A survey on intra-household models and evidence

Xu, Zeyu

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Zeyu Xu

Federal Statistics Program
American Institutes for Research
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Abstract: Intra-household models have achieved significant theoretical development and received considerable empirical support within the past decade. This paper is a comprehensive and updated survey on three most influential categories of intra-household models: the Nash cooperative bargaining settings, the collective settings, and the non-cooperative settings. Various models and the latest development within each category are discussed, along with corresponding testable restrictions and limitations. Dynamic cooperative bargaining models and endogenous collective models are introduced as the latest efforts in incorporating a richer set of elements to the intra-household theory. The latest empirical results are summarized along with their policy implications.

Keywords: Intrahousehold economics, bargaining models, collective models

1. Introduction

In neo-classical family economics, the household is the unit of study. The household's problem is to maximize a single utility function subject to a household budget constraint. Allocation is carried out such that the marginal utility of consumption is equalized across family members. Analogously, a decision on household production is an income maximization problem: Investment is made till the marginal rate of return equals the marginal cost, when there is no credit constraint. However, it is the welfare of individuals that should be the fundamental concern. Earlier unitary household models had to reconcile the single utility framework with the presence of multiple individuals. To do so unitary household models assume that family members' utility functions can be systematically aggregated, that individual budget constraints can be combined, and that household production can be unified. To make such aggregations household members are either assumed to have homogenous preferences, or have an altruistic household head that has all the power within the household (Becker, 1981). When altruism is assumed the household maximizes the altruist's utility function, which "cares" for all the family members, subject to full household income. In the altruistic household, individual welfare is decided by two factors: how far out the family budget constraint can be pushed, and how much the altruist values each beneficiary's welfare (McElroy, 1997). With the unitary approach, who earns the income should not matter to household consumption patterns. In other words, income is "pooled".

Still, much can be learned regarding intra-household allocations with straightforward extensions to the neoclassical household production model with unified preferences (Strauss, et al, 2000). Rosenzweig and Schultz (1982) explain the difference in female and male infant survival probabilities in India on the ground of differential market rates of return to male and female. Pitt et al (1990) find that allocations of calories are more likely to reinforce disparities in health endowments for individuals in groups that have low incomes and engage in energy-intensive labor market activities. Behrman et al (1982) on the other hand, argue that both preferences and market opportunities operate to affect allocations.

Despite the achievements of varied versions of unitary household models, the assumption that family members have homogenous preferences or there is an altruist that decides everything within the household is not satisfactory. In addition, within the unitary approach, any unequal allocation of resources can be justified on efficiency grounds, which is extremely unappealing to the studies on discrimination and gender bias. Leaving resource allocation behavior to the black box of the family can lead to failure in targeting the population group of concern in policy and program design.

The family is a place of conflict and cooperation. Empirical support for the existence of altruistic motives is not overwhelming. Indeed, some of the most influential studies have reached mixed conclusions, possibly favoring "exchange" rather than altruism as a motive for intra-family transfers (Anderberg & Balestrino, 2003). From the late 1970s, various intra-household bargaining models start to appear. Those models pay special attention to the interaction between heterogeneous preferences of household members and power distribution among household members. They have made substantial theoretical progress and gained considerable empirical support. Those models successfully explain phenomena that cannot be understood under the unitary framework and reshape policy designs to make social welfare and individual development programs more efficient. The implications of non-unitary household models also provide additional policy instruments. In the following sections I will first review three categories of intra-household models: the Nash cooperative bargaining settings, the "collective" settings, and the non-cooperative settings, together with the latest theoretical developments in each category. Empirical testing problems and evidence will follow the theoretical reviews, and policy implications and the limitations of bargaining models will conclude this survey.

2. Nash Bargaining Models

Cooperative Nash bargaining household models is the earliest attempt to explicitly describe the decision-making process within household. In fact, as pointed out in Manser and Brown (1980), the altruist approach in Becker's unitary model (1974,

1981) includes two assumptions: explicitly there is an altruist that maximizes his utility function subject to the family resource constraint; implicitly a bargaining rule is assumed for the household to maximize the altruist's utility function (Pollak, 1985). Similar to the unitary approach all cooperative bargaining models considered in the intra-household context yield optimal outcomes.

The Basic Models

The earliest papers that established the Nash bargaining approach to the household include Manser and Brown (1980) and McElroy and Horney (1981). The two papers complement each other, with the first one covering a larger scope than the second. The key features of the cooperative bargaining model are utility gain and "threat points". A two-person household is considered in the game. Household consumption of goods is categorized into five types: public goods, wife's private goods and leisure, and husband's private goods and leisure. Therefore household members choose, correspondingly, $(x^0, x^F, l^F, x^M, l^M)$ subject to their respective prices. When the couple is married, some of the private consumption, like housing, that was afforded privately before marriage is shared as a public good. Before marriage, each person maximizes $(x^0, x^i, l^i), i = M, F$ subject to his or her respective budget constraints. Assuming the preferences are rational, monotonic, convex and continuous, the utility function is increasing and quasi-concave. The solution to this constrained maximization program can then be expressed in a well defined continuous and strictly quasi-convex, homogeneous of degree zero, indirect utility function $V^i = V^i(p^i, Y^i), i = M, F$, where p and Y are price and income.

Once the couple is married, its utility maximization solution, subject to the household's full income also includes the partner's utility and consumption: $U^i = U^i(x)$. People choose to get married because of positive utility surplus within marriage as compared with utility obtainable when remaining single. In the bargaining framework, V^i serves as the "threat point" in the sense that, if utility within marriage is lower than this, the marriage would dissolve. The threat point serves as the reservation utility, which, in addition to price and individual income, also depends on the extrahousehold

environmental parameters (EEP). EEPs can include such factors as the male-female ratio in the marriage market, policies regarding marriage and divorce benefits as well as social and religious norms and traditions. Assuming marriages satisfy the symmetric property, McElroy and Horney (1981) focus on the following special Nash problem:

$$\max_x N = [U^M(x) - V^M(p^M, Y^M; \alpha^M)] \cdot [U^F(x) - V^F(p^F, Y^F; \alpha^F)]$$

subject to the full income constraint. α is the EEPs. The solution is confined by three properties: Pareto optimal outcomes, symmetry and invariance with respect to positive linear transformation of the utility functions.

The scope of solution to a cooperative game is much broader. Manser and Brown (1980) propose three solutions to the cooperative game. First, without assuming symmetry, they consider an extreme case of dictatorial marriage where one partner determines the allocation. With the addition of symmetry assumption they consider a Nash bargaining solution and a Kalai and Smorodinsky solution.[i] Manser and Brown (1980) have shown that the Nash solution can be rewritten as:

$$\max_x N = \max[\ln(U^M - V^M)] + \ln[U^F - V^F)]$$

Because the sum of two quasiconcave functions is not necessarily quasiconcave, a unique solution is not guaranteed without further assumptions for the Nash solution. On the other hand, the K-S solution yields a unique solution. In both cases the objective function is price-dependent, and they yield demand functions that are in general indistinguishable in terms of either the variables included or the general restrictions placed on them [Manser & Brown, p.40]. Other forms of the bargaining solution are also explored. For example, relaxing the symmetry property, Harsanyi and Selton (1972) develop a generalized Nash solution with incomplete information, and Dubra (1999) develops an asymmetric K-S solution. Some of these developments are applied to non-cooperative intrahousehold bargaining models. In addition, Rochford (1984) analyzes the implication for matching in the marriage market in a model characterized by Nash bargaining with transferable utility.

Comparative Statics and Empirical Implications

To evaluate the income effect and the price effect in the Nash bargaining framework, McElroy and Horney (1981) focus on the Nash solution to the household utility maximization problem. In order to capture the additional effect that takes impact through the changes in the threat point utility, an *Iso-gain Product Curves* concept is developed to capture the fact that changes in prices and nonwage incomes not only twist and shift the budget constraint in the traditional way but also change the objective function itself (because the reservation utilities, as arguments of the Nash objective function, would be affected by prices, incomes, and additionally, the EEPs). The household utility curve is analogous to the preference curve in that it describes all possible female and male utility combinations given a fixed level of utility gain product. Two concepts are key to the understanding of the additional effect brought by Nash generalization. 1) The *family rate of substitution* of two goods is defined as the absolute value of the slope of the iso-gain product curves. The partial derivative $\partial FRS_{ij} / \partial p_i$ tells us how the iso-gain product curve would tilt in response to a price change. 2)The ΔMRS *marginal family utility substitution* is defined as the difference in the spouses' individual marginal rates of substitution $\frac{\partial U_i^M}{\partial U_j^M} - \frac{\partial U_i^F}{\partial U_j^F}$. Consider the MRS of male leisure (good *i*) in terms of female leisure (good *j*). When male MRS is greater than female MRS, it indicates the husband places a higher relative value on his own leisure in terms of his wife's leisure than the wife does. ΔMRS tells us how the iso-gain product curve would tilt in response to an income change.

The comparative statics is characterized by the Nash generalization of the substitution matrix. Several matrices are crucial in the new characterization:

X_p has as its element the demand response to price changes;

X_I has as its element the demand response to full income, male income and female income changes;

X_α has as its element the demand response to changes in the EEPs;

D is a matrix that includes the impact of consumption level changes on male and female utility levels with marriage;

V_p has the elements describing the price effect on male and female reserve utilities;

V_I has the elements describing the male and female income effect on male and female reserve utilities.

λ is the Lagrange multiplier that captures the marginal utility of full income as in the classic demand theory.

Let S be the classic Slutsky matrix that has as its element the combination of price effect with compensated wealth effect. The Nash generalized Slutsky matrix is given by SG^{-1}, where

$$G = \lambda I + D(V_p^{'} + \tfrac{1}{2} V_I lq')$$

I is the identity matrix with 5 columns and 5 rows since there are five goods at issue. *l* is a vector of 1's. It can be seen that the generalized Slutsky matrix is weighted by G, which captures the impact of income and of price changes on the threat points. The male's and female's income effects are weighted by the demand for the commodity whose price has changed. In the special case of unitary preferences, the demand responses to male and female income changes are the same, and income and price effects on the reservation utility are zeros. Then the generalized Slutsky matrix collapses into simply S. Therefore the Slutsky matrix that characterizes the unitary preferences is nested in its generalized form.[ii] McElroy and Horney (1981) and McElroy (1990) summarize four empirical implications derived from the generalization that can potentially be tested:

a) Male income effect should not be different from female income effect on demand in the unitary model. However, they can differ in the Nash framework;
b) EEPs should have no effect on demand in the unitary model, whereas they have effect in the Nash model;
c) *S* is symmetric and negative semidefinite in the unitary framework. In the Nash model SG^{-1} is symmetric and negative semidefinite.[iii]

Considering a decomposition of total price effect on the demand bundle of male and female leisure is helpful to see the additional movements incurred by the generalized Nash framework. Graphically speaking, the Nash case is special in that a price change or an income change not only tilts the budget constraint curve, but also changes the slope of

the iso-gain product curves (the preference curves in the neoclassical case). Suppose the male wage rate rises and so the price for male leisure increases. 1) *Neoclassical substitution effect*: As in the neoclassical demand theory, the Hicksian wealth compensated effect keeps the original level of utility but chooses a different male and female leisure bundle. Graphically, the utility curve remains unchanged but the budget constraint twists and the new leisure bundle is the tangent point of the twisted line (compensated for wealth change) and the old utility curve. 2) *Iso-gain product curve price tilt effect*: Since a price change in the Nash framework not only changes the budget constraint but also changes the objective function itself, the iso-gain product curve also twists. The twist is based on the sign of $\partial FRS_{ij} / \partial p_i$. The old and new curves intersect each other. The bundle obtained by step 1 is reevaluated with the tilted utility curve. A new bundle of leisure that generates the same level of utility according to the tilted utility curve is obtained at the minimal cost according to the tilted budget curve. 3) *Neoclassical income effect*: In this step the bundle from step 2 is pushed to the budget frontier that is realizable with the new male leisure price. This move corresponds to the neoclassical income effect. 4) *Iso-gain product curve income tilt effect*: Finally, because the new wealth level is achieved through male wage change, in the Nash framework, male income and female income have different effects and change the objective function through the shifts of the reservation utility terms. If for example the husband is selfish. Then the leisure bundle would shift in the direction favoring him. The curve tilt is given by the sign of ΔMRS .

As is clear from the above example, the sum of step 1 and 3 gives the total price effect on demand in the unitary model. In the unitary case the movements in step 2 and 4 would be non-existent. In the generalized Nash case the price effect is the sum of all four steps, with step 2 and 4 caused by the fact that price and income change affects the objective function itself.

Difficulties with the Nash Household

The generalized Nash framework has important empirical implications. However, those implications are not immediately testable with observable data. Researchers have

realized the difficulties with the Nash bargaining household models from the perspective of empirical testing.

First, Chiappori (1988b) finds an error in the McElroy and Horney's derivation of the weight matrix G in the generalized Slutsky matrix (see note 2). But more fundamentally, Chiappori argues that nothing can be said about the properties of the generalized Slutsky matrix. This is because there is no reason to assume that the threat utility functions are observable. And if those are not observable, no explicit restrictions can be put on the weight matrix G, which is the key that differentiates the Nash properties from the unitary properties. Some of the hypotheses under unitary assumption are not difficult to test. However, rejecting the properties of the unitary model does not by itself prove the Nash bargaining model is correct (Chiappori, 1988b; McElroy, 1990). Failure to reject the property hypotheses under the Nash framework can lend support to single out the Nash model as the more appropriate one. Yet Chiappori's argument shows the comparative statics of the generalized demand system is not empirically differentiable from those from the unitary system.

Second, in McElroy and Horney's model, the married and unmarried utilities are assumed to be independent from each other. Combined with the first difficulty, Chiappori (1988b, 1991) argues that Nash bargaining does not imply anything more than Pareto efficiency. Based on this observation, Chiappori and other researchers have developed a different approach to household decision-making, namely the "collective" approach that will be surveyed in the next section. The "collective" approach has successfully produced theoretical and empirical results even though the approach only assumes Pareto efficiency and nothing about the decision-making process itself.

In McElroy and Horney's reply (1990) to Chiappori's charges as well as in McElroy (1990), the authors propose a scheme to estimate the reservation utilities from a sample of divorced men and women. Considering the very likely sample selection problem whereby the divorced population and the married population might have unobserved characteristics that correlate with variables included in the utility function, they suggest the use of standard econometric methods such as the Heckman's 2SLS (1979) to correct for the problem. The authors argue that if threat points can be independently estimated, the Nash bargaining approach leads to testable restrictions upon

household behavior. However, Chiappori (1997) argues that the concept of Nash bargaining equilibrium requires a cardinal representation of preferences, which is not invariant through an increasing transformation of utilities, threat points, or both. At the same time, there are many preference representations that are compatible with the observed patterns of consumption. The conclusion will then crucially depend on the choice of preference forms.[iv] This weakness is largely an empirical one because most consumption and expenditure data are collected at the household level rather than the individual level (Doss, 1996). Therefore individual preferences are unobservable. In many empirical studies such as Thomas (1990) and Hoddinott and Haddad (1995), an inferential approach is applied to recover individual preferences by examining how expenditure pattern changes according to "who controls how much income". Yet it is the combination of heterogeneous preferences and power that gives rise to the observationally different consumption patterns (Smith & Chavas, 1999). To solve the difficulty with inferred preferences, Kapteyn and Kooreman (1992), and Kusago and Barham (2001) use direct information on preference heterogeneity collected from interviews without assuming sample-wide preference differences between the genders.

A fourth problem with the Nash cooperative bargaining framework is its choice of threat points. A "threat point" can correspond to divorce, to violence or the threat of violence[v] (Touchen, Witte & Long, 1991), or to a non-cooperative equilibrium within marriage (Ulph, 1988; Lundberg & Pollak, 1993). In the case where the threat point corresponds to divorce, although the married and divorce utility functions can be assumed to be unrelated and marriage state-dependent, in general cooperative bargaining models make the more restrictive assumption that utility is invariant across marital statuses (McElroy, 1990). Spouse's consumption argument in the married utility function is suppressed to zero to generate the divorce utility function. There are two criticisms on this treatment. First, it is argued that the marriage utility and divorce utilities may not be comparable if utility depends directly on marriage (Strauss, et al, 2000). And second, as pointed out in McElroy (1990), the invariant utility restriction rules out some functional forms such as the Cobb-Douglas because with invariant utility function the divorce utility is always 0 with Cobb-Douglas. In addition, divorce incurs huge transaction cost. In a daily, repeated game of family cooperation and conflict, using divorce as a threat point is

not realistic. Divorce may be suitable as the fallback position for long run bargaining, while non-cooperative equilibrium might characterize short-term daily negotiating better. Even though non-cooperative equilibrium usually results in under-supply of public good, it is sustainable because of the transaction cost related with divorce.

Another weakness of the cooperative framework is that the results of Nash bargaining are not self-enforcing; That is, cooperative models involve binding and enforceable agreements (Kusago & Barham, 2001). And it is also assumed that the agreements are enforceable costlessly. However, with a household, the ability to commit to a sharing agreement is limited (Ligon, 2003), and quite reasonably enforcing any parts of the agreement cannot be costless. The above difficulties with the cooperative bargaining framework give rise to theoretical development in two directions. The first three weaknesses lead to the "collective" approach to household bargaining where the only assumption is Pareto optimal outcome and nothing is assumed about the decision making process itself or anything about preferences. On the other hand, problems with choosing an appropriate threat point and with providing realistic schemes in which Nash-bargained agreement is binding costlessly lead researchers to develop non-cooperative bargaining models. By contrast, non-cooperative models do not assume household members enter into binding and enforceable contracts. In other words, non-cooperative equilibrium is self-enforcing. The "collective" approach will be reviewed in the next section, and non-cooperative bargaining models will be surveyed in section 4.

Recent Development in Cooperative-Bargaining Modeling: Dynamic Models

The dynamic intra-household cooperative bargaining model is developed out of at least two considerations. First, we need to consider the fundamental motivation for household formation. Household production specialization (Becker, 1974b) and collective production of public goods (Lundberg & Pollak, 1996) are the traditional efficiency considerations for forming a family. However, consumption smoothing is another important reason for household formation (Ligon, 2003), especially in developing agricultural countries where income is subject to high uncertainty. Static models are insufficient to describe such production risks and consumption smoothing behavior.

Second, we also have to consider the motivations of intra-household transfer, whether it is between spouses or between generations. Although Becker, et al (1990) postulate altruism as the driving force, previous studies (for example, Altonji, Hayashi & Kotlikoff, 1992, 1997; Cigno & Rosati, 1996; Cigno, Giannelli & Rosati, 1998; Lillard & Willis, 1997) have reached mixed conclusions, possibly favoring "exchange" rather than altruism as a motive for intra-family transfers (Anderberg & Balestrino, 2003)[vi]. Since intra-household exchange involves efficient investments and "profit" sharing, how such "exchange" agreement is enforced becomes an important question of study. Earlier studies (for example, the cooperative models discussed above, and the overlapping-generations models by Cremer, Kessler & Pestieau, 1992) either ignore the enforcement problem or assume the agreement is binding and costless. Later studies use such concepts as "separate spheres" (Lundberg & Pollak, 1993) and "family social capital" (Cigno, 1993) to explain the informal binding mechanism that enforces the intra-household sharing agreement.

Within the cooperative bargaining framework, Ligon (2003) develops a dynamic bargaining model to address the interactive nature and contract enforcement problems within household. Three features distinguish the dynamic model from the static bargaining models: No household member ever wants to terminate the marriage; Bargaining position adjusts over time and re-negotiation is ongoing; And negotiation results do not have to be always Pareto efficient. In the multi-period setting, negotiation in each period forms a sharing agreement. Such sharing rule produces *ex post* optimality because it is based on history of previous time periods. The allocation is not generally Pareto optimal *ex ante*, because of the lack of costless and binding enforcing mechanisms. Risk averse and forward looking household members negotiate on the basis of the entire sequence of power alternation instead of the relative power of one period. An *ex post* efficient sharing agreement that divides surplus between spouses is reached based on historical periods. Family members will efficiently divide any momentary surplus according to that invariant sharing rule until they reach a point such that continuing to use this rule would make one of the members worse off than if he or she becomes single (Ligon, 2003). At that point, household members re-negotiate the sharing

agreement between them and continue as before until they reach a state in which one of them would be better off by terminating the relationship.

The dynamic bargaining model therefore can be characterized by two rules: the sharing rule, and a rule to update the sharing weights. Uncertainty and shocks can be easily included into the model. In a simulated example corresponding to stylized Bangladesh rural households, it is found that if one household member has higher unconditional surplus from marriage (for example, when the state of divorce is extremely unfavorable to women, wives would be more committed to the relationship), then the surplus for women will eventually depend only on the bargaining position of women when their bargaining power is the weakest (for example, when an adverse "shock" occurs and women's crops experience a low yield year). Ligon concludes that the model explains why women borrowers from the Grameen bank voluntarily "pipeline" their loans to their husbands instead of using the loans for production. Choosing to give up the loans is less productive but also safer, avoiding uncertain shocks that can potentially put women in worse bargaining positions. Since at the same time women have more attachment to the family, the sharing rule depends on the state in which her bargaining power is constrained to its lowest level by the adverse shock. Ligon argues that although "pipelining" is an unexpected outcome of the Grameen bank small loan program, both equity and efficiency can be improved when husbands take most of the risk.

Ligon's dynamic bargaining model is encompassed in a broader array of inter-temporal strategies. Imposed on the bargaining in each single period is a strategy allocating consumptions across periods. Lich-Tyler (2003) discusses a test among three inter-temporal strategies and further probes into the determinants of adopting specific strategies. Households may adopt a myopic procedure, a contractual procedure or a prescient procedure. In the myopic procedure household members solve the allocation problem in each period independently without considering past or future bargaining problems. In the contractual procedure the household makes an allocation decision for all periods simultaneously, viewing the entire lifetime as a single bargaining problem. The prescient procedure is an inter-temporal strategy somewhere between the first two strategies, and is similar to what is described in Ligon's dynamic model. In terms of the bargaining threat point, the myopic procedure considers the instantaneous external

opportunities of a single period. The allocation decision changes according to the yearly change of the outside options. The contractual procedure considers the lifetime expected external opportunities instead of instantaneous threat points, and therefore bargaining outcomes are invariant to instantaneous change in bargaining power. The prescient procedure takes only the future extra-marital opportunities into consideration instead of the whole lifetime opportunities. Therefore newly married couples have more at stake than old couples. The closer to the beginning of lifetime of marriage, the closer the prescient and contractual outcomes are. It is argued that bargained household decisions are not invariant to the inter-temporal procedure. Inferring preferences based on observed household decisions of one single period is misleading if the inter-temporal strategy is not taken into account. The myopic and prescient procedures do not have to produce optimal results, while the contractual procedure produces optimal outcomes. However, without binding and enforceable agreements, the contractual procedure is hard to implement.

Using bargaining outcomes depending on inter-temporal strategies, it is possible to use distinctive Euler equations to characterize the three procedures that embody testable restrictions. There is no dominant inter-temporal strategy across households. Using PSID 1976-1986 data, Lich-Tyler finds that married couples with children are more likely to adopt prescient strategy. The restrictions imposed by the prescient strategy are not rejected. The other two strategies are rejected at a confidence level as low as .5%. On the other hand, married couples without children predominantly adopt the myopic strategy. The results indicate that if a single period behavior is used for couples with children, we cannot properly infer spouse preference because agents are obviously saving or cutting back their preferred consumptions in anticipation of future contingencies.

Empirical evidence also supports that, as we would expect intuitively, increased cost of divorcing would drive the household toward the prescient procedure. It is found that having children, stricter divorce laws, and older age lead the household to adopt the prescient strategy. The contractual procedure, though yielding efficient outcomes, is rarely adopted by households.

3. Collective Models

With minimal assumptions, household models in the collective settings have seen a fast growth in the literature (for example, Chiappori, 1988a; Bourguignon, Browning, Chiappori & Lechene, 1993; Chiappori, 1997; Browning, Bourguignon, Chiappori & Lechene, 1994; Browning & Chiappori, 1998; Basu, 2001; Koolwal & Ray, 2002; Maitra & Ray, 2003). These types of models are called collective household models, or sometimes, Pareto efficient models, due to the fact that they only make the minimal assumption that the outcomes of intra-household conflict and collaboration are Pareto efficient. Unlike the cooperative bargaining models, no household games or decision-making mechanisms are specified. Like the cooperative bargaining model, the outcomes are efficient.

Distinctions between the Collective and the Unitary Approach

In the classical unitary approach, the household maximizes a single utility function subject to the income constraints. The key difficulty in justifying the unitary household approach is to reconcile the single-utility framework with the existence of multi individuals within the household. Restrictive assumptions have to be made to solve the problem. The traditional unitary approach to household decision making assumes either family members have the same preferences, or individual preferences can be aggregated into a household utility function (Chiappori, 1997). Examples of such aggregation includes the altruistic approach, where the household head cares about the welfare of each household member, and the dictatorial approach, where all other members' preferences are subsumed by the household head's own preference, with the household maximizing the head's utility function subject to household income constraint. Samuelson's household welfare index (1956) and Becker's rotten kid theorem (1981) are probably the first two attempts to formally model and justify the unitary approach. The collective approach argues that the same preference assumption and the systematic aggregation assumption are not realistic[vii]. Empirical evidence has consistently rejected the unitary assumptions (for example, Thomas, 1990; Schultz, 1990; Johnson & Rogers,

1993; Quisumbing & Otsuka, 2001; Attanasio & Lechene, 2002). Indeed, "individualism is supposed to lie at the foundation of micro theory, and individualism obviously requires one to allow that different individuals may have different preferences" (Browning, Bourguignon, Chiappori & Lechene, 1994, p1068). A general approach should be developed to depict household decision making before special cases like the unitary models are tested. Keeping the assumption to the minimal, the greatest virtue of the collective approach is its generality.

Even though the distinction between the unitary and the collective approach appears to be obvious, Chiappori (1997) specially points out two issues that are likely to be confusing. First, the fundamental discrepancy between the two approaches does not lie with the number of decision makers within the household. As pointed out above, Samuelson and Becker both recognize that there are multi preferences within the household. The unitary approach simply devises restrictive assumptions to simplify the analytical framework. In this sense, the unitary approach is nested within the collective approach. Second, the point of departure between the two approaches does not lie with the maximization of a unique welfare index. Rather, in the unitary models, the maximand can be interpreted as a utility function; it is independent of prices and incomes—the latter appearing only in the budget constraint (Chiappori, 1997). Once the total expenditure is controlled, income should not affect demand in the unitary model. In all collective models, on the other hand, one the most distinguished features is that the maximand is price-dependent. The household utility will depend on prices and income, and price and income enter the function only through the household "sharing rule" function, which will be discussed later.

The Basic Model

In the basic model a two-person household is considered for simplicity. Young children can be added into the model without changing the basic setup by assuming no decision-making power for the children. However, in the reality, older children also have the power to affect household decisions, which is a factor considered in Becker's "rotten

kid" theorem. Household consumption is divided into public and private goods. House maintenance is an example of public good, and clothing is an example of private good. However, the distinction between the two types of goods is not always unambiguous. In fact, potentially a lot of the private goods have a public element if family members care about each other. The budget constraint can be presented as

$$p'(q^M + q^F) + P'Q = y$$

where y is the total household budget, p and P are vectors of prices for the private and public goods, and $q^i, i = M, F$ are male and female private consumptions. Q denotes public expenditure within the household.

The two-person household's problem is to maximize the weighted utility function:

$$\mu U^M + (1-\mu)U^F$$

where $U^i, i = M, F$ represents husband and wife's preferences, which is a function of (q^A, q^B, Q). μ is the weight attached to each member's preference. Weights are between 0 and 1, and they sum up to 1. μ captures the household decision-making process and its result. Sometimes it is called the "distribution of power" index (Browning & Chiappori, 1998). It can be seen that when $U^M = U^F$, or when μ equals 1 or zero, the collective collapses into a unitary model, with the latter case representing a dictatorial scheme of household decision making. Larger μ makes the household utility represent more the husband's preference than the wife's.

In the unitary model, μ is exogenously given. In the collective model, as in all the bargaining models, μ captures the decision process and is a function of prices, total household income and other variables such as income distribution and marriage market conditions. The outcome of the household decision process is postulated to be efficient. That is, for any price-income bundle, the consumption vector chosen by the household is such that no other vector in the budget set could make both members better off. Without further assumptions except for the typical ones such as U is strictly concave, continuous and increasing in $q^i, i = M, F$, and Q, and μ is a differentiable and zero homogeneous function, we can derive testable implications from this very simple model. For example, after controlling for total expenditure, income source should not matter under the unitary

framework. No assumptions are needed for the nature of goods or the form of preferences (Bourguignon, Browning & Chiappori, 1994).

The "Sharing Rule" Interpretation

The "sharing rule" interpretation of the collective setting is the key to derive more structural implications from the model. "Sharing rule", a term used to describe the division of total expenditure on nonpublic goods between the two partners, is due to Becker (1981) (Browning, *et al*., 1994). To use the sharing rule interpretation in the collective setting, the nature of goods and the form of preferences should be categorized. As in the basic model presented above, consumption goods within the household can be divided into public and private goods. However, the line between the two types of goods is not always clear, depending on the form of preference chosen. For example, if the preference is completely altruistic, every member's private consumption enters his or her partner's utility function. In such a setting, all private goods carry a public element. Private goods can further be categorized as exclusive and non-exclusive.[viii] For example, labor supply (or leisure) is an exclusive good. Among those non-exclusive goods, they are further divided into assignable and non-assignable goods. A nonexclusive good is assignable when each member's consumption can be observed independently; otherwise it is non-assignable (Chiappori, 1997). Such a distinctios between the nature of goods is helpful in deriving testable restrictions from the sharing-rule model: The presence of an assignable good or a pair of exclusive goods increases the predictive power of the model.

The form of preference structure is not independent from the categorization of goods. There are three preference structures as summarized in Browning, *et al*. (1994): altruistic preference, egotistic preference, and caring preference.

Altruistic: $U^i = f^i(q^A, q^B, Q)$, $i = A, B$;

Caring: $U^i = f^i(v^A(q^A, Q), v^B(q^B, Q))$, $i = A, B$;

Egotistic: $U^i = v^i(q^i, Q)$, $i = A, B$;

The altruistic form is the most general structure, where private goods from the partner enter into each other's utility function. At the other extreme, in the egotistic preference, each person only cares about his or her own private consumptions. The caring preference

structure, on the other hand, shows that one person cares about the partner's private consumption insofar as such consumption affects the partner's utility. In the caring structure the utility function is weakly separable (Strauss, et al. 2000) in that it is not the amount of specific goods that the partner consumes, but his or her utility achieved from the consumption that is of concern to the other party in the household.

Altruist preferences encompass single-utility frameworks. This is not true for egoistic models since egoistic preferences exhibit a separable property between each member's private consumption bundles. There are some different opinions on the relationship among the three types of preferences. Strauss *et al* (2000) argue that egoistic preference is nested within both the altruistic and caring structures. In contrast, Chiappori (1997) claims that caring preference is nested within the egoistic preference because caring preferences are a subset of the egoistic preference structure rather than the altruistic structure. Strauss et al's argument is more appealing intuitively.

In order to achieve identification in the sharing rule setting, Browning et al (1994) make four additional assumptions: i) some goods are non-public; ii) preferences are caring; iii) each member's sub-utility function is separable with respect to nonpublic consumptions;[ix]

$$v^i(q^i, Q) = V_i(u^i(q^i), Q)$$

and iv) there is one assignable private good or a pair of exclusive private goods.

The sharing rule interpretation of the collective model postulates that the allocation decisions can be seen as if they were generated by a two-stage procedure under the assumptions that preferences are caring and outcomes are efficient. In the first stage, decisions are made on the allocation of total household income to savings, public goods expenditure and private expenditure for each household member. In the second stage, individuals maximize their utility with the amount of expenditure allocated to them in the first stage. Let x be the total private expenditure, and x_M, x_F are husband's and wife's private expenditures. Then with separable caring preferences, in the second stage each member of the household maximizes his or her own sub-utility subject to the amount allocated:

$$\max u^i(q^i) \text{ subject to } p'q^i = x_i \text{ for } i = M, F.$$

The weight, or the "distribution of power" index μ, now can be characterized by the income-sharing rule that allocates total household income to each household member for private consumptions, conditional on savings and public spending decisions. In the sharing rule framework, μ is embodied in how *x* is divided up into x_M, x_F. To see this, in the collective setting it is postulated that there exists a differentiable, zero-homogenous function $\mu(p, x)$ such that, for any (p, x), the vectors (q^A, q^B, Q) are solutions to the "household utility function" in the collective setting:

$$\max_{q,Q} \mu(p,x)U^A(q^A,q^B,Q) + [1-\mu(p,x)]U^B(q^A,q^B,Q) \; s.t. \; p(q^A+q^B+Q) = x$$

With the sharing rule interpretation, this assumption is equivalent to saying that there exist x_M, x_F such that the sub-utility function of each household member is maximized. The existence of such a sharing rule is ensured given assumptions i-iii above and efficiency (Browning *et al*, 1994). As long as the preferences are caring or egoistic and outcomes are efficient, any collective allocation decision process can be interpreted by a sharing rule procedure. Conversely any arbitrarily chosen rule will generate efficient outcomes when preferences are egoistic or caring (Chiappori, 1997).[x]

Now the household utility is a function of household consumption and the sharing rule μ. Since μ depends on price and income, the sharing rule approach implies price-dependent preferences. Price and income enter only through the sharing rule function μ. It is important to distinguish between "distribution factors" and "preference factors". Distribution factors affect the demand of consumption only via the weight function μ, whereas preference factors shift preferences that are represented by individual utility functions. To derive testable restrictions, the key is to identify those factors that can safely be assumed to influence the decision process but not preferences (Browning, et al: 1994). Such factors can include each member's personal income, the sex ratios in marriage markets, family laws and social traditions. In short, those "extra-environmental parameters" (EEPs) (McElroy, 1990) can all be good candidates of distribution factors.

Empirical Tests

Without making assumptions about the household decision making process, the sharing rule interpretation of the collective setting generates two sets of testable restrictions by simply assuming efficiency and describing decision making outcomes through a sharing rule function.[xi] The first type of test uses cross-section data and explores the income effects. The second type of test exploits price variations across regions and time periods to look at the price effects.

A) Income Effects

As each household member's private income enters household demand through the sharing rule function μ, a straightforward test of the "income pooling" hypothesis. In the unitary model, after controlling for total income or total expenditure, source of personal income should not affect demand on private goods. The coefficient of husband and wife's personal income should be 0 if the unitary model is correct. Although this test is straightforward, it suffers from two limitations. First, it can be used to reject the unitary model but can by no means prove the collective model is correct. Second, personal income is endogenous with consumption choices in that the amount of market labor to supply and the amount of consumption are decided simultaneously. Empirical studies have tried to use non-earned income to alleviate the endogeneity problem. However, it is admitted that even those incomes might be endogenous because they partially reveals previous labor choices.

The sharing rule interpretation of the collective model implies more restrictions than income pooling. Because personal incomes affect demands only through μ,

$$\frac{\partial x_i / \partial Y^M}{\partial x_i / \partial Y^F} = \frac{\partial x_j / \partial Y^M}{\partial x_j / \partial Y^F} = \frac{\partial \mu / \partial Y^M}{\partial \mu / \partial Y^F}$$

Because the right hand side of the above equation is independent of i and j, the implication is that the ratio of marginal income effects of male and female incomes on demand should be constant across goods. Such effects are decided by the impact of male female relative income on the distribution power within the household. The left hand side of the above equation is observable from data and so the right hand side ratio is econometrically identified. If we can observe more than one good, the testable restriction

of the collective model is that the ratio of the coefficients of male and female personal income variable is equal up to some random variation across demand functions. Any distributional factors other than private incomes can also be examined in such a way. If the unitary household model is correct, then the source of income should have the same effect on demands. Therefore it would be expected that the ratio in the above equation is unity. Two nested tests can be established. First we can test on efficiency, and second income pooling. Using French (Bourguignon, Browning, Chiappori & Lechene, 1993) and Canadian (Browning, Bourguignon, Chiappori & Lechene, 1994) data, the income pooling restriction is rejected while the efficiency restriction cannot be rejected. The pair of tests has more power to support the collective approach to household decision making than a single income-pooling test.

From the above characterization, the relative influence of male and female attributes (income) on household allocation can be recovered. If additional information is available, that is, if we can observe an "assignable" good or a pair of "exclusive" goods, the sharing rule itself can be identified (Browning, *et al*. 1994; Deaton, 1997; Strauss, *et al*. 2000). For an assignable good,

$$\frac{\partial q_i^M / \partial Y^M}{\partial q_i^M / \partial Y} = \frac{\partial \mu / \partial Y^M}{\partial \mu / \partial Y}, \frac{\partial q_i^F / \partial Y^M}{\partial q_i^F / \partial Y} = \frac{-\partial \mu / \partial Y^M}{1 - \partial \mu / \partial Y}$$

We have two equations and two unknowns. Therefore, the relative change in power distribution as a response to male income and total income change can be estimated.[xii] Following Chiappori (1997), another pair of similar equations can be set up to examine the demand and power change in response to female income change.

The advantage of the income effect test from the empirical perspective is that it requires only one set of cross-section data. No price variation is needed. As pointed out by Deaton (1997), even when time-series or panel data are available, the variation in relative prices is typically much less than variation in real incomes. Therefore the income effect test has more power and is easier to implement. The difficulty with the test, on the other hand, lies with the assumptions on the nature of goods and the selection of distribution factors that do not affect preferences. First, even with such goods as male and female clothing, assuming their "assignability" implies "that wives care only about their husband's clothing insomuch as it contributes to the welfare of their husband (and vice

versa)" (Browning, *et al*. 1994), which is not very convincing. Second, the distribution factors and consumption choices might be endogenously decided. For example, if relative income is found to affect the sharing rule significantly, spouses will tend to choose to work more. Finally, different types or sources of income having different effects on demand does not instantly reject the unitary model, when such differential effect is caused by the fact that some income sources are more regular than others, and some income flows are better measured than others (Deaton, 1997). The problem with the regularity and the measurement of income is especially pronounced in agricultural developing countries.

B) Price Effects

A natural second restriction is to examine the price effect (or the substitution effect). Three most basic properties of the Slutsky matrix are negative semidefiniteness, $S(p,w)p=0$, and symmetry. The first two properties are implied when the Walrasian demand is homogenous of degree 0 and satisfies the Walras' law, and when the weak axiom[xiii] is satisfied. The matrix is not necessarily symmetric until the demand is considered as generated by a preference maximization process. Empirical studies have rejected the symmetry assumption (for example, Browning and Meghir, 1991), but this result serves to reject the unitary model without lending much support for the collective household theory. The question is whether the properties of the Slutsky matrix in the unitary framework can be nested in a more generalized format.

Although there are other earlier attempts to examine the intra-household implications on the Slutsky matrix (see a series of discussion and follow-up papers by Chiappori, 1988b, 1991; McElroy & Horney, 1990), the gap is filled by Browning and Chiappori (1998) eventually. Continuing effort along this line in the Nash bargaining framework is being made by Lechene and Preston (2000), though their research is not complete yet.

Browning and Chiappori's principal theoretical result is "SR1"; that is, in a two-person household, the Pseudo-Slutsky matrix is the sum of a symmetric, negative semidefinite matrix and a matrix that has at most rank one. In the standard preference and

demand system, the Hicksian demand is a funtion of price p and utility u, which in turn is a function of price p and wealth Y.

$$D_p h(p,u) = D_p q(p,Y) + D_Y q(p,Y) \cdot q(p,Y)$$

It can be seen that the price effect on demand when utility is kept constant has two components, one being the demand response to the price change and the other the demand response to wealth compensation. The Slutsky matrix is a function of price and income (wealth), *S(p, Y)*. In the collective setting, the Hicksian demand of the household is also a function of μ, $h = h(p,u,\mu)$. The corresponding "Slutsky" matrix has the components that can be interpreted as the partial derivatives of demands with respect to prices, holding both household utility and the "distribution of power" index μ constant. Therefore, the demand change in response to a price change includes a substitution effect with both utility and μ kept constant, captured by a symmetric and negative semidefinite matrix, and an effect in response to the change in μ, captured by a matrix that has at most rank one in the collective setting.

To empirically implement the generalized SR1 pseudo-Slutsky matrix, Browning and Chiappori resort to a new matrix $M=S-S'$. $M'=-M$ and therefore it is a so-called antisymmetric matrix. The testable proposition is given as: a) in the collective setting, M has rank 0 or 2; b) If M has rank 0, the unitary case cannot be ruled out; c) If the rank of M is more than 2, the collective model is rejected.[xiv] To run the SR1 test, the authors propose that information on at least 5 commodities is needed.

Browning and Chiappori successfully applied these new hypotheses with respect to the price effect on a Canadian dataset. The unitary model is rejected whereas they cannot reject the collective model. The lack of empirical tests taking advantage of price variance reveals the limitation of the price effect approach: Price variance is very difficult to obtain, even with time-series or panel data. The lack of price variation reduces the power of the test.

Endogenous Collective Household Model and Empirical Results

An important shortcoming of the "collective" approach is that it assumes the determinants of the power function are exogenous (Basu, 2001; Hoddinott & Adam, 1998). Therefore, the power itself is exogenously given. Such an assumption is argued to be unrealistic. For example, one of the widely acknowledged determinants of within family power is the male/female earning power, which in turn is often captured by the prevailing market wage rate for male/female workers (for example, Bourguignon & Chiappori, 1994). Basu (2001) argued that what determines the relative bargaining power within household is not just the wage rate but what he/she actually earns. The real income of a spouse is affected by the amount of hours he/she works, which is obviously a deliberate choice (choice of leisure in terms of consumptions).

Along this line of argument, efforts have been made in the latest literature to address the "endogeneity" problem of power within the original collective household framework developed by Chiappori, Browning and others[xv]. Basu (2001) provided the first theoretical exploration of an "Endogenous Power" collective household model and preliminary empirical evidence supporting this model comes in from Nepal, Australia and India (Koolwal & Ray, 2002; Maitra & Ray, 2003; Lancaster, Maitra & Ray, 2003). Basu's (2001) endogenous power framework extends our attention from the impact of household power balance on household decision making to the opposite direction of influence: the effect of household decisions on the balance of power. In his model the budget share equations of consumption items, the total expenditures and the power equation are jointly and endogenously determined. Following the tradition of the collective approach, household members of a two-member household are assumed to have "caring" preferences: $U_i = F_i(v_M(q_M, Q), v_F(q_F, Q))$, $i = M, F$, and q_M, q_F, Q are husband's and wife's private consumptions and household public goods respectively. In the "caring" preference structure each person cares about the other's private consumptions insofar as such consumptions improve the other person's utility. The household's problem is to maximize the combined household utility function with husband and wife sub-utility functions weighted by the "sharing rule" function, subject to the household budget constraint. The sharing rule guides the division of total expenditure on nonpublic goods between the two partners conditional on savings and public good

expenditure share that were decided in the first stage of household decision making (Browning, Bourguignon, Chiappori & Lechene, 1994). Besides those variables that affect intra-household power balance but do not influence individual preferences (such as male and female wage rates[xvi] and cultural factors), the endogenous model includes the choice of some private goods such as leisure in the sharing rule function θ as well. Hence the sharing rule function is $\theta = \theta(z, q_i)$. For a given power distribution index, the household maximizes the household utility function by choosing q_i, which may in turn cause the relative power weights to change. The household may adjust q_i further.

The balance of power and choice of private goods are thus characterized by a dynamic adjustment process. Indeed, "a woman used to domination in the household is unlikely to become powerful immediately if the circumstantial conditions change in her favor" (Basu, 2001). The current period private consumption choice not only generates satisfaction in the present but also affects future intra-household power balance shift. Within each period a "sub-game equilibrium" is reached and the household's "consumption path" is generated across periods. Over time a "household equilibrium" $\left(\theta^*, q_i^*\right)$ is reached by employing a "natural equilibrium" idea (Basu, 1999): The household's private consumption is given by $q_i^* = \eta(price, budget, \theta^*)$ and its balance of power is given by $\theta^* = \theta(z, q_i^*)$. It is shown that such a household equilibrium exists as long as a) θ is continuous in q_i, b) U_i is strictly concave, continuous and increasing in q_i, and c) $budget > 0$ and $price >> 0$ (Basu, 2001).

The endogenous collective model implies that if there is a household equilibrium, there exists a sub-game perfect equilibrium. However, the existence of a sub-game perfect equilibrium does not guarantee consumption levels lying on the household equilibrium utility frontier. In other words, even when the outcomes of each game period are efficient, those outcomes are not necessarily efficient to the household in the long run. This is an interesting point as the collective approach to household was designed to capture the efficiency concept. Yet once dynamics are introduced, strategic maneuvering by the husband and wife can trap the household in inefficient situations[xvii]. Indeed, Udry (1996) estimated a 6% efficiency loss in Burkina Faso agricultural household production.

The endogenous collective model provides a potential explanation for such incongruity between empirical results and theoretical predictions.

Preliminary empirical results are appearing for countries like India, Nepal and Australia (Koolwal & Ray, 2002; Maitra & Ray, 2003; Lancaster, Maitra & Ray, 2003). Two empirical estimation strategies are employed in this literature. The first is to jointly estimate the structural equation system composed of sharing rule equation, total expenditure equation and a system of Engel curves of private goods (Koolwal & Ray, 2002). The second is to estimate the reduced form of the structural equations (Maitra & Ray, 2003). "Income pooling" is the restriction to be tested. In the models the endogenous intra-household power (or weight) equation depends on the share of earnings and the relative education level between spouses, in addition to other traditional exogenous determinants of power. In all the countries tested it is found that the weights and hence the relative bargaining power of males and females have statistically significant effects on household expenditure patterns. The income pooling hypothesis is rejected. The results are consistent with the general collective setting predictions. In addition, the relationship between relative power (approximated by the female share of household earnings) and household expenditure outcomes is non-monotonic, and such relationship varies across commodities. Koolwal and Ray (2002) also found that an increase in the woman's educational experience leads to a rise in her bargaining power, over and above a positive indirect relationship between education and power through education's contribution to the rise of woman's earning capability.

Two limitations emerge from the empirical literature. First, the results are not differentiable from those based on the exogenous collective models. The findings rejected the unitary model but are not able to prove the advantage of endogenous models as compared with other household models. Second, using education level as both an outcome of household decision-making and a determinant in the power function is problematic. Formal education is more likely to be an investment decision before the formation of household than after. Marriage itself might be conditional on education levels, and any continuation of formal education after marriage is likely to be based on a pre-marriage agreement between agents without being subject to further bargaining within the household. Therefore, choice of education level is not best described by an

endogenous collective model. Rather, Konrad and Lommerud's completely non-cooperative and partially non-cooperative models that consider both pre- and within-marriage stages integrate educational decisions better (2000)[xviii].

4. Non-cooperative Bargaining Models

There has been growing interest in non-cooperative bargaining approach to the household. Some of the earliest models were developed as the result of dissatisfaction with the Nash (as well as other types of) cooperative bargaining models. The major problems with those models include an unrealistic threat point external to the marriage and the fact that agreements resulting from bargaining are not self-enforcing at the same time when such agreements are little likely to be binding without cost. The non-cooperative household models so far developed, however, are not fully non-cooperative. Rather, those models are typically characterized by a two-stage decision making process with non-cooperative bargaining solutions integrated into a generalized Nash cooperative game as its fallback position, or the "threat point" (Ulph, 1988; Woolley, 1988; Lundberg & Pollak, 1993; Konrad and Lommerud, 1995, 2000; Chen & Woolley, 2001).

Game Theoretic Foundations

Nash's axioms for a cooperative bargaining solution give us no guidance about the appropriate threat points for bargaining in a marriage. Later theoretical work on non-cooperative bargaining provides solid foundations for appropriate choice of threat points (Bergstrom, 1996). Three studies are key to the development of non-cooperative household models: Harsanyi and Selton (1976) generalize the Nash solution to a cooperative game by relaxing the symmetry assumption, while Rubinstein (1982) and Binmore, Rubinstein and Wolinsky (1986) integrate a non-cooperative threat point with a repeated game with an alternate offering from two agents.

Rubinstein finds that, in a repeated game with an alternate offering from two agents across time periods, when the time interval between offerings approaches 0, at the

limit the only perfect equilibrium is the allocation that maximizes the generalized Nash product: $u_1^{\alpha 1} u_2^{\alpha 2}$, where u, α are the utility and weight for each agent. In other words, the Rubinstein solution converges to the Nash solution. In a repeated game, α can be considered as each agent's discount rate, or time preference. It can also be a function of law, institutional practices and cultural norms that decide individual's bargaining power. If the two agents have the same discount rate, this outcome is equivalent to a symmetric Nash solution with threat point (0,0). Binmore, et al extend the game by including a threat point (m1, m2) that represents the utilities agents can get if they break out from the game. Therefore m1 and m2 represents the external options for agents. The equilibrium, however, is generally not equivalent to an allocation that maximizes $(u_1 - m_1)^{\alpha 1}(u_2 - m_2)^{\alpha 2}$ on the possible utility set, which would correspond to a generalized Nash solution with threat point shifted to (m1, m2). The reason is that fallback utilities should be interpreted as "utilities during conflict" rather than utilities that can be obtained by breaking out of the game.

Three Parallel Non-cooperative Household Models

Lundberg and Pollak (1993) propose a separate spheres bargaining model, whereby they incorporate into McElroy and Horney's Nash bargaining framework (1981) a non-cooperative "threat point".[xix] Compared with the original Nash household, the threat point in the separate spheres model is internal to the marriage, which is argued to be a more believable threat in day-to-day marital bargaining. Such a model depicts a household where resources are allocated in a Nash bargaining process, with the alternative reservation level of utility given by non-cooperative utilities characterized by gender specialization in the provision of household public goods. For example, during household conflict, women may solely take the responsibility of child-caring while men contribute nothing to it. The threat point utility is generated when each spouse, taking his/her partner's contribution to the public good as given, maximizes his/her own utilities subject to his/her own budget constraint in an unhappy (non-cooperative) marriage. Such decision-making process from both sides lead to a pair of "reaction functions" that determine a Cournot-Nash equilibrium where the contribution to the public good is

inefficiently low. To what and how much the husband and the wife would contribute, or are "assumed" to contribute by the opposite party are, according to the authors, based on "socially recognized and sanctioned gender roles" (Lundberg & Pollak, 1996). The non-cooperative allocation serves as the "threat point" in the daily bargaining game. While the daily Nash bargaining can be efficient, the fact that the threat point is the inefficient outcome of family conflict decides the whole bargaining outcome is inefficient. The separate spheres bargaining model and the divorce threat-point model have different policy implications. For example, in the divorce threat-point model, redistribution of income control within marriage, if having no impact on relative incomes for divorced men and women, should have no effect on consumption allocation within marriage. The separate spheres model would predict otherwise: Since the threat point in this model is internal to the marriage instead of external, even when the chances outside of the marriage remain unchanged, bargaining power can shift between the husband and the wife in response to a redistribution of income control.

Another important difference between the cooperative and non-cooperative models is the interpretation of efficiency. In the cooperative bargaining model, Pareto efficiency can be realized when a) information is symmetric and b) the agreement resulting from the bargaining game is binding and costlessly enforceable. These are not realistic assumptions. By contrast, non-cooperative models have the advantage of focusing on self-enforcing equilibriums, which can be Pareto optimal but not necessarily so. When time dimension is incorporated into a repeated game scheme, it is believed that non-cooperative bargaining can eventually generate optimal outcomes (see Lundberg & Pollak, 1996; Basu, 2000; Ligon, 2003). Therefore, instead of being assumed exogenously, efficiency can be achieved endogenously in the non-cooperative approach. In the separate sphere model, efficiency is endogenously determined by traditional gender roles and social norms. After all, efficiency does not imply harmony (Lommerud, 1995).

One question raised about the separate social spheres theory is how those social norms are maintained. In the framework the traditional norms are taken as given. As Sen (1990) points out, people are so used to the gender role assigned to them that they are not even aware of their own rights. Some of the social norms that appear to be biased against

women are not only accepted by the men but also reinforced by women as well. The endogeneity of social norms is not considered in the separate sphere model.

Chen and Woolley (2001) have developed a Cournot-Nash model of family decision-making based on some of their earlier models attempting to describe non-cooperative bargaining within household. The Chen-Woolley model, like the Lundberg-Pollak model of separate spheres, combines a non-cooperative threat point with a Nash solution to a cooperative bargaining problem. The two models differ in their treatment of non-cooperative threat points. The most important feature of the C-W model is "voluntary transfer" between household members. It is this "voluntary" element that makes the bargaining outcome self-enforcing. In the first stage of bargaining, a "pre-transfer equilibrium" is established in a context in which no transfer occurs between husband and wife. Each spouse maximizes his or her own objective utility function subject to individual budget constraint, taking partner's contribution to household public good as given. This stage is a typical non-cooperative game. Each spouse's utility depends on his/her own utility as well as the partner's utility with an assigned weight of *s* (representing the degree of "caring" for the partner). Therefore, as in the collective approach, the household preference structure is assumed to be "caring", which in general involves separability (Spouse cares about his/her partner only in terms of the partner's utility, not the amount of consumption itself) and cardinalization (Bourguignon & Chiappori, 1992). "Caring" is treated as exogenous. Preference on private and public goods is also separable. The utility for person *i* therefore can be written as:

$$W_i = [u(x_i) + v(x_i^h + x_j^h)] + s[u(x_j) + v(x_i^h + x_j^h)]$$

where x_i, x_j are private consumptions and x_i^h, x_j^h are contributions to public goods. The household utility is then the weighted average of both agents' welfare function. Husband and wife's relative income defines a "contribution threshold" I_a: Suppose wife has lower income. I_a is then on the interval between 0 and husband's income. When her income is lower than the contribution threshold, the pre-transfer equilibrium is a corner solution in which only the husband contributes to household public good. Otherwise an interior solution is obtained in which both partners contribute to public good.

In the second stage transfer is allowed. Chen and Woolley argue that if wife's income is above the contribution threshold, a small transfer from husband to wife has no effect on either person's private consumption or the provision of household public good, if the couple face the same price in household public good provision[xx]. The more interesting case is when wife's income is lower than I_a. On the interval between 0 and I_a, there exits a "transfer threshold" I_b. If wife's income were lower than the threshold, a small transfer from husband to wife would raise husband's welfare. When wife's income is higher than the transfer threshold, a small transfer reduces husband's welfare. The interval (0, I_b) defines voluntary transfer equilibrium. Husband and wife's relative income defines the location of the two threshold points I_a and I_b, whereas the distance between the two points is a function of the degree of caring: $f(s)$.

The transfer decision described in stage two is completely under the control of the husband. In real life the husband does not have all the bargaining power, and the wife can either accept or reject the transfer. In addition, the amount of transfer is not decided. Therefore, in the last stage of the game, once agents decide transfer is favorable, they have to negotiate the amount of transfer via a generalized Nash solution to a cooperative bargaining game, with the "pre-transfer equilibrium" as each agent's reservation utility:

$$\max_{\pi}[W_i(\pi)-W_i(0)]^{\alpha}[W_j(\pi)-W_j(0)]^{1-\alpha}$$

where $W(\cdot)$ is the utility when there is no transfer (0) and when there is a transfer amount of π. The amount of transfer now depends on α, representing power, and *s*, representing the degree of caring[xxi].

Given the theoretical framework, Chen and Woolley suggest several empirical tests. We can examine the effect of male/female relative income on public good provision. We can also examine the flow of financial transfers between spouses and the extent of income sharing. The theoretical predictions of the Chen-Woolley model are consistent with the four types of household financial management developed in sociology: whole-wage, allowance system, independent management and shared management (see Pahl, 1983 for details). The tests suggested by Chen and Woolley, however, cannot single the model out as the only correct one. Those tests serve to reject the unitary model and can say nothing more.

The Chen-Woolley model does not consider such dynamic aspects as education of spouses or investment in children. Konrad and Lommerud (2000) consider a model in which couples choose the amount of education and hence the capability of earning market labor return in the first stage (See the addendum for a discussion on a set of education issues to which intra-household theories can be applied). Long-term decisions (investment in education in the K-L model) at the outset of marriage are taken non-cooperatively. The later day-to-day management of the family is reached in efficient bargaining, but with non-cooperative behavior as the fallback position. Taking the future period bargaining positions into consideration, household members tend to over-invest in education in the first period so that he/she obtains higher market value in the second period. Higher earnings capability then improves the individual's bargaining power within family, which produces an incentive of over-investment in education. Over-investment in education and over engaging in market labor result in an under-supply of household public good and therefore the equilibrium thus reached is sub-optimal.

The key contribution of Konrad and Lommerud is that they compare the inefficiency resulting from a fully non-cooperative game and a semi-cooperative game. Observationally we observe an under-supply of public good. A fully non-cooperative game theory explains that because in each period of the game investing too much in household good productivity rather than market labor productivity makes agents vulnerable in future bargaining. And so decisions are made non-cooperatively. A semi-cooperative game theory explains that the efficiency is caused by over-investment at the outset of marriage. In the time period that follows, household members engage in cooperative bargaining using the first period non-cooperative outcome as the "threat point". The policy treatment to correct the under-supply of household good is different, depending on how to interpret family behavior. The first best policy treatment to correct public good distortion is to stimulate public good provisions directly. The second best policy to counter the distortion is to curb the over-investment in education by levying an education tax for example. Konrad and Lommerud argue that the two policies have same effect on household behavior if fully non-cooperative bargaining is the cause of inefficiency. Yet the effect would be different if the family engaged in semi-cooperative bargaining. In the semi-cooperative scheme, the allocation given education investment in

the second stage is efficient, and so policies stimulating public good provisions would have no effect. Here the primary distortion is in fact over-education. Therefore policies targeting education investment, such as an education tax, should be the first best choice.

Although the study has important policy implications, unfortunately Konrad and Lommerud do not provide testing strategies that can be used to distinguish which underlying game represents the reality better, given the observationally same household behaviors. Appropriate data need to be collected to find empirical evidence. In addition, the K-L model also needs to consider marital matching between educationally similar couples. If the semi-cooperative model is realistic, and education is used as the fallback position in future bargaining games, then each person has the incentive to compete for a favorable bargaining position by marrying a partner with lower education levels rather than someone with similar education backgrounds. But the latter type of matching seems to be more frequent in real life.

Recent Development

Although there is growing interest in non-cooperative models (or, more accurately, cooperative models with non-cooperative threat points), little work has been done to derive testable restrictions that characterize a non-cooperative game. The most recent effort in this direction that the author is aware of is Lechene and Preston's derivation of departures from Slutsky symmetry in non-cooperative household demand models (2003). Unfortunately, the study is preliminary and incomplete as it is posted on the Center for Household, Income, Labor and Demographic Economics (CHILD) web site.

5. Empirical Tests and Evidence

Empirical Difficulties

The testable restrictions derived for each of the three categories of models are very limited, most of the time due to insufficient information available from existing datasets. Those restrictions range from the very simple but not very powerful ones such as the "income pooling" hypothesis, to the very complicated but powerful Slutsky matrix generalizations. Rejecting "income pooling" lends some support for bargaining models as contrasted with the traditional unitary models, but cannot by itself prove any specific form of bargaining model is correct. On the other hand, the distinctive properties of the generalized Slutsky matrix in either the cooperative bargaining settings or the collective settings are not easy to test because, for example, utility if divorced is not observable in the cooperative settings while price variance is very hard to obtain in the collective settings.

As the bargaining approach to household economics focuses on individuals instead of households, it imposes extra requirements on household expenditure and income data for more detailed information. At the same time, as the models now generally consider the interaction between heterogeneous preferences and power distributions, subject to individualistic budget constraints, more parameters need to be estimated. This adds extra difficulty to empirical studies in addition to data limitations. Without making further assumptions, imposing structural restrictions, or collecting new information, models are not identified. McElroy and Horney (1990) and McElroy (1990) suggest using unmarried individual's preference to approximate married couple's utility if they divorce. Chiappori (1997) and Deaton (1997) suggest the use of assignable goods or a pair of exclusive goods. Kapteyn and Kooreman (1992) and Kusago and Barham (2001) suggest the use of additional preference information collected directly from interview. All these examples collect extra information in various ways to identify parametric models.

The most fundamental difficulty, for the bargaining models as well as the neo-classic models, is "observational equivalence": Different theoretical models predict observationally indistinguishable household behavior patterns. Put it another way, what economists observe can be as successfully explained by several models. For example, Senauer, Sahn and Alderman (1986) find that in Sri Lanka an increase in women's earnings results in higher expenditures on bread than on rice. This can be attributed either

to changes in relative prices due to the increased value of women's time, or to women's increased bargaining power (and women systematically prefer bread more than men), or to both.

Despite the difficulties, numerous studies are able to reject the unitary model and examine the household black box more closely. Typically those studies take advantage of existing data on both spouses' incomes and information on one assignable good or a pair of exclusive goods. In most occasions the "income pooling" hypothesis is tested since the unitary model predicts that after the total expenditure is controlled, source of income (whether the income accrues to the husband or the wife) should not affect consumption choices. In a few other studies the efficiency assumption is tested. Since bargaining models consider household behavior as the outcome of two factors: power, and preference, the measurement (or, more precisely, inference) of the two factors is not without problems. Many empirical researchers (for example, Hoddinott and Adam, 1998; Pollak, 1994) note that, since individual income is considered as a factor deciding bargaining power, it should be exogenously given. Yet income is obviously endogenous to household choices of consumption and leisure. To solve the problem some studies (for example, Thomas, 1990) use non-wage income as the power indicator. However, although non-wage income such as pension or property income is independent with current household decisions and therefore might mitigate the endogeneity problem, it carries over earlier household decisions. Some researchers further improve on power approximation by using dowry or parental wealth (for example, Thomas, Contreras & Frankenberg, 2002). The best studies in this group use a quasi-experimental power shift resulting from a sudden change in children allowance policy (Lundberg, Pollak & Wales, or divorce law (Hoddinott and Adam, 1998). Lundberg, Pollak and Wales use data collected before and after the change of the children allowance regulation from a longitudinal household survey in the UK, while Hoddinott and Adam (1998) implement a difference-in-difference analysis by exploiting the fact that the divorce law changed in some Canadian provinces earlier than in the other regions. On the other hand, heterogeneous preferences are inferred from household behavior. The implicit assumption is that male and female preferences differ systematically in the whole sample. Only then can we infer that, for example, different male and female income effect on

children's nutrition intake imply different levels of caring about children's welfare. Such assumption may not be realistic. Kapteyn and Kooreman (1992) and Kusago & Barham (2001) therefore use direct preference information instead of using the inferential approach. Finally, another typical problem in the income-pooling test is that we need to control for total expenditure, which might be affected by occasional purchase of expensive items. Such occasional purchase is not observable in the data, and so the information is included in the stochastic term, resulting in a non-zero regressor-error correlation. A typical empirical strategy for dealing with the problem is to instrument total expenditure with household income. In some cases researchers use regional wage levels (see Attanasio & Lechene, 2002).

One recent study by Browning and Lechene (2003) makes an attempt to differentiate between three non-unitary models: cooperative bargaining, non-cooperative bargaining and cooperative bargaining with non-cooperative equilibrium as the fallback position[xxii]. They also try to distinguish between caring and selfish preferences. They take advantage of the fact that the provision of public and private goods is not monotonically increasing in the wife's share of household income. Different types of models interact with preferences to generate different shapes (bending points) of demand curves. Using the Canadian household expenditure data, they find evidence against both non-cooperative behavior and a bargaining game with non-cooperative threat point. Income pooling is again rejected, and preference is caring (see the definition in section 3). They conclude that the data are consistent with a collective model with caring partners. The idea is very innovative. However, the study suffers from a logic flaw in that although models predict distinctive curve shapes, a specific shape derived from data does not prove one of the models should be the only correct one unless that shape occurs if and only if that model is the underlying driving force.

Empirical Evidence

Household economics covers a wide and complicated range of intra-family relations. Besides the intra-generational relation between spouses, intergenerational relationships are also examined in the literature. The areas covered in the intra-

generational relation include family violence, male and female consumptions and household production. Intergenerational studies cover children's health, nutrition intake, education expenditures, difference between investment in boys versus girls and adult children's support for parents. The table in the appendix lists some of the important and most recent evidence on intrahousehold bargaining.

Generally speaking, the following findings are consistently supported by empirical evidence:

- Income is not pooled. The unitary model is consistently rejected.
- Although household consumption might be efficient, household production is not.
- In terms of household consumption, mothers care more about children's welfare. Empowering mothers through marital law change, children's allowance scheme, education, and increased income leads to more spending on children's and women's consumption and health relative to spending on men.
- Fathers and mothers also have different preferences on boys and girls. It appears that fathers invest more in sons while mothers invest more in daughters. Such a phenomenon may be explained by higher returns to the mothers by daughters and higher returns to the fathers by the sons.
- Empowering women also reduces fertility and women's share of housework but improves household health by reducing the consumption of tobacco and alcohol (vices).
- In terms of household production, it is found that about 6% of output is lost due to inefficiency in Burkina Faso (Udry, 1996). Women tend to shun away from uncertainty by voluntarily channeling productive capital to men (Ligon, 2003).
- Finally, household production and consumption are not independent. As suggested in the endogenous collective models developed by Basu, labor supply and goods consumption are not separable. Therefore the sharing rule is endogenously decided. This point finds empirical support from Browning and Meghir's study (1991) on a family expenditure data set from the UK. They

conclude that labor supply and goods consumption are indeed intertwined. In addition, they find that male and female labor supplies are not substitutable in their effect on the demand system. Estimates of demand that only take account of labor participation without controlling for hours of work are likely to be biased. Ignoring labor supply completely results in even more bias in demand estimates.

All of this evidence can be found in developed countries as well as developing countries. The source of power is found to come from market labor wage rates, inheritance tradition, social norm and institutions such as alimony rights and divorce laws.

6. Policy Implications and Limitations of Intra-household Models

Household economics extends beyond marriage. Most of the bargaining models that exist today take an existing marriage as given, ignoring marital market selection and matching. However, intra-household bargaining potentially gives household economics within and beyond marriage richer contents. The introduction of a threat point, for example, links pre- and post-marriage stages together. Arrangements after divorce not only affect divorced individuals but also influence the behavior of married couples (Boca, 2001). On the other hand, policies targeting children's welfare will not only incur within household re-negotiation in the short run, but will also make the individuals in the marriage market adjust their selection and matching choices of partners in the long run.[xxiii]

The development of intra-household resource allocation models has important policy implications. Haddad and Kanbur (1991) note the link between the intra-household literature and the literature on targeting.[xxiv] The research on intra-household economics by studying the mechanism within the black box of "household" can improve the accuracy and effectiveness of social welfare and human development policies and programs. For example, in the 1970s a social welfare policy change was proposed in the UK regarding children's allowance. Before the proposal the allowance was deducted

from the amount of tax withheld from father's paycheck. It was proposed that the allowance should be replaced by a cash payment to the mother. The implication of such a policy change was not clear until Lundberg, Pollak and Wales (1996) found that the new allowance scheme put more resource under the control of the mother, significantly improved children's welfare. A second example, due to Lundberg and Pollak (1996), is the long-standing debate on the topic of reducing the birth rates in developing countries. One side of the debate insisted on family planning services while the other side supported women empowerment. In the traditional unitary models of family it would be hard to interpret how women empowerment could ever be linked to reduction in birth rate. But proponents of the latter alternative suggest that husband and wife have different preferences, and that more power given to women can lead to the policy goal. Based on the unitary household framework, some programs led to unexpected results. For example, the school-feeding program in the Philippines in the mid 1990s did not consider which family member the program should target. As a result, children's calorie intake decreased in some cases because the extra food from schools led to dramatic reduction in food allocated to them at home. Jacoby (2002) calls this phenomenon a "flypaper effect" because children's benefits from the program were "taxed" by family members.

The exploration into the black box of family not only supports more efficient policy and program designs, but also provides additional powerful policy instruments. For example, a hundred dollars reallocated to the wife not only improves her welfare directly from the extra amount of goods she can purchase with the money, but it also has a far-reaching effect by increasing her relative power with the household. Even the prospect of getting a hundred dollars without actually receiving it can improve the wife's benefit. Taking all these factors into consideration creates new powerful policy tools, whereas failure to do so may lead to unexpected and undesirable results.

There is still a lot to do before intra-household theories can help policy design improve further. The existing bargaining models have developed mainly in response to the dissatisfaction with the neoclassical unitary household model and focus on alternative ways to re-interpret observed household economic behaviors. A lot of emphasis has been put on refuting the unitary model. Yet rejecting the properties that characterize the unitary model does not by itself prove any specific bargaining model to be *the* correct

model. There are also few testable restrictions that can effectively distinguish among the class of bargaining models. The question of *how* household members allocate resources that was locked in the black box by the unitary model, and the more fundamental question of *why* households choose the way in which they make allocation decisions still remain largely unanswered. Before the advent of bargaining household models, a rich variety of models have been developed within the neoclassical framework to explain the same set of observed behavior. One good example is unequal boy's and girl's nutrition intake in some developing countries. This phenomenon can be explained by arguing that parents prefer boys to girls. It can be explained by higher market return to investing in boys as well. It can also be argued that boys engage in more intensive labor and so they need more nutrition. Behrman, Pollak and Taubman (1982) develop a model that integrates both preference and market opportunity concerns. An observed unequal distribution of nutrition between boys and girls does not immediately reveal parental preferences: Such an allocation might be endowment-reinforcing, but it might be endowment-compensatory as well. This example shows us the greatest difficulty of household economics: Observationally similar behavior can be interpreted by lots of models that have different policy implications. Without being able to distinguish between non-unitary models, it is hard to choose the correct policy tools.

Appendix: Empirical Studies within the Intra-household Bargaining Framework

Study	Topic	Country/Region	Model	Findings	Notes
Anxo & Carlin (2003)	Housework	France	Bargaining model and specialization model	Controlled for endogeneity, greater husband's share of labor income leads to lower male share of housework. The reverse is true when wife's share of labor income increases. The own wage elasticity of wife's housework is -.3 and husband's housework elasticity with respect to wife's wage is .25	
Attanasio & Lechene (2002)	Household consumption pattern, source of power	Mexico	Differential preference model	Global income pooling is rejected. Women's income share is positively related with her decision making power	PROGRESA as exogenous power shift factor
Beegle, Frankenberg & Thomas (2001)	Child bearing and birth health	Indonesia	Cooperative bargaining	Four dimensions of power: asset share, education, relative social status of husband and wife's family, relative education level of father versus father-in-law. More female power leads to better reproductive health choices.	
Blacklow & Ray (2003)	Household consumption patter and tax policy	Australia	Collective settings	Identical preference is rejected. Price and expenditure elasticity of demand differs between family members, and so the marginal social cost of raising revenue by taxing is also different.	

Breunig & Dasgupta (2000)	Welfare of children and the elderly	US	Non-cooperative bargaining	Welfare cutbacks that increase household income may in fact reduce the well being of children and elderly. Special notice is paid to welfare income and market income effect.	Food stamp
Brown (2002)	Dowry and women's welfare	China	Cooperative Nash bargaining	Dowry is positively associated with women's welfare such as leisure time and consumption on women's private goods. More dowry also puts women in a favorable position when dispute arises within family	
Browning & Meghir (1991)	Interaction of labor supply and commodity demands	UK	Differential preference model	Labor supply and commodity demands are endogenously decided. Male and female labor decisions have different effects on demands.	
Browning, Bourguignon, Chiappori & Lechene (1994)	Household expenditure pattern	Canada	Collective setting	Relative incomes, ages and the level of lifetime wealth have substantially significant impact on expenditure allocations.	
Browning & Chiappori (1998)	Household demand	Canada	Collective setting	Slutsky matrix is not symmetric. Income is not pooled. Predictions of unitary model are rejected for couples but not for singles. Predictions of collective settings are not rejected for couples.	A rare but powerful study looking at both price and income effect
Bubois & Ligon	Food and nutrition	The	Collective	Unitary allocation of food and nutrition	

(2003)	allocation	Philippines	setting with incentive and productivity considerations	is rejected. Allocation of food depends on both providing incentives and productivity considerations	
Chiappori, Fortin & Lacroix (2001)	Marriage market, household labor supply	US	Collective settings	Sex ratio and divorce law in favor of women lead to favorable changes in female labor supply change	
Duflo & Udry (2003)	Household expenditure patterns affected by uncertainty	Cote d'Ivoire	Semi-cooperative bargaining	Conditional on overall levels of expenditure, the composition of household expenditure is sensitive to the gender of the recipient of a rainfall shock. Positive "shocks" on women's crop shifts expenditure towards food. Adverse shocks on men's production take toll on food and education provisions. Different sources of income are allocated for different uses according to social norms on gender roles.	
Duflo (2000)	Child nutrition	South Africa	Cooperative bargaining	Pensions received by grandmothers have a large impact on the anthropometric status of girls but no effect on that of boys. No similar effect is found with pensions received by men	Pension scheme change
Gibson (2003)	Household expenditure pattern	Papua New Guinea	Differential preference model	Women's share of control over expenditure has different effects on household expenditure pattern than men's share of control. Therefore	Using both income and expenditure data.

				without increasing women's income, policy tools are still available to affect household expenditure pattern.	
Hoddinott & Adam (1998)	Suicide and divorce law	Canada	Cooperative bargaining	Change in the divorce law in Canada leads to improvements in women's expected settlement upon divorce, which results in reduced suicide rates for older married women. No effects are found with younger unmarried women	Divorce law change as quasi-experiment
Hoddinott & Haddad (1995)	Household expenditure pattern	Cote d'Ivoire	Non-cooperative bargaining	Raising wife's share of cash income increases food expenditure and reduces the budget shares of alcohol and cigarette.	
Jacoby (2002)	Children's food consumption	The Philippines	Differential preference	Without considering intrahousehold allocation, school feed program leads to reduction in children's home food consumption. As a result, the total food for children decreases in some cases	Quasi-experiment
Koolwal & Ray (2002)	Household consumptions and source of power	Nepal	Endogenous collective settings	Women empowerment leads to different household consumption patterns. Education level increases women's power in addition to her share of income	
Kapteyn & Kooreman (1990)	Labor Supply	The Netherlands	Cooperative bargaining	Utility functions of spouses are significantly different.	Preferred working hours as additional identifying information

Lancaster, Maitra & Ray (2003)	Household expenditure pattern, gender bias	India	Endogenous collective settings	There is significant gender bias in education expenditures. The bias is not always in favor of boys, depending on the regions. Bargaining power has varied effects on different consumption items	
Lich-Tyler	Inter-temporal allocation strategies	US	Dynamic cooperative bargaining	Increase in difficulty of divorce leads families to choose prescient inter-temporal strategy. Decrease in the difficulty leads to myopic strategy. Few families adopt the contractual strategy	
Lundberg, Pollak & Wales (1996)	Household expenditure pattern	UK	Cooperative bargaining	Shifting child allowance from granting to father to giving to mother leads to increased share of expenditure on children and women's clothings.	Quasi-experiment from child allowance policy change
Maitra & Ray (2002)	Household expenditure pattern	South Africa	Collective settings	Sources of income have different impact on expenditure patterns, depending on who is the recipient of the income. Neither income nor non-labor earnings is pooled.	Social pension scheme change as quasi-experiment
Maitra & Ray (2003)	Household expenditure pattern	Australia	Endogenous collective settings	The relative spousal power has effect on expenditure patterns. The effect varies a great deal across commodities	
Maitra (2003)	Children's health and mortality	India	Collective settings	A woman's education has larger impact on positive health choice than man's	

				education; Women's control of household resources has similar impact.	
Phipps & Burton (1998)	Household expenditure pattern	Canada	Semi-cooperative bargaining	Income is pooled for housing but not for other consumptions. Traditional gender roles decide whose money is mainly used for what.	
Quisumbing & Maluccio (2003)	Children's education expenditure	Bangladesh, Ethiopia, Indonesia, South Africa	Differential preferences	The unitary household explanation is rejected in four countries. The allocation is Pareto-efficient. In Bangladesh and South Africa women's asset shares increase education expenditures. In Ethiopia however, it is men's asset shares that matter.	
Quisumbing (1994)	Intergenerational transfer	The Philippines	Differential preferences	Parents exhibit preferential behavior towards children of their own gender.	
Rangel (2003)	Women's labor supply, teenage girl's schooling	Brazil	Cooperative bargaining	Empowerment of women through alimony rights extension to cohabitants reduces women's labor supply and redistributes resources to girl's education.	Alimony rights change as exogenous source of power change
Rubalcava & Thomas (2000)	Household allocation patterns	US	Cooperative bargaining	AFDC pays to single women with children, which leads to improved divorce fallback position in family bargaining. Consumption patterns change as a result for lower income families with very young children.	AFDC as fallback position of a bargaining game

Rubalcava, Teruel & Thomas (2002)	Children's clothing, food	Mexico	Cooperative bargaining	Empowering mothers through exogenous funding improves children's and adults' welfare.	Using PROGRESA as exogenous power shifting factor
Schultz (1990)	Labor supply and fertility	Thailand	Nash cooperative	Women with more bargaining power are shown to prefer more leisure and having more children. Men also prefer more leisure when they have more un-earned incomes. However, the causation of more un-earned income on preferring more children may be the other way round.	
Stevenson & Wolfers (2003)	Family distress and divorce law	US	Cooperative bargaining	Allowing unilateral divorce contributes to a large and significant reduction in women suicide, murder and domestic violence. No effect on men.	Divorce law reform as quasi-experiment
Tauchen, Witte & Long (1991)	Domestic violence	US	Differential preference	For low-income families, rise of injurer's income increases violence while rise of victim's income has no effect. For high-income families, rise of injurer's income and rise of victim's income both reduce violence	
Thomas (1990)	Family health	Brazil	Differential preferences	Resources controlled in the hands of mother have different impact on family health than resources controlled by the father. Maternal resources lead to twenty times higher child survival	

				probability than the same level of paternal resources. Mothers prefer to devote resources to the health of daughters and fathers to sons.	
Thomas (1994)	Child height	US, Brazil, Ghana	Differential preferences	Mother's education has larger effect on daughter's height and father's education has larger effect on son's height. In Brazil, women's nonlabor income has effect on daughter's health but not her son's	
Thomas, Contreras & Frankenberg (2002)	Child health	Indonesia	Cooperative bargaining	Child health is affected by the relative wealth brought into the marriage by men and women. The bargaining outcome is efficient.	Javanese tradition makes premarital assets good indicator of power
Udry (1996)	Household production	Burkina Faso	Differential preferences	Agricultural household production allocation is not efficient. Women's plots are farmed less intensively than similar men's plots. About 6 percent of outcome is lost due to such inefficient allocations	
Zhang & Chan (1999)	Dowry and women's welfare	Taiwan	Cooperative bargaining	A dowry improves bride's welfare but bride price has no effect	

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[i] The difference between the Nash solution and the K-S solution is that, in addition to all the assumptions made, the Nash solution satisfies the independence of irrelevant alternatives property (Nash, 1953, quoted in Manser & Brown, 1980). The K-S solution instead assumes the property of monotonicity, which states that "…if, for every utility level that player 1 may demand, the maximum feasible utility level that player 2 can simultaneously reach is increased, then the utility level assigned to player 2 according to the solution should also be increased" (Kalai & Smorodinsky, 1975, p.515, quoted in Manser & Brown, 1980).

[ii] Chiappori (1988b) in his comment on McElroy and Horney's work finds the expression for the inverse of G is in fact singular and thus not invertible. The expression for G, however, is correct and invertible.

[iii] The Nash hypothesis for implication a) is described as: $X_{I_M} - X_{I_F} = SG^{-1}DV_I\begin{pmatrix}1\\-1\end{pmatrix}$; b) is described as: $X_\alpha = SG^{-1}DV_\alpha$; c) can be examined by showing the symmetry and negative semidefiniteness of the generalized Slutsky matrix.

[iv] See the discussion in Blundell and Lewbel (1991) and Deaton (1997) on the analysis of equivalence scales.

[v] Violence can be considered as a bargaining tool. But it can also be interpreted as the outcome of household power distribution.

[vi] Such arguments are more likely untrue, however, for inter-generational relationship within the household. Borrowing from evolution biology and anthropology, Bergstrom (1996) summarizes two competing characterizations of inter-generational relationship (wealth flow as an observable example): Kaplan's biological evolution theory (1994), and Turke (1989) and Caldwell (1978)'s transitional society theory. The evolution theory argues that wealth flows from parents to children because the genetically more caring species would eventually have more offspring that are also caring than species that regard offspring as assets. The transitional society theory argues that in pre-transitional societies, children are assets of parents and so wealth flows from children to parents overall. Anthropological evidence predominantly supports Kaplan's prediction that wealth flows from parents to children (Fricke, 1990; Kaplan, 1994). Indeed, using the Consumer Expenditure Survey, Lee and Miller (1994) find that in the US the net payment from parents to children is about $25,000, with an additional $81,000 child rearing cost.

[vii] Strauss, Mwabu and Beegle (2000) point out that in dynamic models of household, it is possible that the preferences of partners converge over time, as the partners become more alike and get accustomed with and identified with each other's values. However, the authors also admit the great difficulties involved in modeling such taste formulation across time.

[viii] Exclusive goods are included along with private goods in the collective settings. Together they are termed as nonpublic. This lineup is for the sake of establishing a clean theoretical framework. As pointed out in Browning, *et al* (1994), both public and private goods can be exclusive goods. They give the example of cigarette and telephone. The former is a private good but if only one person smokes, it is exclusive. Whereas the latter is a public good, if only one person ever uses it, it is also categorized as exclusive.

[ix] Strauss, *et al* (2000) indicates that the separability assumption in the preference structure might be a problem. They quote from Kapteyn and Kooreman (1992) and argue that such an assumption can be too strong. One hypothetical example given in Strauss is that meals eaten together may not be equivalent to meals taken separately, yet under separability no difference would be permitted. However, Browning et al (1994) notes that without condition iii it is still possible to define and identify a sharing rule (see p.1074).

[x] Chiappori (1997) points out that with altruistic preferences, the sharing rule interpretation is no longer equivalent to efficiency in general. The efficiency equivalence interpretation also does not hold in the "caring" case for "too unfair" sharing rules because intuitively, if partners care about each other, making household allocation less unfair improves both side's utility. The incompatibility between the collective setting and efficiency is found in the empirical literature (for example, Jones, 1983, 1986; Udry, 1996). But as Chiappori points out, the fact that the sharing rule idea is not compatible with efficiency does not necessary imply that it is irrelevant. Strauss et al (2000) points out that it is important to distinguish production efficiency with consumption efficiency. Production inefficiency does not necessarily imply consumption inefficiency. In fact, production allocations may be potentially socially inefficient because of intra-household disputes. Another theoretical development that reconciles the incompatibility is the endogenous power framework developed by Basu (2001).

[xi] As pointed out by Chiappori (1997), an attractive property of the sharing rule interpretation is that it provides a description of the decision making process that is independent of the particular, cardinal

representation of preferences. It is very difficult to distinguish empirically between ordinally equivalent but cardinally different utility functions. The Nash bargaining models suffer from the difficulty by contrast (pp 43-44).

[xii] In the sharing rule interpretation, the amount of good i consumed by M is a function of sharing rule, price of good i, conditional on expenditure allocated to public goods. The amount of good i consumed by F depends on total income minus public expenditure and private expenditure of M. Therefore, the demand function is given by

$$q_i = g_i^A[\mu(Y, Y^A, Y^B)] + g_i^B[Y - \mu(Y, Y^A, Y^B)]$$

Take the partial derivatives we can get the two ratio equations. Strauss, et al (2000)'s exposition of the two ratio equations is wrong (p. 98), and although Deaton (1997) provides the framework correctly, there seems to be a typo in the equations presented in his work (equation 4.10, p.228).

[xiii] If $p \cdot x(p', w') \leq w,$ and $x(p', w') \neq x(p, w)$, then $p' \cdot x(p, w) > w'$.

[xiv] Chiappori (1997) explained intuitively why the matrix in addition to the traditional symmetric negative-semidefinite matrix should have at most rank 1. Basically price change incurs the utility frontier to span inward or outward. Then on the new frontier, as μ has also changed, the point of allocation moves along the new frontier. With a 2-person household, the movement of allocation along the frontier occurs in a one-dimensional space, no matter how many goods the household consumes.

[xv] There are anthropological and sociological evidence that woman's contribution in the household or household farm is not valued the same as her actual earnings from the market, even though her work at home enabled the husband to go out and earn a wage (Basu, 2001, Mencher, 1988, Riley, 1997). This phenomenon is also observed in the context of American labor market (Zelizer, 1994). The choice of going to the market, in turn, is a voluntary choice that is often decided by social norms and traditional perceptions on the role of men and women (Alderman, Haddad & Hoddinott, 1997). Sen (1990) pointed out that such gender role inequalities reflect the perceived legitimacy as seen by women as well as men.

[xvi] Browning, Bourguignon, Chiappori & Lechene (1994) pointed out the possibility that wage rate may also affect individual preferences. For example, it is not completely impossible that a better-paid job requires more expensive clothing.

[xvii] Basu (2001) suggested two schemes where inefficiency may occur and persist. First, assuming the husband preference dominates in the first period. Among all the feasible set of utilities the husband may stick to the strategy of not letting the wife to work to maintain his power. In this scheme there is an inefficient under-provision of market labor. Second, the apprehension that to work less would diminish bargaining power in future household decisions may lead to an inefficient over-provision of labor. That is, household members work more than they would ideally like.

[xviii] Their models will be discussed at the end of the following section.

[xix] Kusago and Barham (2001) apply the concept of separate spheres to the analysis of rural Malaysian household decision-making. Thomas, Contreras and Frankenberg (2002) also pay special attention to role specialization within family in their study on Indonesia families.

[xx] This corresponds to the surprising and remarkable result due to Warr (1983) and the result is sometimes called "neutrality". It states that if a group of agents are all voluntarily contributing to a public good then small re-distributions of income will not lead to any changes in the allocation to any public or private goods.

[xxi] Carter and Katz (1997) and Katz (1995) develop a similar model that models intra-household transfer. Their model is called "conjugal contract model". It differs from the Chen-Woolley model in two ways: It allows both labor and income transfer. And it examines voluntary transfer to partner's private consumption and household-produced goods. The conjugal contract model also uses a non-cooperative bargaining framework to decide intra-household transfer and a cooperative framework to determine the levels of transfer. Guatemalan highland households are studies using this model.

[xxii] Cheryl Doss (1996) also discusses the testing problem among various household models. She summarizes a list of null hypotheses that are expected to be either consistent or rejected under those models [Table 1, p. 1602]. Based on the cross-tabulation, theoretically collective models and cooperative models are not differentiable, whereas these two should be distinguishable from non-cooperative models.

[xxiii] One example of extending intra-household models beyond marriage is McElroy (1997). The study explores a general equilibrium of bargaining and marriage markets.

[xxiv] The targeting literature studies the design of tax and transfer programs for poverty alleviation in the presence of limited information on who the poor are (Haddad & Kanbur, 1991).