substitution is not one for one, then at least part of the

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objective will have been achieved.

Some of these questions can be addressed in the simple framework we have developed. We think of a general resource transfer problem where the choice is between targeting the transfer to the disadvantaged within a household, and not doing so. In the latter case, we may suppose that resources are divided equally between the two individuals in our model.

There are several ways in which we can model the impact of transfers on the bargaining structure. First of all, we can suppose that these transfers do not alter the security levels of the two players in the game--they are merely an addition to the overall size of the cake. In this case, in the Nash bargaining model there will be equal division of the total increment to household resources (see eq. 3), no matter how and to whom the increment is targeted. In the non-cooperative bargaining model, however, the story can be very different, provided the increment is not so large as to not change the structure of the solution (6). If there was already equal division (because the two outside options were each less than one half of the total cooperative resource), then this will continue and the increment will also be divided equally, as in the Nash model. But if the dominant player's outside option exceeds one half of the total cooperative resource, so that the solution entails this player getting exactly his outside option, then the entire increment will go to the disadvantaged player, even though we assume that the transfers do not change outside options.

Now suppose that the transfers are indeed incorporated into outside options and increase them one for one. With Nash bargaining, the increment now stays with whoever gets it--there is a clear benefit to targeting the transfer to the disadvantaged player (assuming that the object is to increase his consumption). The same is true in the non-cooperative bargaining model. If the transfer is to the dominant player and this increases his outside option one for one, the resulting allocation entails him getting all the surplus. If the transfer is not to the dominant player then the disadvantaged keeps all the transfer.

Thus bargaining models tend to strengthen the argument in favour of targeting resource transfers to disadvantaged members within an additional household. Unlike household welfare maximization models, where the transfer is seen as an additional household resource to be distributed according to the rules of the household welfare function, if we view the transfer to a specific person as influencing his bargaining power, then there is a targeting gain to making sure that the transfer is indeed to the disadvantaged person.

4.2   Structural Adjustment and Intra-Household Inequality

During the 1980s, many developing countries, particularly those in Africa, have undergone programs of "structural adjustment." Among the important policy changes these programs entail is the encouragement of cash crop production for export. This is done through increasing the producer price of these crops (such as cocoa or coffee). In many of these countries certain food crops (eg root corps like cassava) are not internationally traded, and part of the general adjustment is to reduce the price of non-trade goods relative to traded goods.

These relative price changes, driven though they are by macroeconomic considerations, have significant distributional implications. A literature has begun to develop around these questions (eg Kanbur, 1987) but this has ignored intra-household inequality. At the same time, however, those familiar with the structure and division of responsibilities within African agricultural households have pointed to the fact that in these households cash crops are primarily a male preserve. Males tend to control the revenue from cash crops and dispose of them as they wish. At the same time, the "food crop plot" is the woman's responsibility and she uses the output from this to feed the family and the revenue from market sales of food to attend to children's needs. In this context, it has been argued by some that the price changes in favor of cash crops may end up worsening intra-household inequality.

It is beyond the scope of this paper to develop an adequate and satisfactory model of African agricultural structure. What we can do is to see what light the framework developed

in this paper can shed on structural adjustment and intra-household inequality. In order to do this we suppose, in our two-person household, that the man's fall back option is the cash crop plot while the woman's fall back option is the food crop plot. While cooperation can increase the total value of household income, division of the fruits of cooperation is with respect to the fall back options.

We use the following notation with food as the numeraire:

p   - price of cash crop relative to food

C_1 - cash crop output without cooperation

C   - cash crop output with cooperation

F_2 - food output without cooperation

F   - food output with cooperation

We need to assume that

$$F_2 + pC_1 < F + pC$$

so that cooperation is worthwhile. We also assume

$$pC_1 > F_2$$

so that individual 1 (the man, growing the cash crop) is the dominant bargainer.

We can now lay out the allocations in the two bargaining models and trace through the impact of relative price changes. Starting with the Nash bargain:

For the non-cooperative bargain, we assume that

$$pC_1 > \frac{1}{2}(F + pC)$$

$$\chi_1^N = \frac{1}{2}(pC_1 - F_2) + \frac{1}{2}(F + pC)$$

(24)
$$\chi_2^N = \frac{1}{2}(F_2 - pC_1) + \frac{1}{2}(F + pC)$$

$$I^N = \frac{1}{2} \cdot \frac{pC_1 - F_2}{F + pC}$$

so that player 1 receives his outside option always. In this case:

$$s_1^R = pC_1$$

(25)
$$\chi_2^R = F + pC - pC_1$$

$$I^R = \frac{pC_1}{F + pC} - \frac{1}{2}$$

Consider now the impact of an increase in p. For the Nash bargain:

(26)
$$\frac{d\chi_2^N}{dp} = \frac{1}{2}(C - C_1) > 0 \;\; if \; C > C_1$$

$$\frac{dI^N}{dp} = \frac{1}{2} \cdot \frac{FC_1 + F_2C}{[F + pC]^2} > 0$$

Thus, provided cooperative cash crop output exceeds non-cooperative cash crop output (a plausible assumption), we get that the disadvantaged party benefits. However, the advantaged party benefits even more--leading to an increase in inequality. In the Rubinstein non-cooperative bargaining model we have:

Thus in this model too, intra-household inequality increases, but not at the expense of actual immiserization of the disadvantaged member of the household.

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(27)

$$\frac{d\chi_2^R}{dp} - C - C_1 > 0 \quad \text{if } C > C_1$$

$$\frac{dI^R}{dp} - \frac{FC_1}{[F + pC]^2} > 0$$

5. Conclusion

The object of this paper has been to investigate the implications of intra-household bargaining models for the behaviour of intra-household inequality as a function of total household resources. We find theoretical support for a Kuznets inverse-U curve at the micro level--under certain conditions, a general improvement in household resources leads to first an increase and then a decrease in intra-household inequality. An empirical investigation of such a relationship is to be found in Haddad and Kanbur (1989b). In the latter part of the paper we investigated the implications of intra-household bargaining models for two questions that are prominent in the policy debate. We found that as compared to household welfare maximization models, bargaining models tend to lead to a greater emphasis on targeting to disadvantaged members of a household. Secondly, we found support for the worry some commentators have expressed concerning the impact of structural adjustment an intra-household inequality. In a situation where the male fall back option is cash crops and the female fall back option is food crops, an improvement in the relative price of the former can, through the bargaining allocation, worsen intra-household inequality. However, this does not mean an immiserization of the disadvantaged member--both benefit, but one benefits more than the other.

It should be clear that the analysis in this paper represents but a small part of the systematic application of bargaining theory to the emerging questions of intra-household allocation in developing countries. Much more theoretical and empirical work remains to be done, and the policy implications are important enough that this work should continue at an accelerated pace.

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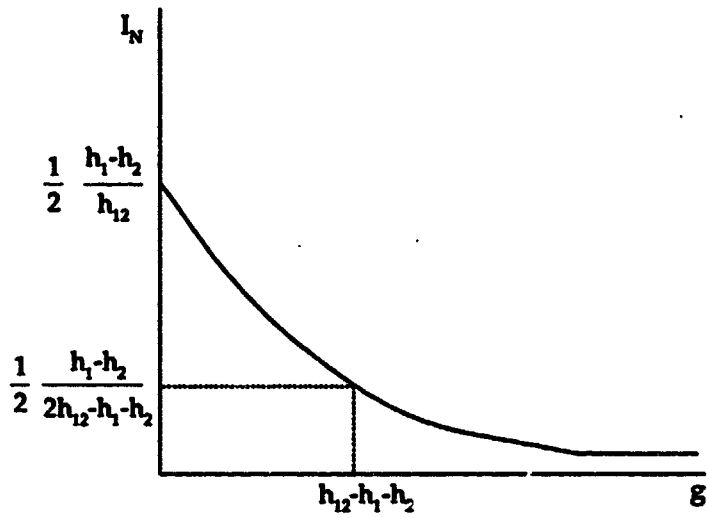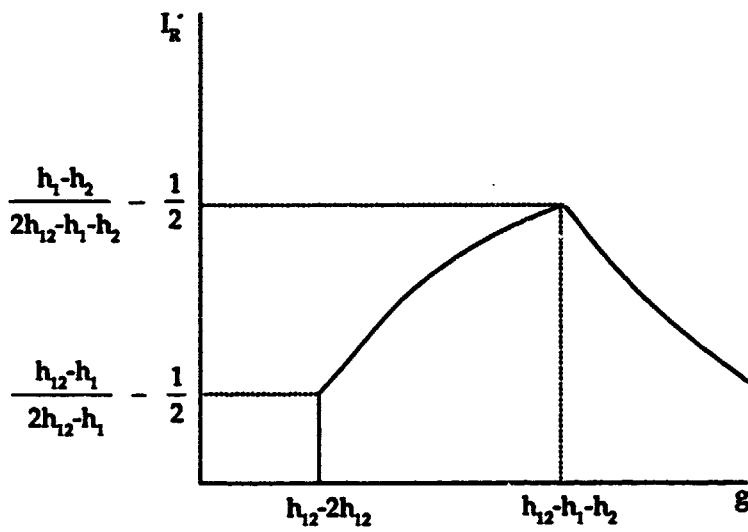
Figure 1

Figure 2
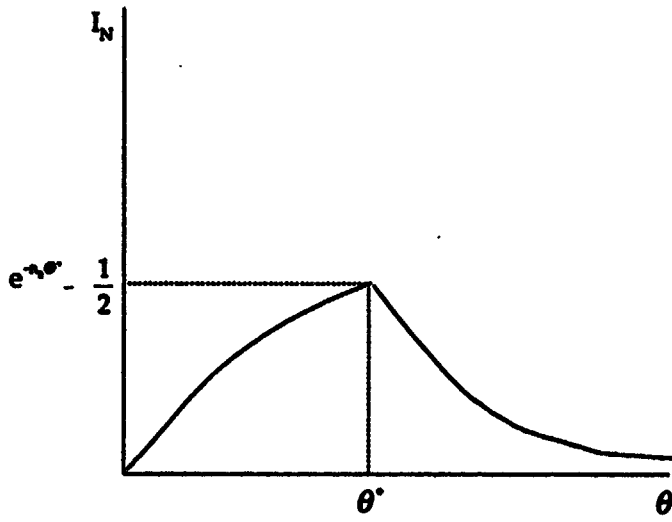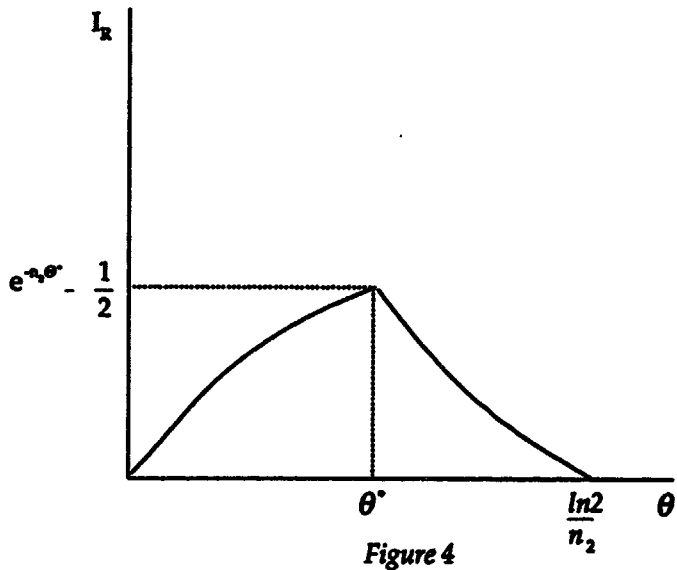
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Figure 3

Figure 4

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