Can robust pro-female policies be identified when the true model of the household is unknown?

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Abstract: This paper seeks to identify parameter changes which are robust in the sense that they benefit women relative to men in a wide range of household models. The models considered are unitary, Nash-bargaining and non-cooperative with and without cash transfers. Reductions in the relative price of 'female' consumer goods prices are robust; increases in relative wages are highly non-robust. Increases in the relative returns to domestic activities and transfers of financial, physical, and human assets to women are weakly robust in that they are unlikely to hurt women and benefit them in some cases though they make no difference in others.

1 Introduction

Work which uses the household as the fundamental unit of analysis is often accused of implicit gender bias. However, there are at least three competing models - unitary, bargaining and non-cooperative - consistent with intra-household inequality. Results on the policy and behavioural implications of different models are to be found in Sen (1988), Apps and Rees (1988), Ulph (1988), Alderman et al. (1994), Haddad and Kanbur (1992), Lindberg and Pollak (1993), Appleton and Collier (1995), Darity (1995), Doss (1996), Mackinnon (1996) McElroy (1997), Carter and Katz (1997), Alderman et al. (1997) and Appleton et al. (1997). However, the multiplicity of models tends to undermine the foundations of gender-sensitive economic policy; the literature cited above presents some very interesting specific cases where different models generate different policy conclusions, but there has not been a systematic treatment of the welfare implications of policies in all three kinds of model.

While some non-economists have used the multiplicity of models as a reason for replacing formal analysis by participation (Kabeer 1994), economists can respond to the multiplicity in two ways without abandoning formal policy analysis. The first approach, which motivates many of the papers cited above, is to identify observable differences between the models and test them. However, while empirical work has revealed a great deal about the household over the last fifteen years, it has not so far reduced the multiplicity of models, for two main reasons: the results are often not conclusive for a variety of econometric reasons surveyed in Behrman and Deolalikar (1988): and there is no reason to expect all households to be the same, especially since there is empirical evidence against the universal applicability of income-pooling and Pareto-efficiency. Indeed, some researchers who test for diversity find evidence of it. Dercon and Krishnan (1997) find interesting differences in the extent of risk-sharing across different parts of Ethiopia and attribute this to different marital institutions. The analogies of Keynesian-monetarist controversies and Cournot-Bertrand models of oligopoly show that even intense and prolonged research does not always achieve the elimination of plausible competing models.

This paper adopts a second, complementary approach, which examines the theoretical predictions of the models about the effects of exogenous parameter changes on the welfare of men and women within the household. In particular, I ask: if a policymaker believes that women are suffering relative disadvantage, but is unsure about the nature of the households in the population, can s/he identify policies which are **robust** in the sense that they will improve the relative status of women in all models ? Because welfare is not directly observable, this is a different theoretical problem from the derivation of testable implications of the different models (surveyed in Doss (1996)). Welfare, throughout this paper, is evaluated by a self-interested utility or subutility function in which an individuals' own consumption and time use are arguments.

This choice of utility function is important for two reasons. First, the inclusion of different forms of time use contrasts with the income-based approach which has been widely stressed in the empirical literature and which has been defended by Kanbur et al. (1994) as a basis for theoretical policy analysis, but corresponds to the practice in the literature on optimal taxation. It is important to include time use because there is evidence in some countries that women suffer relative disadvantage in time use rather than in consumption. One important consequence is that in some models a rise in relative wages for disagreeable jobs for women can reduce their welfare even though it increases their incomes. Secondly, the restriction of the welfare function to self-interest,

even where behaviour is partially altruistic, is designed to address the argument of Sen (1987) and Nussbaum (1995) that a utilitarian approach which incorporates altruism discriminates against women if they are conditioned to behave in a more self-sacrificing way than men.

I consider four alternative models of a two-person household: a unitary model, a Nash-bargaining model, and a non-cooperative model with two regimes, with and without cash transfers from husband to wife. Duality is used to simplify the analysis of unitary and bargaining models; this is not possible with non-cooperative models, where the household does not have a single maximand and it is necessary to examine consumption and time use separately. I examine four compensated parameter shifts: reductions in the relative prices of 'female' consumer goods: increases in relative female wages: increases in the returns to domestic output relative to cash-crops: and transfers of financial, physical and human assets from men to women. Compensated shifts are analysed in order to isolate the effects of parameter changes on relative welfare of the sexes; no claim is made about the effects of non-compensated changes. A full analysis of policy would need to relate the parameter shifts explicitly to policy instruments such as tax rates, and integrate the results of this paper with already existing results in public economics; this is, however, beyond the scope of one paper (some cases are considered in Apps and Rees (1988)). While it is not claimed that the range of models and policies considered is comprehensive (the range of possible non-cooperative models is infinite), it does provide a reasonable sense of the main competing alternatives.

Although many of the arguments are of universal interest, the structure of the non-cooperative models, and the structure of the non-cooperative model, is motivated by the case of sub-Saharan Africa. Many authors (for example (Gladwin (1991) Darity (1995), Whitehead (1991)) have argued that structural adjustment, which typically increases the returns to cash crops, is likely to be gender-biased because men are more involved in cash-cropping than women. What has not been widely appreciated is that this claim is highly sensitive to the structure of the model; the observations than men are better off than women and that they control most of the income from cash cropping do not imply that women lose from increases in the absolute or even relative returns to it. The results in this paper suggest that increases in the relative returns to cash cropping are likely to hurt women in some models; however, it is important to stress that the claim that women lose from absolute increases in cash cropping is much stronger and is not explored here.

The main results are as follows. Reductions in the price of commodities which form a higher share of women's than of men's spending benefit women; however, in some models the relevant variable is the share of total expenditure whereas in others it is the share of marginal expenditure. Increases in relative female wages can either hurt women or benefit them, depending on the model. Increases in the relative returns to domestic output, and transfers of assets to women, are much more likely to benefit women than to hurt them, although they may be gender-neutral.

The paper is organised as follows. Section 2 sets out the constraints on the household, the competing models of household allocation, and the representation of the policymaker's problem. Sections 3 to 6 use this framework to consider specific parameter changes which can be caused by economic policy. In each of these sections, I discuss the findings of each model and then discuss how robust the parameter change is. Section 7 concludes, raising various issues not captured in the formal models.

2 The alternative models of the household

The constraints on the household are common to all the models, but behaviour differs among them.

2.1 The constraints on the household

There are two individuals, a husband and wife, indexed *m* and *f*. They consume vectors of goods x_m and x_f at a price vector *p*, and scalars of domestically produced goods z_m and z_f which are produced by domestic labour h_m, and h_f through a production function $f(h_m, h_f)$. The household also produces a cash crop using its own labour l_m, l_f through a production function $g(l_m, g_f)$ and sells the output for the exogenously given price p_c. Both production functions are assumed to have diminishing returns and to be increasing in both parties' labour; it is also assumed that the cross-partial derivatives are negative, so that male and female labour are (not necessarily perfect) substitutes. Each individual's time endowment is normalised to unity and distributed across *h*, *l*, *L*, which is leisure, and labour supplied to the market for the exogenously set wage w_m or w_f; thus wages received are $w_m(1-h_m-l_m-L_m)$ and $w_f(1-h_f-l_f-L_f)$. Finally, individual unearned income is given by y_m and y_f.

Total consumption must satisfy the following equations:

$$C \equiv p'x_m + p'x_f = w_m(1-l_m-h_m-L_m) + w_f(1-l_f-h_f-L_f) + p_c \qquad \textbf{(1)}$$

$$z_m + z_f = f(h_m,h_f) \qquad \textbf{(2)}$$

Finally, individual welfare is measured by a self-interested utility function, assumed cardinal and interpersonally comparable, given by

$$u_i = u_i(x_i,z_i,l_i,h_i,L_i), \quad \frac{\delta u_i}{\delta x_{ij}} > 0, \quad \frac{\delta u_i}{\delta z_i} > 0, \quad \frac{\delta u_i}{\delta L_i} > 0 \qquad \textbf{(3)}$$

This utility function is used to measure welfare in all models and will play a role in predicting individual behaviour in the non-cooperative model. Wage labour is implicitly included through the requirement that all forms of time use sum to 1 for each person. The first derivatives of utility with regard to *l*, *h* and *L* represent the marginal utility from substituting these forms of time use for wage labour; these first derivatives are ambiguous in sign for *h* and *l* but must be positive for *L*. The matrix of second-derivatives is assumed negative definite. It is assumed that $\delta u_i/\delta z_i$ and $\delta u_i/\delta L_i$ tend to infinity as z_i and L_i respectively tend to zero. Defining individual cash expenditure C_i as $p'x_i$, indirect utility v_i is defined as

$$v_i(C_i, p, z_i, h_i, l_i, L_i) = \max_{x_i} u_i(x_i, z_i, l_i, h_i, L_i) \; s.t. \; p'x_i \qquad \textbf{(4)}$$

and is increasing and concave in income. It will be assumed that $\delta v_i/\delta C_i$ tends to infinity as C_i tends to zero.

These functions represent the welfare of men and women used by the policymaker. The prediction of individual behaviour uses them indirectly. In the unitary and bargaining models, the household maximises a function of the individual utility functions. In the non-cooperative case, men and women are imperfect altruists who maximise weighted sums of their own and their spouse's self-interested utility.

2.2 Pareto-efficient models of the household

The econometric implications of internal Pareto-efficiency have been studied by Chiappori (1992). Chiappori's representation encompasses models with very different policy implications; for the purposes of this paper, it is necessary to distinguish them. Hence I analyse both unitary and Nash-bargaining models. In both, the household jointly takes labour supply and consumption decisions to maximise functions of individual self-interested utility. In the unitary model, the household maximises H as defined by

$$H = \alpha_m u_m + \alpha_f u_f, \quad \alpha_m > \alpha_f \qquad \textbf{(5)}$$

The constancy of α_m and α_f distinguishes the unitary model from other Pareto-efficient models. This model might represent the outcome of the decisions taken by a single household member, a 'patriarch', or a negotiated solution to internal family discussions. The paper's results continue to hold if $\alpha_m = \alpha_f$ or $\alpha_m < \alpha_f$, but policy implications change since women are no longer relatively disadvantaged.

In the bargaining model the household maximises N defined by

$$N = (u_m - \overline{u_m})(u_f - \overline{u_f}) \qquad \textbf{(6)}$$

where u represents the outside option taken in the event that bargaining fails. Outside options have been variously interpreted as divorce, return to the parental home, and reversion to a non-cooperative equilibrium defined by social norms (see McElroy (1997) and Lundberg and Pollak (1993)). In this paper, outside options are not explicitly modelled, but the discussion will assume that they represent the welfare of one-person male and female households after divorce. McElroy (1997) offers an interesting general justification of the importance of outside options based on the functioning of marriage markets.

Comparative statics for these two models are derived using a dual approach as follows. Define the household's full income Y by

$$Y = \Sigma_{i=m,f} w_i(1 - l_i - h_i - L_i) + p_c g(l_m, l_f) + p^* f(h_i, l_i) + w_i L_i + (w_i \qquad \textbf{(7)}$$

where p^* is the shadow price of non-traded output and w^*_{il} and w^*_{ih} are the shadow wage of labour on cash crops and household goods respectively. Time is thus valued at the market wage, and activities which are less (more) productive than wage labour are treated as positive (negative) expenditure valued at the difference between the returns to them and the market wage. Because there is no joint consumption or externality, all consumption is clearly attached to individuals and therefore individual shadow expenditure E_i can be defined

$$E_i = p'x_i + (w_i - w^*_{li})l_i + (w_i - w^*_{hi})h_i + p^*z_i + w_iL_i \qquad \textbf{(8)}$$

All Pareto-efficient allocations can be represented by a decision process whereby individuals are allocated a total shadow expenditure E_i and then choose consumption and time use to maximise utility subject to their personal expenditure constraint (Chiappori 1997). The constraints on the household require that shadow prices adjust to induce labour supplies and consumption which satisfy equations (1) and (2); this will imply that

$$\Sigma_{i=m,f} E_i = Y \qquad \textbf{(9)}$$

Equivalently, the household chooses consumption and time use for both individuals to minimise total shadow expenditure $\Sigma_i E_i$, given p_c, w^* and p^*, subject to a given level of the maximand H or N. Individual shadow expenditures, similarly, are minimised subject to a utility constraint, implying an expenditure function E_i for any given utility level u_i'

$$E_i(w_i,\ w^*_{li},\ w^*_{hi},\ p,\ p^*, u_i') = \min_{x_i,z_i,x_i,h_i,l_i} E_i \ \ s.t.\ \ u_i = u_i' \qquad \textbf{(10)}$$

The solutions to the household's problem imply first-order conditions, where subscripts denote partial derivatives:

$$\frac{E_{um}}{\alpha_m} = \frac{E_{uf}}{\alpha_f} \qquad \textbf{(11)}$$

for the unitary model and

$$E_{um}(u_m - \overline{u_m}) = E_{uf}(u_f - \overline{u_f}) \qquad \textbf{(12)}$$

I now derive the comparative statics of compensated parameter changes. A compensated change will be defined for the unitary case as one which satisfies

$$du_m = -\frac{\alpha_f}{\alpha_m} du_f \qquad \textbf{(13)}$$

and for the bargaining case as one which satisfies

$$du_m = -\frac{(u_m - \overline{u_m})}{(u_f - \overline{u_f})} du_f \qquad \textbf{(14)}$$

A compensated price change in the unitary model leaves the maximand H unchanged. In the Nash-bargaining case, a compensated change is defined as one which moves the utility of the two parties in opposite directions and would leave the maximand N unchanged if it did not also alter the outside options. (Defining compensation by constancy in N would allow 'compensated' price changes to hurt, or benefit, both parties; hence the definition used here).

Totally differentiating (11) and (12), substituting (13) and (14) into the result, and exploiting the equality of the second derivatives of cost functions with the derivatives of Hicksian demands, we get for the unitary case,

$$du_f = (\alpha_m E_{uuf} + \frac{\alpha_f^2}{\alpha_m} E_{uum})^{-1} [\alpha_f (\frac{dx_m}{du_m} dp + d\frac{(1 - l_m - h_M - L)}{du_m} dw_m +$$
$$-\alpha_m (\frac{dx_f}{du_f} dp + d\frac{(1 - l_f - h_f - L_f)}{du_f} dw_f + \frac{dh_f}{du_f} dw_{hf}^* + \frac{dl_f}{du_f} \qquad \textbf{(15)}$$

and for the bargaining case

$$du_f = (\frac{(u_m - \overline{u_m})^2}{(u_f - \overline{u_f})} E_{uum} + (u_f - \overline{u_f}) E_{uuf} + (1 + \frac{u_f - \overline{u_f}}{u_m - \overline{u_m}}$$
$$[(u_m - \overline{u_m})(\frac{dx_m}{du_m} dp + d\frac{(1 - l_m - h_M - L_m)}{du_m} dw_m + \frac{dh_m}{du_m} dw_{hm}^* + \frac{dl_m}{du_m} dw_{cm}^* +$$
$$-(u_f - \overline{u_f})(\frac{dx_f}{du_f} dp + d\frac{(1 - l_f - h_f - L_f)}{du_f} dw_f + \frac{dh_f}{du_f} dw_{hf}^* + \frac{dl_f}{du_f} dw_{cf}^* + \cdot \qquad \textbf{(16)}$$

These apparently complex equations have a simple structure. The first term on the right-hand side of each equation is positive, from the convexity of the expenditure function in utility. Hence the sign of (15) depends on the sign of the product of changes in (market and shadow) prices and wages with the derivatives of the respective Hicksian demands with respect to utility. (16) has the same structure, but movements in the outside options also feature. (16) allows us to disaggregate the impact of any parameter change into three components: the direct impact of the change itself,

the effects of resulting changes in shadow prices, and the effects of resulting movements in the utility derived from outside options.

Finally, Pareto-efficiency implies the equality of shadow wages with shadow marginal products in any activity undertaken:

$$w_{li}^{*} \leq p_c(\delta g/\delta l_i), \quad l_i \geq 0 \qquad \textbf{(17)}$$

$$w_i^{*} \leq p_z^{*}(\delta f/\delta h_i), \quad h_i \geq 0 \qquad \textbf{(18)}$$

2.3 Non-cooperative models

The *a priori* appeal of Pareto-efficiency is balanced by empirical evidence against it. Jones (1986) found that women in Cameroon under-allocated labour to cash crops because their husbands controlled income from them. Udry (1996) found that marginal products differed across men's and women's plots; the incentive to work on one's own plot was important. In East Africa, qualitative evidence shows that husbands often control most of the income generated from cash crops and that women resent working on them as a result (Nalwanga-Ssebina and Natakunda (1988), von Bulow and Sorensen (1993), Harmsworth (1991)).

This section develops a non-cooperative alternative. There cannot be a single archetypical non-cooperative model, because the allocation of decisions, the order of moves, and the modelling of non-cooperative equilibrium can all vary between models. Non-cooperative models have been developed by Ulph (1988), Darity (1996), Hoddinott and Haddad (1995) and Carter and Katz (1997)), though most of these authors do not explicitly derive the comparative statics of individual utility. Typical features of these models include the use of noncooperative Nash solutions in labour allocation and/or consumption and the importance of transfers. The model presented in this paper starts from some stylised facts about African rural households. First, men control most of the income from cash crops. Secondly, women have responsibility for some decisions involving food crops (though there is sometimes strong male involvement here too; in some parts of Uganda, a wife will consult her husband before picking bananas for the evening meal). Thirdly, women do some of the work on cash crops. Fourthly, this allocation of decisions creates an incentive problem.

The two agents are imperfect altruists. The husband's objective function is

$$\beta_m u_m + \beta_f u_f \,,\ \beta_m > \beta_f \qquad \textbf{(19)}$$

and the wife's is

$$\gamma_m u_m + \gamma_f u_f \,,\ \gamma_m < \gamma_f \qquad \textbf{(20)}$$

In the first stage, both parties choose labour supply to all three activities. They take these decisions independently, generating a noncooperative Nash equilibrium in amounts of time supplied to each activity. At the second stage, the husband collects his wage income and the income from cash crops; the wife collects her own wage earnings and also controls domestic output. Each party may then make a transfer to their spouse. In the final stage, individuals choose their expenditure, constrained by the post-transfer endowments of domestic and purchased goods. The first-stage labour supply decisions correctly anticipate the effect on the subsequent allocation of goods.

In this model, a compensated parameter change will be defined as one which produces no change in the sum of utility, $u_m + u_f$. As with the Pareto-efficient models, this implies that if a compensated change benefits one party it will hurt the other. In the absence of a household maximand, the dual approach fails to simplify the problem, and comparative statics are therefore analysed using the primal, starting with the decomposition

$$du_i = \frac{dv_i}{dC_i} dC_i + \frac{du_i}{dz_i} dz_i + \frac{du_i}{dL_i} dL_i + \frac{du_i}{dh_i} dh_i + \frac{du_i}{dl_i} dl_i \qquad \textbf{(21)}$$

The two second-stage decisions, which allocate purchased and domestic goods, follow from the choice of transfers to maximise (19) and (20) subject to (1) and (2) respectively, yielding first-order conditions

$$\beta_f u_{xf} \leq \beta_m u_{xm} \qquad \textbf{(22)}$$

and

$$\gamma_m u_{mz} = \gamma_f u_{fz} \qquad \textbf{(23)}$$

The restrictions on the utility function imply that there must be transfers of domestic output from women to men; otherwise men's marginal utility from domestic output would be infinite. If women are earning wages, the same argument does not apply to transfers of purchased goods; hence (22), but not (23), can hold with inequality. This give two regimes, with and without cash transfers, whose comparative static properties differ.

If there are cash transfers, totally differentiating (22) and (23) and substituting in the total derivatives of (1) and (2), we get

$$\begin{aligned} dC_f = (\beta_f v_{CCF} + \beta_m v_{CCm})^{-1} [\beta_m (v_{CCm} dC + v_{zCm} dz_m + \Sigma_j v_{Cp_j n} \\ - \beta_f (v_{zzf} dz_f + \Sigma_j v_{Cp_j f} dp_j + v_{lCf} dl_f + v_l \end{aligned} \qquad \textbf{(24)}$$

and

$$dz_f = (\gamma_m u_{zzm} + \gamma_f u_{zzf})^{-1}[\gamma_m(u_{zzm}df(h_m,h_f) + u_{Czm}dC_m + u_{l}$$
$$- \gamma_f(u_{zCf}dC_f + u_{lzf}dl_f + u_{hzf}dh_f + u \quad \textbf{(25)}$$

These resemble (15-16) but apply to any set of parameter changes, whether compensated or not.

Both agents take labour supply decisions in correct anticipation of their effect of increasing income on personal welfare, dv_i/dC and $du_i/df(h_m, h_f)$. These can be found from (22-5), setting $dp=dl=dh=dL=0$ and using the chain rule

$$\frac{du_i}{dC} = v_{Ci}\frac{dC_i}{dC}, \qquad \frac{du_i}{df(h_m,h_f)} = u_{zi}\frac{dz_i}{df(h_m,h_f)}, \qquad i = m, f \quad \textbf{(26)}$$

First-order conditions then give, for men:

$$\beta_m u_{Lm} \geq w_m(\beta_m\frac{dv_m}{dC}+\beta_f\frac{dv_f}{dC}),\ (1-h_m-l_m-L_m)\geq 0 \quad \textbf{(27)}$$

$$\beta_m u_{Lm} \geq \delta f/\delta h_m(\beta_m\frac{du_m}{df(h_m,h_f)}+\beta_f\frac{du_f}{df(h_m,h_f)}) + \beta_m u_{hm},\ h_m\geq 0 \quad \textbf{(28)}$$

$$\beta_m u_{Lm} \geq p_c\delta g/\delta l_m(\beta_m\frac{dv_m}{dC}+\beta_f\frac{dv_f}{dC}) + \beta_m u_{lm},\ l_m\geq 0 \quad \textbf{(29)}$$

and for women:

$$\gamma_f u_{Lf} \geq w_f(\gamma_m\frac{dv_m}{dC}+\gamma_f\frac{dv_f}{dC}),\ (1-h_f-l_f-L_f)\geq 0 \quad \textbf{(30)}$$

$$\gamma_f u_{Lf} \geq \delta f/\delta h_f(\gamma_m\frac{du_m}{df(h_m,h_f)}+\gamma_f\frac{du_f}{df(h_m,h_f)}) + \gamma_m u_{hm},\ h_h\geq 0 \quad \textbf{(31)}$$

$$\gamma_f u_{Lf} \geq p_c\delta g/\delta l_f(\gamma_m\frac{dv_m}{dC}+\gamma_f\frac{dv_f}{dC}) + \gamma_f u_{lf},\ l_f\geq 0 \quad \textbf{(32)}$$

with complementary slackness in each case. Both parties always consume some leisure. It will be assumed that this problem generates a unique Nash equilibrium in labour supply. One individual's

commitment of time to a particular activity is typically decreasing in the other person's commitment of time to the same activity.

2.4 The policymaker

The policymaker wants to transfer welfare, measured by self-interested-preferences (3), from men to women. Of course, a full treatment of optimal policy would derive this objective from a social welfare function, but the purpose of this paper is to isolate the effects on the relative welfare of the sexes rather than to attempt the much larger exercise of characterising optimal policy. The tools directly available to policymakers are not modelled. However, changes in prices and wages can be influenced by taxes, subsidies, and employment generation schemes (see Ravallion and Datt (1995)): the distribution of assets can be influenced by direct transfers, incentives for female education, or changes to land rights: and the relative returns to cash cropping and domestic production can be influenced by marketing and exchange rate policy, and improvements in water supply, energy sources, and cooking technology. Only compensated parameter changes are modelled. The question addressed is whether a given change will make women better off, and men worse off, in each model. A compensated parameter change is defined as *robust* if it benefits women in all cases, or *weakly robust* if it does not hurt women in any case.

3 Changes in relative consumer prices

The gender implications of changes in consumer prices have been relatively little discussed in the literature (though see Apps and Rees (1988)). The change considered here is a compensated movement in different elements of the vector p.

Unitary and bargaining models

(15) and (16) provide the basis for analysis, setting $dw_m = dw_f = 0$. For a compensated price change, some elements of the vector p will rise while others fall.

The direct effects are found by setting $dw_m = dw_f = dp^* = dw^*_{il} = dw^*_{ih} = 0$ in (15) and (16). The sign of (15) and (16) now depends on the sum, over commodities, of the product of the movement in the price of the good with the derivative of demand for the good with respect to utility. Substituting the first-order conditions (13) and (14) into the relevant terms from (15) and (16), we get the conditions for a fall in a particular commodity price p_j to benefit women:

$$\frac{dx_{jm}/du_m}{E_{um}} < \frac{dx_{jf}/du_f}{E_{uf}} \qquad \textbf{(33)}$$

which can be expressed

$$\frac{dx_{jm}}{dE_m} < \frac{dx_{jf}}{dE_f} \qquad \textbf{(34)}$$

This is the slope of the Engel curve in full expenditure. So the policymakers should reduce the relative prices of goods for which women have a steeper full Engel curve than men; this reduces the marginal cost of conferring utility on them and therefore increases the incentive for the household to do so.

The effect of price changes on outside options, which operates only in the bargaining model, favours women if

$$E_{um}d\overline{u}_m/dp_j > E_{uf}d\overline{u}_f/dp_j \qquad \textbf{(35)}$$

Applying Roy's identity to the expenditure of divorced people, it follows that the outside option effects benefit women if the relative prices of commodities which are a larger share of the expenditure of divorced men than divorced women fall.

Finally, if shadow prices and shadow wages move, there are effects on labour supply which can influence welfare. These effects favour women if there are reductions in the relative prices of goods which complement forms of time use which are increasing in women's welfare at the margin. For instance, the consumption of bread, rather than rice, in Sri Lanka has been shown to substitute for cooking time (Senauer et al. (1986)); a fall in the price of bread would therefore typically reduce w^*_{hf} (by reducing du_f/dz_i and hence p^*; an alternative formalisation, which would give the same result in a more complex way, would treat bread and rice as purchased inputs into household production). If women find preparation of a given kind of food particularly tedious or unpleasant, then increases in its price or reductions in the price of a substitute will benefit them. In principle these effects could be gender-neutral, but in most cultures women do most of the cooking. Whether women like cooking can to some extent be estimated econometrically, but it may be simpler and more effective to ask them.

The non-cooperative models

The decomposition in (21) distinguishes consumption and labour supply effects. If there are transfers, the husband's allocation of consumer goods has exactly the same form as the unitary case and can be found from (22); the term u_{Cpji} is the primal equivalent of the term in E_{upji} in the dual problem. Hence the results from the unitary case hold.

The effects of consumer good prices on time use are somewhat harder to analyse. If prices move so as to induce an increased allocation of consumer goods to women, this will have both income and substitution effects on labour supply to cash-raising activities; it will reduce $\delta v_f/\delta C_f$ but will increase dC_f/dC, so that (from (26)) the overall change in dv_f/dC, and the direction of the induced shift in time use, is ambiguous. The same applies to dv_m/dC. Hence it is unclear whether women will move into or out of the generation of cash income. Moreover, even if the direction of the labour supply effect were known, its welfare effects would also be ambiguous. If women increase their marketed labour supply at the expense of leisure, then they lose from the labour supply effects, but if they increase it at the expense of unpleasant domestic work, they may gain.

Since the labour supply effects are ambiguous and the consumption allocation effects are the same as those in the unitary case, a reasonable presumption is that the results from the unitary case on the benefits of reducing the prices of goods which women consume at the margin will hold.

For the non-cooperative case without transfers, things are simpler. A relative price change will directly benefit women and hurt men if

$$\Sigma_j dp_j x_{fj} < 0,\ \Sigma_j dp_j x_{mj} > 0 \qquad \textbf{(36)}$$

This will be the case if the prices of commodities which form a larger share of female than male consumption fall while others rise. Labour supply effects can arise in this model as well, although one possible outcome of the model is that no activity is performed by both parties, in which case the Nash-equilibrium effects considered above do not come into play.

Robustness

Provided the direct price effects are not swamped by indirect labour supply effects of ambiguous sign, a reduction in the prices of 'female' commodities will benefit women in all models. However, the exact meaning of 'female' commodities varies, referring sometimes to average and sometimes to marginal shares of expenditure. Fortunately, commodities with higher average shares of average female than male expenditure will also usually have higher marginal shares. There is evidence in Uganda that clothing may have these properties (Appleton and Mackinnon 1995); alcohol certainly often has the opposite properties. Outside-option effects, if they operate, tend to reinforce the direct price effects. Finally, reductions in the relative prices of foods which are arduous to prepare usually benefit women.

4 Changes in relative wages

Differentials between male and female wages are often taken as evidence of gender discrimination, though in some countries they may reflect differences in productivity (see Quisumbing (1996)). It may therefore be surprising that the effect on relative female welfare of a rise in relative female wages is ambiguous; this is a very non-robust recommendation which may hurt women.

4.1 Pareto-efficient models

For the unitary model, (15) is again the critical equation. The direct effects are found by inserting changes in w_f and w_f of opposing sign while making no change in shadow prices or the outside option. It can be seen immediately that women lose from the direct effects of this change in relative wages provided only that

$$\frac{d(1-l_f-h_f-L_f)}{du_f} < 0,\ \frac{d(1-l_m-h_m-L_m)}{du_m} < 0 \qquad \textbf{(37)}$$

which will be true if, for instance, wage labour is the least preferred activity. The reason is that the change in wages increases the marginal opportunity cost of women's preferred activities. The effect is more powerful the more unpleasant wage labour is; so increasing women's wages for the worst jobs may, paradoxically, have the worst intra-household distributional effects. Since time use is the main dimension of relative female deprivation in many societies, the effect is worth taking seriously.

If leisure complements consumption, this tends to increase the magnitude of $d(1-l_f-h_f-L_f)$ and therefore increases the size of the reduction in female welfare; intuitively, women will now lose in consumption as well as leisure. The opposite applies if consumption substitutes for leisure.

Movements in shadow wages will in general reinforce the direct effect, because the shadow wages for other female activities will rise, leading to an increased burden of time on women and a reduction in their leisure. The direction and effects of the induced movement in the shadow price of domestic output are ambiguous; women's greater involvement in domestic production suggests that it is likely to rise. If women are also more intensive consumers of domestic output, this will hurt them further.

In the bargaining model, these negative effects are likely to be counteracted by a positive effect through the increase in the value of women's outside options. Haddad and Kanbur (1992) discuss this effect, noting that it has a 'long reach' in that it affects even households where women supply no labour to the market, so long as they would do so if they became divorced. The overall impact on female welfare depends on the relative strength of the opportunity-cost and the outside-option effects: for instance, if shadow prices and wages do not move, the net effect depends on the sign of

$$(u_m-\overline{u_m})\frac{d(1-l_m-h_M-L_m)}{du_m}dw_m \; - \; E_{um}d\overline{u_m} \; - \; (u_f-\overline{u_f})\frac{d(1-l_f-h}{du_f} \qquad \textbf{(38)}$$

which is ambiguous.

4.2 Non-cooperative models

Consider first the case with cash transfers. Since the wage increase is compensated, there is no general reason to expect consumption to move in either direction; hence the substitution effect on labour supply is likely to dominate the income effect, leading to increases in female and reductions in male labour supply. From (27-32), it can be seen that the reaction curves shift in opposite directions, and movements along the new reaction curves reinforce the effect (as women's labour supply increases, men react by reducing their labour supply). The welfare implications are therefore as in the unitary model; if wage labour is the least preferred activity, then women will lose. As with the unitary case, effects on the pattern of consumption may affect relative welfare but will not typically dominate the labour supply effects.

In the noncooperative case without cash transfers, however, it is trivial that women gain from the increase in relative female wages, because their incomes increase.

Regime-switching can complicate these results; a large enough increase in relative wages can benefit women even in the case with transfers, because it shifts the regime of the model. However, if the increase is large enough, women may start transferring cash income to men, in which case they begin to lose from any further increase in their relative wages.

4.3 Robustness

The above discussion shows that the distributional benefits of increases in relative female wages are far from robust. Even if attention were restricted to the Pareto-efficient models, or to the non-cooperative models, it would be uncertain whether increases in relative female wages benefit women. These results arise from the time burden on women; hence the consensus that increases in the female share of income are good news for children (see Hoddinott and Haddad 1995) do not remove the possibility that women themselves may lose from them.

Two caveats apply. First, if wage labour is an activity preferred by women, then women will benefit both from the substitution and the outside-option effects. The ambiguity applies most strongly to wages for disagreeable work. Secondly, if women prefer to work at the margin but are prevented by male coercion, as Chen (1995) reports for higher-caste women in rural India, then the results would not hold.

5 Increases in returns to cash crops and domestic production

In Africa, structural adjustment usually aims to increase the opportunities for households to earn their income by growing cash crops. This objective has been widely criticised on the grounds that it increases the burden on women's time while the control of income is passed to men. It is often suggested that women will prefer an increase in productivity in the production of non-marketed goods (Whitehead (1991)).

Here I consider a reduction in the price of cash crops compensated by a rise in the productivity of domestic labour; if the arguments of the critics of adjustment are right, this will benefit women. The cause of the increase in domestic productivity is not specified, but policy instruments include improved access to clean water and the promotion of improved energy sources and energy-efficient stoves. Malmberg-Calvo (1994) found that for rural African households the burden of time taken up by carrying water and firewood for a household were equivalent to a full-time job; so reductions in this burden are potentially important.

5.1 Pareto-efficient models

A reduction in returns to cash cropping is represented by a fall in p_c and a consequent fall in w_{lm}^* and w_{lf}^*. The reduced opportunity cost of time will typically reduce p^* and w_h^* for both sexes as well. The outside option may also be reduced for both sexes.

The increase in productivity in domestic goods causes an excess supply of the good in the short run, driving down p^*. The shadow wage of labour in domestic production, w_{hm}^* and w_{hf}^* may either rise or fall, as can be seen from (18); an additive rise in $f(h_m, h_f)$ causes a fall in w_{hm}^* and w_{hf}^*, because p^* falls and $\delta f/\delta h_i$ does not change. A multiplicative increase, which increases the marginal as well as the average productivity of domestic labour, can drive w_h^{m*} and w_h^{f*} either

way; the more inelastic demand for the output is, the more likely that the wage will fall. The outside option may also be increased for both sexes.

The net effects of the compensated package change are therefore to reduce w_{lm}^*, w_{lf}^* and p^*_z. The effect on w_{hm}^*, w_{hf*} and u is theoretically ambiguous for both sexes.

We now apply these parameter changes to (15) and (16). First, the policy increases the shadow price of domestic goods relative to purchased goods; the relative welfare effects depend on the relative slopes of men's and women's full Engel curves for the two kinds of commodity, and are ambiguous. Secondly, the increase in shadow wages applies to both parties. The increase in the shadow wage in cash-crop production will depend on the relative values of dl_m/du_m and dl_f/du_f, which depend both on the relative roles of both sexes in crop output and in the disutility attached to different tasks. Neither the effects on shadow prices nor the effects on shadow wages therefore gives any clear guide to the gender effects of adjustment in the unitary model.

The analysis for the bargaining model is identical to that for the unitary model except for the inclusion of outside-option effects. Empirically, there is some evidence that female-headed households are much less involved in cash crop production than male-headed households. Appleton et al. (1997), drawing on Collier (1989), discuss the reasons for this. Whatever the cause, it is clear that given the observed pattern of behaviour, an increase in returns to domestic production relative to cash crops will improve women's bargaining position relative to men's. This provides a reason to expect women to benefit from the policy.

5.2 Non-cooperative models

The non-cooperative model offers a structure specifically designed to address this problem. As above, the policy change as above is represented by a reduction in p^c and a compensating increase in the function $f(h_m, h_f)$. Again, the decomposition in (21) is useful. The consumption effects are found from (24) and (25), setting $dC < 0$, $df(h_m, h_f) > 0$ and $dp = 0$. There is no general answer, but one special case is illuminating. Assume that both parties have the same utility function which is additively separable in time use, purchased goods and domestic goods. Now the cross-partial derivatives are zero. Substituting the first-order condition (22-23) into the simplified form of (24-5), and dividing the female expressions by the male, we get

$$\frac{dv_f/dC}{dv_m/dC} = \frac{v_{CCm}}{v_{CCf}}, \frac{du_f/df(h_m,\ h_f)}{du_m/df(h_m,\ h_f)} = \frac{u_{zzm}}{u_{zzf}} \qquad \textbf{(39)}$$

No , if the utility function is quadratic in consumption, then the utility benefits from marginal increases in income in both sectors are equally split across genders. However, if the third derivative of utility is positive, as Deaton (1991) has shown to be a reasonable condition for decisions involving risk, then v_{CCm} will be smaller in absolute terms than v_{CCf} (because men consume more purchased goods than women) but for domestic goods (where women control the allocation and as a result consume more), u_{zzf} will be smaller in absolute terms than u_{zzm}. As a result, women will benefit more than men from increases in domestic productivity, and will lose less than men from reductions in cash income; they therefore benefit from the policy package. So

the natural view that women benefit from a transfer of income to the sector where they control it turns out to depend on a reasonable assumption about the third derivative of utility.

As with the unitary model, the effects in income are complicated by effects on time use whose welfare implications are uncertain.

Finally, in the non-cooperative model without transfers it is obvious that men gain and women lose from the change, since men are assumed to get all the income from cash cropping: the first part of (39) is replaced by

$$\frac{dv_m}{dC} = \frac{\delta v_m}{\delta C_m}, \quad \frac{dv_f}{dC} = 0 \qquad \textbf{(40)}$$

5.3 Robustness

In the unitary model, there is very little presumption that increasing the relative returns to domestic production benefits either sex. In the non-cooperative model with transfers, there is some presumption that women will benefit, depending on a realistic assumption about the third derivative of the utility function. In the bargaining model (making realistic assumptions about the outside options facing men and women) and in the non-cooperative model without transfers, the presumption that women will benefit is strong. We can therefore describe the policy of improving the relative returns to domestic rather than cash crop production as weakly robust; it is good for women in some cases and not very likely to be bad for them in any of the models.

These results do not show that women lose in absolute terms from adjustment, because they have been established only for compensated changes. Adjustment in Africa has produced non-compensated increases in the incomes of cash-cropping households, and although it is possible women might not benefit, further empirical and theoretical work is needed to establish how likely this is. Moreover, women can gain from increases in wages in cash-cropping sectors, which are sometimes important employers of poor women (Sender and Smith (1990)). A full empirical study needs to examine both female consumption and time use and to disaggregate the effects of different policies and other events, explicitly modelling the counterfactual; no such study currently exists. What the results do suggest is that the distribution of the benefits of trade liberalisation is likely to be gender-biased in that men benefit more than women, and that actions to promote the productivity of domestic work can help to correct this bias.

Some insight into the labour-supply effects can be derived from Malmberg-Calvo (1994). Malmberg-Calvo surveys studies of water supply which suggest that although water consumption increases when water supplies are brought nearer to the household, the time spent collecting water usually falls, suggesting that demand is inelastic and that w_f^h* falls. Since women carry most of the water, their time burden is directly reduced. However, this may not increase their welfare, because their time my be diverted into more disagreeable activities. For instance, women in part of Tanzania expected their time burden to be reduced by improved water supply, but instead found themselves performing different kinds of work (it is not stated whether they were glad about the change). In a study in Lesotho, on the other hand, most of the released time was spent resting and on social activities. Finally, the evidence on the disutilty attached to fetching water

also varies; in one study 22% of women reported that fetching water was their favourite activity, but in other cases it was found unpleasant. These studies show that local knowledge is important but also that even those directly affected by public actions may not accurately predict their own households' responses.

6 Transfers of assets

Cash incomes, but not land or education, are explicitly included in the models given above; however, something can be said about all three cases.

Cash transfers from men to women are modelled by reducing y_m and increasing y_f (though in a dynamic case it would be important to distinguish between one-off gifts and recurrent incomes). They have no effect on outcomes in the unitary model. They will benefit women if they improve the outside option for them in the bargaining model; this will follow so long as they are paid to divorced women as well as married women. They have no effect on the non-cooperative model with transfers, because the man's allocation of purchased goods will adjust to keep the first-order conditions observed, unless they cause a regime shift. In the model without husband-wife cash transfers, however, they improve women's relative welfare. Cash redistribution is thus weakly robust; it never hurts women and helps them in some models. This finding is familiar; several authors, including Ulph (1988) and Lundberg and Pollak (1993), have explored whether child benefit should be paid directly to women.

Transfers of land from men to women probably have the same effect as cash transfers, though in the non-cooperative model they may have more complex effects on production. To assess these effects it would be necessary to model the productive role of land explicitly. The effect of land on the outside option in the bargaining model is of great practical importance; law on the rights of couples at marital separation is a very important gender issue in much of Africa. In one African country, a proposal to strengthen these rights was physically shouted down in the Constituent Assembly. Related measures not formally modelled here include requiring the wife's consent to sale of land, and strengthening the inheritance rights of women in the event of their husband's death.

Finally, consider an increase in female education at the expense of male. Education is assumed to increase returns to the individual's time in all activities. This is represented by upward shifts in the wage, the production functions and the outside options and (especially if education makes leisure more rewarding) the utility function. There are then three effects. First, the increase in utility directly benefits women in all models. Secondly, the change in production functions and wages will benefit women in the non-cooperative models without transfers, but has ambiguous effects in the other three models; only if education disproportionately increases the returns to agreeable forms of time use do these effects benefit women in all models. Finally, in the bargaining model, the change strengthens women's outside options. While the results are not conclusive, they are much more positive than those for relative increases in female wages, because education enhances leisure as well as work.

7 Conclusions

Table 1 summarises the findings of the above analysis.

Table 1: The effects of compensated policy changes

Policy	**Household model**			
	Unitary	**Bargaining**	**Non-coop. with transfers**	**Noncoop. without transfers**
Reduce relative price of female consumer goods	F	F	F	F
Small increase in relative female wages	?M	?	?M	F
Large increase in relative female wages	?M	?	F	F
Increase relative returns to domestic rather than cash crop output	?	?F	?F	F
Cash transfers to women	N	F	N	F
Land transfers to women	N	F	?N	F
Female rather than male education	?	?F	?	F

F- almost certainly pro-female
?F - probably pro-female
? - ambiguous
?M -probably pro-male
M- almost certainly pro-male
N - no effect

While female-headed households have not been analysed, it is clear that they would benefit from most of these policies, with the possible exception of the shift from returns to cash crops to domestic output.

The static and utilitarian approach adopted here has some limitations. This paper has tried to meet the arguments of Sen (1987) by restricting the policymaker's concerns to women's self-interested preferences, not their altruism. However, some concerns remain. Women's deprivation might reduce their assertiveness in bargaining or their marginal utility of consumption, affecting all the models' solutions (Sen (1987)): contributions as well as outcomes may matter (Tobin (1980), Margolis (1982), Mackinnon (1987), Sen (1987)): autonomy may matter as well as expenditure and time use (Jackson (1996)); and women's labour supply may be constrained by male preferences (Chen (1995)). Finally, while the extension to several adults is trivial, the extension to children whose interests may be defended by the mother (Haddad and Hoddinott (1994), Hoddinott and Haddad (1996)) raises substantial issues. In particular, as noted above, the evidence that increases in female incomes improve children's welfare does not necessarily imply they increase women's welfare.

Making the models dynamic would raise two issues. First, income gains may generate savings and hence higher incomes in later years, while leisure gains may not. Secondly, time-consistency problems afflict Pareto-efficient models if solutions can be renegotiated. For instance, a husband might resist his wife's acquisition of education which would increase her future bargaining power; in this case dynamic Pareto-efficiency will not be achieved.

Four areas for further investigation are the extension of the results to uncompensated price changes: the determinants of the division of labour in non-cooperative models (for instance, van Braun and Webb (1989) found that commercialisation of rice production changed control of the income from the crop from female- to male-dominated), and the explanation of the empirically supported Pareto-inefficiency characteristic of these models: explicit modelling of the interests of children: and the nutritional implications of policy changes. If food is not marketed, all the models, even without female disadvantage, are consistent with the evidence (discussed in Kennedy (1994)) that rises in income often fail to improve nutrition, but the issue deserves more theoretical work.

The theory developed here encourages three approaches to addressing gender inequality in developing countries: reductions in the relative prices of female consumer goods: improvements in domestic productivity, such as the development of better water supply, energy sources and cooking technology: and improvements in women's education and legal rights to own assets. However, the theory remains complex and fluid, so that the beneficial effects of such policies cannot be taken for granted. Theory can suggest how policy may help women, and issue some important caveats; but only careful empirical investigation can confirm whether the suggested policies are in fact practicable and effective.

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