Heterogeneity and Aggregation: Testing for Efficiency in Intra-Household Allocation

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Abstract

Intrahousehold resource allocation is an important and widely-studied topic in economics. A substantial literature tests whether observed resource allocations are Pareto efficient, as predicted by the influential collective/cooperative household model. The empirical evidence regarding the validity of the cooperative model is mixed. We present what we believe is the first evidence of within-sample variation in the efficiency of intrahousehold resource allocation. We document that in a sample of rural, low-income Mexican households, observed resource allocations are Pareto efficient for young but not old households. This suggests that tests for "the validity of the cooperative household model" may be misplaced; researchers should instead aim to identify which models best characterize different groups of households. In ongoing work we examine whether this heterogeneity is driven by cohort or life-cycle effects, which may inform future models of non-cooperative household bargaining.

1 Introduction

Intrahousehold resource allocation is an important and widely-studied topic in economics. An extensive literature studies how households accumulate resources and allocate these resources between members. Describing and modeling these decisions can provide important insights into households' use of productive resources (Udry, 1996), investment in children's human capital (Thomas, 1990), and labor supply decisions (Rangel, 2006). In particular, many papers test whether households can be accurately modeled as *unitary* actors with rational and consistent preferences and/or as *cooperative* units whose consumption, investment, and production decisions are Pareto efficient. Most empirical work rejects unitary models of household behavior but the evidence regarding cooperative models is inconclusive.

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We present a novel potential explanation for the range of results regarding the validity of cooperative models of household behavior. We show that in a sample of rural Mexican households, the cooperative model is strongly rejected for young households but not rejected for old households.[1] We believe that this is the first example of within-sample heterogeneity over observed demographic characteristics in the efficiency of household resource allocations.[2] Our results show that the efficiency of houshold decision-making, and hence the validity of cooperative models of the household, can differ even when households face the same geographic, institutional and socio-economic environment. This suggests that tests for "the validity of cooperative household models" may be misplaced; researchers should instead aim to identify which models best characterize different groups of households. For example, the disparate results of prior empirical tests may reflect differences in the age composition of samples. Standard approaches that test whether an entire sample's behaviour is consistent with a specific model do not take this into account. Ongoing work explores whether the difference we find is explained by cohort differences between younger and older households or life-cycle effects, though we present preliminary evidence supporting the forme hypothesis. This will help to identify the factors explaining why some households achieve Pareto-efficient resource allocations and others do not. This contributes to an active research program into the best way to model non-cooperative household behavior.

Studies of household decision-making have considerably broader implications for understanding group decision-making. Households may plausibly face more conducive conditions for achieving efficient outcomes than other groups. Household members have relatively extensive information on other members' behavior, face substantial costs of leaving the group, are more likely to have altruistic preferences toward each other, and may have relatively homogeneous preferences. If households are not able to achieve efficient outcomes, the scope for other groups to do so may be even more limited.

We begin by outlining a theoretical and empirical framework in section 2. This framework closely follows the canonical cooperative model of household behavior (Chiappori, 1992; Browning and Chiappori, 1998). In section 3 we describe the setting and data for our empirical work: the Progresa/Oportunidades evaluation in rural Mexico. We discuss the results in section 4 and conclude in section 5.

Our contribution builds off an extensive empirical and theoretical literature on intra-household decision-making. A substantial body of empirical work fails to reject the null hypothesis that household resource allocations are Pareto efficient (Akresh, 2005; Bobonis, 2009; Bourguignon, Browning, Chiappori, and Lechene, 1993; Browning, Bourguignon, Chiappori, and Lechene, 1994; Chiappori, Fortin, and Lacroix, 2002; Rangel and Thomas, 2005) However, rejections of Pareto efficient consump-

[1] We define "young" and "old" households as households whose is head is respectively younger or older than the sample median, 39. The results are robust to small changes in the value of this cutoff.

[2] In related work, Angelucci (2008) shows that behavioral responses to cash transfers vary across rural Mexican households with different baseline characteristics. Farfán (2013) documents differences in resource-sharing and expenditure for Mexican households depending on whether their members are co-resident in one household or split across multiple locations. Hoel (2013) shows that asymmetric information prevents some but not all households from playing Pareto efficient strategies in modified dictator games.

tion decisions are not uncommon (Dercon and Krishnan, 2000; Djebbari, 2005) and several studies reject Pareto efficient allocation of productive resources (Udry, 1996; Duflo and Udry, 2004). Several recent papers explore possible reasons why Pareto efficiency is not achieved, including limited information (Ashraf, 2009), heterogeneous time preferences (Schaner, 2013), and limited intertemporal commitment (Mazzocco, 2007).

2 Theoretical and Empirical Framework

We consider a simple model of household consumption decisions. Households maximize the weighted sum of the utilities of members A and B

$$u_A(q^A, q^B, Q; a) + \mu(y, p, z) \cdot u_B(q^A, q^B, Q; a), \tag{1}$$

subject to a budget constraint

$$p \cdot q \leq y$$

where q^i is a vector of consumption of private goods for household member i, Q is a vector of consumption of public goods, $q = (q^A, q^b, Q)$, p is a vector of prices, a is a vector of preference parameters, and μ is the relative weight attached to member B's utility. μ depends on a vector of distribution factors $z = (z^1, \ldots, z^M)$, which are typically interpreted as measures of bargaining power. The specification of the demand problem in equation 1 assumes that distribution factors influence equilibrium consumption only through the weight function μ, not through the utility functions u_A and u_B. Substantively, this rules out candidate distribution factors from which household members might derive direct utility.

The solution to this problem yields a reduced form household demand for good $j \in q$ of

$$d^j = d(x, z, p, a),$$

where x is total consumption expenditure. This demand function implies that the household budget shares for goods $j = 1, \ldots, J$ are given by

$$w^j = \tilde{d}(x, z, p, a). \tag{2}$$

If the household behaves as a unitary actor, then intrahousehold resource allocations should not depend on the bargining power of the individual actors. Hence, conditional on total household consumption, the distribution factors should not influence the distribution of consumption between different goods and so $\frac{\partial w^j}{\partial z^m} = 0$ in equation 2 for all $j \in \{1, \ldots, J\}$ and $m \in \{1, \ldots, M\}$. This provides a testable restriction of the unitary model.

If the household's allocation of resources is Pareto efficient, then the relative effect of changes in different distribution factors on the budget share for each consumption good should be identical across all goods: $\frac{\partial w^j}{\partial z^m} / \frac{\partial w^j}{\partial z^n} = \frac{\partial w^k}{\partial z^m} / \frac{\partial w^k}{\partial z^n}$ for all $j, k \in \{1, \ldots, J\}$ and $m, n \in \{1, \ldots, M\}$. Intuitively, restriction arises because distribution factors satisfying the formulation in equation 1 shift households between different Pareto efficient consumption bundles but do not change which bundles are Pareto efficient. This provides a testable restriction of the collective or cooperative model. Note that this is a strictly weaker restriction on consumption behavior than that implied by the unitary model. Hence, consumption behavior may be consistent with the cooperative model and not the unitary model but not *vice versa*.

We impose some parametric structure on the budget share models in equation 2. While this structure is restrictive, it is standard in the literature and we believe that following nonparametric estimation of household demand models is a largely open problem. We begin by estimating Engel curves derived from almost ideal demand system (Deaton and Muellbauer, 1980):

$$w^j_{i,t} = \alpha^j \ln(x_{i,t}) + \sum_{m=1}^{M} \phi^j_m z^m_{i,t} + \beta^j a_{i,t} + \eta^j_{i,t} + \epsilon^j_{i,t} \tag{3}$$

for each good j and for households $i = 1, \ldots, n$ in periods $t = 1, \ldots, T$. $\ln(x_{i,t})$ represents total consumption expenditure; $z^1_{i,t}, \ldots, z^M_{i,t}$ represent distribution factors; $a_{i,t}$ represents a vector of demographic characteristics which proxy for unobserved preferences a; and $\eta^j_{i,t}$ are state-by-surve wave fixed effects whic proxy for unobserved prices.[3] We estimate the set of all budget shares are simultaneously using a seemingly unrelated regression and cluster standard errors at the village level. We use log total household income $\ln(y_{i,t})$ as an instrument for log total household expenditure to address possible measurement error.[4]

We also estimate a quadratic almost ideal demand system Banks, Blundell, and Lewbell (1997):

$$w^j_{i,t} = \alpha^j_1 \ln(x_{i,t}) + \alpha^j_1 \ln(x_{i,t})^2 + \sum_{m=1}^{M} \phi^j_m z^m_{i,t} + \beta^j a_{i,t} + \eta^j_{i,t} + \epsilon^j_{i,t} \tag{4}$$

which conditions on quadratic log total expenditure and so allows a more flexible Engel curve. As a final robustness check, we estimate equations 3 and 4 with interactions between the log consumption expenditure terms and the state-by-survey wave fixed effects. This allows the slope of the Engel curve to vary with regional or temporal price variation, in the spirit of the full linear and quadratic almost ideal demand systems.

The unitary model predicts that $\phi^j_m = 0$ for all $j \in \{1, \ldots, J\}$ and $m \in \{1, \ldots, M\}$. The cooperative model predicts that $\phi^j_m / \phi^j_n = \phi^k_m / \phi^k_n$ for all $j, k \in \{1, \ldots, J\}$ and $m, n \in \{1, \ldots, M\}$. We implement

[3]The canonical almost ideal demand system includes price indices and interactions between total consumption expenditure and prices.

[4]Attanasio, Battisin, and Mesnard (2011) emphasize the potential importance of accounting for measurement error in expenditure. In our setting, the results are very similar with and without this correction.

these tests in section 4. We depart from the literature in estimating the tests for the entire sample and separately for younger and older households. Our key innovation is the finding that the efficiency of household resource allocations varies across households with different observed characteristics: younger households' allocations are not on average efficient while older households' allocations are on average efficient.

3 Data

We use data from the evaluation of Mexico's PROGRESA/Oportunidades program. This program, started in 1997, still ongoing, and currently reaching about one quarter of the Mexican population, provides conditional cash transfers to eligible households. To be eligible, a household must be sufficiently poor. The transfers, paid bimonthly, are largely in the form of scholarships to the last 4 grades of primary school and the three grades of secondary school. These transfers are contingent on (i) schoolchildren attending at least 85% of classes, (ii) household members undergoing periodical health checks, and (iii) transfer recipients (typically, the mothers of the schoolchildren) attending nutrition and health classes.

The evaluation data are collected from 506 rural villages across seven states whose school-aged children met minimum school attendance and clinic visitation conditions. We have a complete census of all village residents. Moreover, in our data, all households received a score on a wealth proxy-means test: households who score below a threshold score are eligible for the PROGRESA transfers.

To evaluate the program, until the end of 1999 the transfers were offered only to eligible households in 320 randomly chosen treatment villages. The baseline data was collected in September-October 1997, while the first cash transfers were paid in March/April 1998 in the treated villages and between the end of 1999 and the beginning of 2000 in the control villages. We also have three follow-up waves, collected in October/November 1998, May/June 1999, and October/November 1999.[5]

Since the cash transfers were paid directly to mothers, women's bargaining power in the household plausibly increases among eligible households in treatment villages. Therefore, we follow the existing literature (Bobonis, 2009; Angelucci and Attanasio, 2013; Attanasio and Lechene, 2014) and use an indicator variable for Progresa eligibility as a distribution factor, denoted z^1. Since the PROGRESA cash transfer are conditional, they might change other features of the household which affect the shape of the Engel curves, besides bargaining power. One relevant change that PROGRESA causes is increased school attendance in households that would not have sent their children to school in the absence of the program. This, in turn, may affect household demand by changing food and non-food expenditures, as the children attending school may have school-related expenses and also change their and their household members' nutrition. Since primary school enrollment is virtually 100% in

[5]By November 1999, some eligible households in control villages had received their first transfer. We return to this issue later.

these villages, the program can have minimal changes in primary school enrolment and attendance. Conversely, secondary school enrollment in the absence of the program is about 65% and, indeed, the program has been shown to have large effects on secondary school enrollment (Schultz, 2004; Angelucci, de Giorgi, Rangel, and Rasul, 2010).

To use living in a treated village as a distribution factor, we restrict the sample to households eligible for PROGRESA in both treatment and control villages. Moreover, avoid potential confounding effects of the program on households in which it caused a change in school attendance, we drop households with potentially eligible secondary schoolchildren at baseline. To do that, we restrict the sample to households without any child aged 10 to 16 with 5 or 6 maximum completed school grades in September 1997.[6] These are the children who may start secondary school in 1998 or 1999, i.e. the group whose enrollment is most likely affected by the program.[7].[8] Lastly, we drop single-headed households and also all households for which we have missing observations. This provides a total of 25372 observations spread across 506 villages

Our second distribution factor is the municipality-level ratio of female to total population in 1995, computed using data from the Mexican National System of Municipal Information database. This variable is approximately continuous and a higher female:male sex ratio is likely to reduce the relative bargaining power of women by skewing the marriage market in men's favor. The distribution factors are assumed to be independent of prices and preferences. The second part of this independence assumption may fail if there is selective migration out of villages in response to perceived marriage market conditions. Preliminary results suggest that the results are robust to replacing the contemporaneous village sex ratio with the sex ratio from the Mexican census closest to the time that each cohort reached age 18. This also goes some way toward addressing the potential concern that the sex ratio at the time marriages are formed has a larger impact on bargaining power within relationships than the contemporaneous sex ratio. The latter measure is only appropriate if exit from marriages is a credible threat, as discussed in Mazzocco (2007).

We split our sample into "old" and "young" households, defined by whether the household head is above or below median age. Table 1 shows the means of socio-economic variables separately for the two sub-samples (columns 1 and 2) and their difference (column 3). Older households have a bigger spousal age gap and a higher likelihood of being indigenous, illiterate and less educated. They also have fewer children aged 0-9, more children aged 10-18, and more adults in the household. Conversely, neither the village characteristics – emigration share and marginalization index – nor the distribution factors – the treatment dummy and female ratio – vary by sub-group. We also find that the characteristics of

[6]All results are robust to also dropping households with any children aged 10 to 16 irrespective of their level of schooling at baseline.

[7]Once enrolled in seventh grade, the first of the three years of secondary school, the likelihood of dropping out is low

[8]The receipt of PROGRESA may also change health and nutrition for recipient households via changes in knowledge and habits. However, Angelucci and Attanasio (2013) provide evidence inconsistent with this hypothesis using a sample of urban program recipients.

these two groups are balanced by village type, with few exceptions, consistent with random assignment (columns 4 and 5).

Lastly, we regress female ratio on the socioeconomic variables by household sub-group (columns 6 and 7). As expected, female ratio is negatively correlated with spousal age gap (as one can marry within one's age range) and both positively correlated with village emigration (which occurs primarily among males) and negatively correlated with village marginalization (as marginalized villages are more geographically isolated, hence less likely to have emigrants). The other variables are generally not statistically significantly correlated with female ratio, besides adult males and female, as expected.

Next, we repeat this exercise for household expenditure, income, and budget shares. We use thirteen expenditure categories to construct the budget shares w^j: seven food types (vegetables, fruit, starch, meat, dairy, fats, and sugar) and six non-food commodities (female clothing and household goods (eg. kitchen equipment), male clothing and tobacco products, children's clothing, children's school-related expenditures, health, and utilities).

Table 2 shows that households are poor, as shown by their low income (about 1000 pesos at constant 1998 values, which equals approximately USD100), which is entirely consumed, and their budget is spent largely on food. The main differences in budget shares between old and young households are that the latter group, having younger children, spends more on child-related items. However, these differences are not large. The other budget shares are similar. Even when there are statistically significant differences, they are not very large.

When we look at the differences between treatment and control households, we find, as expected, that expenditure increases in the treatment group, more so for younger households, which have more school-age children and, therefore, larger cash transfers. Nevertheless, the effect of being in the treatment group on the budget shares is qualitatively similar for young and old households: the budget shares of starchy food decreases while the budget shares of fruit and meat increase, as well as child-related and women-related expenses, consistent with the evidence that women have more marked preferences than men for private goods such as women's clothing and household goods, and child-related goods. The budget share for school and health expenses decrease. This change may be partly caused by PROGRESA providing school- and health-related goods to its recipients.

The correlations between the female ratio and income, expenditures, and budget shares are also qualitatively similar for old and young households. Areas with larger budget shares are wealthier (higher income, consumption, and nonfood, meat, dairy, and utilities budgets shares; lower starches budget share) and have a higher budget share on women, children, and health goods.

In sum, the descriptive relationship between consumption behavior and both distribution factors is broadly consistent with the informal predictions of economic theory.

4 Results

Table 3 shows relevant results from estimating equation 3 with the full sample of households. PROGRESA eligiblity increases expenditure shares for fruit, meat and healthcare, while decreasing expenditure shares for education, utilities, children's clothing and adult men's clothing. This shift in expenditure may reflect the health and nutrition counselling required for PROGRESA recipients. Higher values of the female:total population ratio are associated with increases in the expenditure shares for vegetable and utilities, and with decreases in the expenditure shares for sugary foods and for adult men's and women's clothing. Recall that higher values of this ratio are plausibly linked to lower female bargaining power, so this pattern of results is perhaps surprising. Most non-food categories are luxury goods, whose expenditure share increases with income. This is consistent with a broad literature documenting that low-income households spend a higher share of their income on food. Protein-rich dairy and meat also appear to be luxury goods, while the expenditure shares of fats and starch are falling in log total consumption.

The distribution factors are jointly significant in 8 and of the 13 Engel curves. It is thus unsurprising that the unitary model, which assumes that neither distribution factor have an effect on any budget share, is strongly rejected. The χ^2 test statistic for this set of exclusion restrictions is reported in column 1 of panel A of table 5. The test statistic for the joint proportionality conditions implied by the collective model is 20.07, which is significant at the 5% level. We therefore reject the hypothesis that consumption allocations within households are on average Pareto efficient. Both results are highly robust to a range of alternative model specifications. The test statistics are marginally larger when controlling for a quadratic term in log total expenditure (columns 2 and 4) or interacting the log total expenditure terms with state-by-survey wave fixed effects. These provides some reassurance that the results are not driven by unobserved prices that stop us from estimating a fully specified almost ideal demand system.

Table 3 shows relevant results from estimating equation 3 separately for households whose head is below the median age (panel A) or above the median age (panel B). The relationship between budget shares and total expenditure is broadly consistent across the two subgroups: non-food shares are generally luxuries, as are dairy and meat. Expenditure shares on fats and starch fall particularly quickly as total expenditure rises.

The PROGRESA-eligible households in both age subsamples spend more on fruit, meat and healthcare, while decreasing expenditure on education and some categories of clothing. In both subsamples, a higher fraction of women in the population is associated with much higher expenditure on utilities and lower expenditure on sugary foods and adult men's clothing. The magnitudes of many of these relationships differ across the subsamples but the signs seldom differ and in very few cases can we reject statistical equality across the two subsamples.

However, results of the formal tests reports in table 5 panels B and C do differ across the subsamples. We reject the unitary model for both subsamples but by a considerably larger margin for the younger than older households (χ^2 test statistics 146 and 91 respectively, both with 12 degrees of freedom). We reject the collective model for the younger households only, not for the older households. These results are again highly robust to alternative model specifications, shown in columns 2-4.

This difference in the efficiency of consumption decisions between older and younger households is consistent with both cohort and life-cycle effects. Households may reach more efficient outcomes over repeated rounds of bargaining, perhaps by learning about each others' preferences or because exit becomes a less credible threat for at least one partner. Alternatively, efficiency may be an essentially time-varying characteristic of households that is more common amongst the cohort of rural Mexican households with older heads. One obvious life-cycle explanations can be fairly quickly tested: older individuals are more likely to be divorced or separated than younger individuals but this difference is relatively small (2.8% versus 1.9%). It is possible that households that reach inefficient allocations are more likely to separate over time but the relatively small number of separations in rural Mexico makes this explanation unlikely.

We attempt to separate these hypotheses in two ways. First, in ongoing work we test the efficiency of household consumption using a subsequent census of the same villages conducted in 2007. The sets of older and younger households in this subsequent dataset have the same age distribution as their 1998/9 counterparts, but were born in different years. We thus obtain variation in the cohort composition holding age constant or variation in the age distribution holding cohort constant.

Second, we consider characteristics of the older and younger cohorts might potentially drive the difference in the efficiency of household allocations. If there exist characteristics that (1) do not vary through the life-cycle but (2) differ across cohorts and (3) are associated with cross-sectional differences in the efficiency of household allocations, this provides evidence in support of cohort ahead of life-cycle factors. We depart from an observations by Angelucci (2008) that in households with high scores on a "backwardness" index, PROGRESA receipt is more likely to be followed by rising domestic violence. This provides some evidence that this backwardness index might predict broader changes in how household's respond to changes in a distribution factor. The backwardness index is constructed as the simple average of three standardized variables: the age gap between spouses, the household head's education and the husband's age. We construct this index and implement the same analysis described above for the subsamples of households with above- and below-median backwardness.

The test results are shown in table 6. The pattern is very similar to that shown in table 5. The unitary model is rejected for both subsamples but by a larger margin for the less than more backward sample. The collective model is rejected for the less backward but not for the more backward sample. The results are again very robust to alternative model specifications. The backwardness and household head age splits are fairly strongly correlated ($\rho = 0.69$), there is some variation in the former measure conditional on household head age. The spousal age gap and household head education are essentially time-invariant characteristics, so if these drive the main result, cohort explanations are more plausible than life-cycle. We also construct a backwardness index using only these two time-invariant variables are find very similar results: the collective model is rejected for less backward households but not more backward households ($\chi^2 = 27.61$ and 11.34 respectively).

5 Conclusion

We present a novel empirical finding regarding the validity of the cooperative model of household resource allocation. This model predicts that households containing members with potentially heterogeneous preferences will engage in a process of bargaining that yields a Pareto efficient set of resource allocations. Prior empirical evidence regarding this model is mixed: most but not all tests fail to reject the key testable prediction. We show that within a sample of rural Mexican households, Pareto efficiency of household expenditure is rejected for younger but not older households. This result is robust to a range of model specifications, sample definitions, and to using more aggregated expenditure categories, though the latter results are not presented here.

Our finding suggests that tests for "the validity of cooperative household models" may be misplaced; researchers should instead aim to identify which models best characterize different groups of households. For example, the disparate results of prior empirical tests may reflect differences in the composition of samples. Standard approaches that test whether an entire sample's behaviour is consistent with a specific model do not take this into account. We present preliminary evidence that this finding may be driven by a time-invariant cohort-level differences between younger and older houseolds. Future work will further explore this hypothesis by using subsequent rounds of data collection to generate direct variation in the cohort composition holding age constant or variation in the age distribution holding cohort constant. This will help to identify the factors explaining that explain why some households achieve Pareto-efficient resource allocations and others do not. This contributes to an active research program into the best way to model non-cooperative household behavior.

References

Akresh, R. (2005): "Understanding Pareto Inefficient Intrahousehold Allocations," Discussion Paper 1858, IZA.

Angelucci, M. (2008): "Love on the Rocks: Domestic Violence and Alcohol Abuse in Rural Mexico," *The B.E. Journal of Economic Analysis and Policy: Contributions*, 8(1).

Angelucci, M., and O. Attanasio (2013): "The Demand for Food of Poor Urban Mexican Households: Understanding Policy Impacts using Structural Models," *American Economic Journal: Policy*, 5(1), 146–178.

Angelucci, M., G. de Giorgi, M. Rangel, and I. Rasul (2010): "Family Networks and School Enrollment: Evidence from a Randomized Social Experiment," *Journal of Public Economics*, 94(3-4), 197–221.

Ashraf, N. (2009): "Spousal Control and Intra-Household Decision Making: An Experimental Study in the Philippines," *American Economic Review*, 99(4), 1245–1277.

Attanasio, O., E. Battisin, and A. Mesnard (2011): "Food and Cash Transfers: Evidence from Colombia," *Economic Journal*, 122(559), 92–124.

Attanasio, O., and V. Lechene (2014): "Efficient Responses to Targeted Cash Transfers," *Journal of Political Economy*, 122(1), 178–222.

Banks, J., R. Blundell, and A. Lewbell (1997): "Quadratic Engel Curves and Consumer Demand," *Review of Economics and Statistics*, 79(4), 527–539.

Bobonis, G. (2009): "Is the Allocation of Resources within the Household Efficient? New Evidence from a Randomized Experiment," *Journal of Political Economy*, 117(3), 453–503.

Bourguignon, F., M. Browning, P.-A. Chiappori, and V. Lechene (1993): "Intra Household Allocation of Consumption: A Model and Some Evidence from French Data," *Annales d'Economie et de Statistique*, 29, 137–156.

Browning, M., F. Bourguignon, P.-A. Chiappori, and V. Lechene (1994): "Income and Outcomes: A Structural Model of Intrahousehold Allocation," *Journal of Political Economy*, 102(6), 1067–1092.

Browning, M., and P.-A. Chiappori (1998): "Efficient Intra-household Allocation: A General Characterization and Empirical Tests," *Econometrica*, 66(6), 1241–1278.

Chiappori, P.-A. (1992): "Collective Labor Supply and Welfare," *Journal of Political Economy*, 100(3), 437–467.

Chiappori, P.-A., B. Fortin, and G. Lacroix (2002): "Marriage Market, Divorce Legislation and Household Labor Supply," *Journal of Political Economy*, 110(1), 37–72.

Deaton, A., and J. Muellbauer (1980): "An Almost Ideal Demand System," *American Economic Review*, 70(3), 213–326.

Dercon, S., and P. Krishnan (2000): "In Sickness and in Health: Risk Sharing within Households in Rural Ethiopia," *Journal of Political Economy*, 108(4), 688–727.

Djebbari, H. (2005): "The Impact on Nutrition of the Intrahousehold Distribution of Power," Discussion Paper 1701, IZA.

Duflo, E., and C. Udry (2004): "Intrahousehold Resource Allocation in Cote d'Ivoire: Social Norms, Separate Accounts and Consumption Choices," Working Paper 10498, NBER.

Farfán, G. (2013): "Extended Families across Mexico and the United States," Duke University.

Hoel, J. (2013): "When the Average Obscures What is True for Most: A Within-Subject Test of Household Model Assumptions," International Food Policy Research Institute.

Mazzocco, M. (2007): "Household Intertemporal Behavior: A Collective Characterization and a Test of Commitment," *Review of Economic Studies*, 74(3), 857–895.

Rangel, M. (2006): "Alimony Rights and Intrahousehold Allocation of Resources: Evidence from Brazil," *Economic Journal*, 116(513), 627–658.

Rangel, M., and D. Thomas (2005): "Out of West Africa: Evidence on the Efficient Allocation of Resources within Farm Households," University of Chicago.

Schaner, S. (2013): "Do Opposites Detract? Intrahousehold Preference Heterogeneity and Inefficient Strategic Savings," Dartmouth College.

Schultz, P. (2004): "School Subsidies for the Poor: Evaluating the Mexican PROGRESA Poverty Program," 74(1), 199–250.

Thomas, D. (1990): "Intra-household Resource Allocation: An Inferential Approach," *Journal of Human Resources*, 25(4), 635–664.

Udry, C. (1996): "Gender, Agricultural Production, and the Theory of the Household," *Journal of Political Economy*, 104(5), 1010–1046.

Table 1: Summary Statistics and Balance Tests for Households by Age Group: Socio-Economic Status

	Old	**Young**	**O - Y**	**T-C | O**	**T-C | Y**	**Female ratio**	
						Old	**Young**
Variable	**Mean**		**Coeff.**	**Coeff.**		**Coeff.**	
	(st. dev.)		**[st.err.]**	**[st.err.]**		**[st.err.]**	
spousal age gap	6.192	2.838	3.354	-0.283	-0.092	-42.048	-16.247
	(7.651)	(4.382)	[0.154]***	[0.309]	[0.159]	[15.100]***	[8.360]*
husband age	58.084	29.256	28.828	-0.148	-0.033	8.819	-8.327
	(12.368)	(5.166)	[0.246]***	[0.467]	[0.209]	[23.967]	[9.997]
husband education	1.665	4.102	2.438	0.187	-0.192	-5.429	-12.104
	(1.923)	(2.381)	[0.074]***	[0.122]	[0.162]	[6.672]	[8.088]
husband indigenous	0.432	0.356	0.076	0.007	0.009	-3.866	-4.643
	(0.495)	(0.479)	[0.017]***	[0.058]	[0.057]	[2.890]	[2.750]*
husband literate	0.569	0.836	-0.267	-0.067	0.018	0.555	-0.096
	(0.495)	(0.37)	[0.013]***	[0.030]**	[0.022]	[1.633]	[1.112]
# relatives	2.771	2.777	-0.006	-1.237	0.121	-21.924	0.711
	(4.837)	(3.162)	[0.212]	[0.505]**	[0.204]	[17.411]	[12.533]
#males aged ≤ 5	0.31	0.765	-0.456	-0.018	0.04	-1.172	-2.178
	(0.619)	(0.782)	[0.017]***	[0.023]	[0.028]	[1.085]	[1.358]
# females aged ≤ 5	0.321	0.783	-0.463	0.025	-0.044	0.077	-0.729
	(0.644)	(0.791)	[0.017]***	[0.025]	[0.027]	[1.256]	[1.352]
# males aged 6 - 9	0.263	0.395	-0.132	0.003	0.038	-2.477	-0.207
	(0.53)	(0.617)	[0.012]***	[0.019]	[0.019]**	[0.945]***	[0.953]
# females aged 6 - 9	0.249	0.369	-0.120	0.009	-0.014	-0.632	-0.335
	(0.515)	(0.608)	[0.012]***	[0.018]	[0.020]	[0.935]	[1.044]
# males aged 10-12	0.184	0.129	0.055	-0.009	-0.001	-1.116	0.825
	(0.433)	(0.366)	[0.009]***	[0.015]	[0.013]	[0.873]	[0.573]
# females aged 10-12	0.169	0.123	0.046	0.004	-0.017	-0.782	-0.68
	(0.414)	(0.356)	[0.008]***	[0.014]	[0.012]	[0.718]	[0.591]
# males aged 13-15	0.188	0.064	0.123	0.02	-0.003	-0.788	0.686
	(0.424)	(0.27)	[0.008]***	[0.014]	[0.009]	[0.784]	[0.391]*
# females aged 13-15	0.165	0.061	0.104	-0.034	-0.017	-0.928	-0.217
	(0.408)	(0.257)	[0.007]***	[0.015]**	[0.009]**	[0.670]	[0.403]
# males aged 16-18	0.18	0.042	0.138	0.027	-0.015	-1.169	-0.243
	(0.42)	(0.213)	[0.008]***	[0.014]*	[0.007]**	[0.734]	[0.369]
# females aged 16-18	0.174	0.072	0.102	0.002	0.006	0.524	-0.168
	(0.418)	(0.267)	[0.007]***	[0.013]	[0.008]	[0.744]	[0.422]
# males aged ≥ 19	1.474	1.041	0.433	-0.002	0.015	-3.19	-0.733
	(0.73)	(0.266)	[0.015]***	[0.032]	[0.009]*	[1.780]*	[0.452]
# females aged ≥ 19	1.466	1.047	0.419	-0.001	0.009	2.465	1.918
	(0.737)	(0.423)	[0.015]***	[0.030]	[0.018]	[1.587]	[0.632]***
Village emigration share	0.048	0.043	0.005	0.008	0.001	0.581	1.118
	(0.073)	(0.063)	[0.006]	[0.009]	[0.008]	[0.581]***	[0.430]**
Village marginalization	0.465	0.464	0.001	-0.020	0.011	-11.376	-13.360
index	(0.685)	(0.781)	[0.066]	[0.094]	[0.101]	[4.987]**	[4.876]***
Treatment	0.661	0.607	0.055	1	1	2.500	-4.261
	(0.474)	(0.490)	[0.043]			[3.417]	[3.111]
Female ratio 1995	0.501	0.501	0.001	0.001	-0.002	1	1
	(0.009)	(0.010)	[0.001]	[0.001]	[0.001]		

Notes: The sample consists of 25372 household-by-survey wave observations in 506 villages.

Table 2: Summary Statistics and Balance Tests for Households by Age Group: Socio-Economic Status and Demographics

	Old	**Young**	**O - Y**	**T-C | O**	**T-C | Y**	**Female ratio**	
						Old	**Young**
Variable	**Mean**		**Coeff.**	**Coeff.**		**Coeff.**	
	(st. dev.)		**[st.err.]**	**[st.err.]**		**[st.err.]**	
income	1037.016	948.599	88.417	44.706	-121.403	3,629.25	4,732.06
	(2829.693)	(5927.015)	[60.741]	[69.806]	[149.072]	[3,364.515]	[2,991.726]
expenditure	1002.558	997.293	5.265	49.869	116.335	4,709.38	4,475.08
	(932.802)	(1069.168)	[18.539]	[29.552]*	[34.328]***	[1,757.944]***	[1,937.912]
food share	82.688	81.529	1.159	0.442	0.376	-151.464	-217.041
	(12.717)	(11.944)	[0.233]***	[0.533]	[0.636]	[28.056]***	[30.206]***
nonfood share	17.312	18.471	-1.159	-0.442	-0.376	151.464	217.041
	(12.717)	(11.944)	[0.233]***	[0.533]	[0.636]	[28.056]***	[30.206]***
starches share	42.292	41.636	0.656	-0.097	-1.401	-118.085	-156.753
	(14.948)	(14.48)	[0.276]**	[0.637]	[0.643]**	[30.250]***	[32.117]***
vegetable share	7.72	7.839	-0.119	-0.036	0.156	3.315	9.359
	(5.519)	(5.537)	[0.092]	[0.181]	[0.172]	[10.129]	[8.543]
fruit share	2.688	2.764	-0.076	0.384	0.583	5.679	-8.247
	(4.271)	(4.333)	[0.067]	[0.157]**	[0.160]***	[8.532]	[9.283]
meat share	7.353	6.96	0.393	0.509	1.24	31.418	22.41
	(9.084)	(8.425)	[0.173]**	[0.396]	[0.354]***	[17.502]*	[16.935]
dairy share	6.137	6.76	-0.623	0.055	0.209	29.874	30.941
	(6.281)	(6.581)	[0.103]***	[0.215]	[0.247]	[10.824]***	[13.344]**
sugar share	10.757	9.839	0.919	-0.259	-0.117	-94.526	-101.814
	(8.407)	(7.764)	[0.140]***	[0.354]	[0.344]	[18.027]***	[16.254]***
fats share	5.74	5.732	0.009	-0.114	-0.295	-9.139	-12.938
	(4.846)	(5.223)	[0.080]	[0.151]	[0.150]*	[7.512]	[7.509]*
women share	1.17	1.185	-0.015	0.135	0.145	14.461	9.206
	(2.241)	(2.115)	[0.034]	[0.072]*	[0.068]**	[3.604]***	[3.185]***
men share	1.244	1.097	0.146	0.104	0.054	5.133	7.316
	(2.763)	(2.247)	[0.036]***	[0.083]	[0.070]	[4.898]	[3.290]**
kids share	1.408	2.644	-1.236	0.338	0.604	4.551	28.919
	(2.566)	(3.283)	[0.061]***	[0.084]***	[0.130]***	[4.394]	[5.981]***
school share	1.242	1.364	-0.123	-0.23	-0.26	-3.062	15.757
	(4.144)	(3.86)	[0.064]*	[0.116]**	[0.127]**	[5.907]	[5.867]***
health share	8.109	7.953	0.158	-0.422	-0.579	66.88	52.244
	(9.167)	(7.598)	[0.122]	[0.257]	[0.249]**	[12.747]***	[13.126]***
utilities share	4.139	4.228	-0.089	-0.367	-0.34	63.5	103.6
	(5.094)	(5.042)	[0.104]	[0.254]	[0.283]	[13.112]***	[13.781]***

Notes: The sample consists of 25372 household-by-survey wave observations in 506 villages.

Table 3: Engel Curves for Full Sample

	Dairy	Fats	Fruit	Meat	Starch	Sugar	Vegetables	Children	Health	Men	School	Utilities	Women
Log HH	3.804***	-3.025***	0.023	5.076***	-13.069***	-0.330	0.826	-2.985***	2.234***	2.262***	0.866*	2.632***	1.687***
expenditure	(0.719)	(0.578)	(0.500)	(1.068)	(1.929)	(0.953)	(0.682)	(0.930)	(0.320)	(0.272)	(0.455)	(0.643)	(0.260)
PROGRESA	-0.176	0.043	0.476***	0.590**	0.204	0.117	-0.036	-0.397**	0.260***	-0.122**	-0.292***	-0.651***	-0.015
eligibility	(0.153)	(0.110)	(0.122)	(0.268)	(0.479)	(0.250)	(0.140)	(0.175)	(0.061)	(0.056)	(0.101)	(0.170)	(0.050)
Sex ratio	13.946	8.210	0.341	-15.743	-40.614	-28.584**	14.256*	13.798	-0.818	-7.451**	4.957	41.806***	-4.015*
	(9.095)	(6.199)	(8.268)	(14.972)	(31.703)	(12.587)	(7.540)	(9.553)	(4.151)	(2.943)	(5.505)	(9.822)	(2.474)
χ^2 test stat. for both dist. factors	3.702	1.852	15.611***	6.065**	2.002	6.291**	3.757	7.740**	18.166***	8.989**	9.747***	28.160***	2.756
Mean of dep. var.	6.453	5.736	2.727	7.153	41.959	10.291	7.780	8.030	2.036	1.169	1.304	4.184	4.517

Notes: The sample consists of 25372 household-by-survey wave observations in 506 villages. Standard errors in parentheses are clustered at the village level. *, **, and *** denote significance at the 10, 5, and 1% levels respectively. The system of equations is estimated simultaneously in a seeming unrelated regression model. Log household expenditure instrumented by log household income with first stage F-statistic 225.95 ($p < 0.001$). All equations include state-by-survey wave fixed effects; controls for household head age, education literacy, and indigenous descent; controls for the number of household members of each gender in ages brackets 0-5, 6-9, 10-12, 13-15, 16-18, and 19 or older; and controls for the village-level marginalization index and migrant share.

Table 4: Engel Curves for Sample Split by Age of Household Head

Panel A: Households with Younger Heads													
	Dairy	Fats	Fruit	Meat	Starch	Sugar	Vegetables	Children	Health	Men	School	Utilities	Women
Log HH	5.759***	-2.750**	-0.754	6.289***	-19.410***	-2.194	0.461	-1.804	2.802***	3.430***	1.286*	4.702***	6.271***
expenditure	(1.335)	(1.155)	(0.868)	(1.985)	(3.453)	(1.577)	(1.186)	(1.596)	(0.657)	(0.496)	(0.726)	(1.053)	(1.308)
PROGRESA	-0.384	0.031	0.578***	0.488	0.885	0.408	0.068	-0.481*	0.209**	-0.328***	-0.392***	-0.958***	-0.305
eligibility	(0.107)	(0.164)	(0.150)	(0.343)	(0.581)	(0.306)	(0.194)	(0.250)	(0.101)	(0.068)	(0.135)	(0.209)	(0.207)
Sex ratio	8.807	8.018	-5.388	-21.649	-42.260	-25.310*	13.906	6.846	2.587	-7.197**	14.818**	53.847***	10.362
	(12.708)	(7.349)	(9.523)	(17.200)	(34.003)	(14.319)	(8.842)	(11.368)	(5.826)	(2.961)	(6.243)	(11.356)	(10.904)
χ^2 test stat. for both dist. factors	3.099	1.192	14.787***	3.780	4.261	6.431**	2.503	4.477	4.321	25.256***	20.800***	41.295***	3.724
Mean of dep. var.	6.760	5.732	2.764	6.960	41.654	9.839	7.839	7.953	2.644	1.097	1.364	4.228	5.193
Panel B: Households with Older Heads													
	Dairy	Fats	Fruit	Meat	Starch	Sugar	Vegetables	Children	Health	Men	School	Utilities	Women
Log HH	2.964***	-2.982***	0.151	4.231***	-8.584***	0.440	1.097	-4.135***	1.590***	1.553***	0.605	1.659**	3.606***
expenditure	(0.802)	(0.607)	(0.592)	(1.147)	(2.120)	(1.133)	(0.770)	(1.127)	(0.288)	(0.326)	(0.584)	(0.679)	(0.788)
PROGRESA	-0.145	0.018	0.427	0.589***	0.013*	0.006	-0.051	-0.396*	0.264***	-0.008	-0.230*	-0.534***	0.093
eligibility	(0.158)	(0.140)	(0.130)	(0.327)	(0.545)	(0.284)	(0.160)	(0.218)	(0.057)	(0.072)	(0.120)	(0.180)	(0.567)
Sex ratio	19.808**	8.598	9.216	-12.028	-34.052	-30.622*	13.878	21.272*	-5.293	-9.064**	-4.995	25.030**	-12.035
	(9.242)	(8.167)	(8.874)	(17.214)	(33.957)	(15.666)	(9.221)	(11.899)	(3.501)	(4.180)	(6.197)	(9.939)	(9.163)
χ^2 test stat. for both dist. factors	6.446**	1.157	12.704***	3.700	1.065	3.845	2.354	6.867**	25.995***	4.847*	4.895*	12.738***	1.988
Mean of dep. var.	6.137	5.740	2.688	7.353	42.292	10.757	7.720	8.110	1.408	1.244	1.242	4.139	3.819

Notes: Sample consists of 25372 household-by-survey wave observations in 506 villages. The young and old subsamples consist of 12888 and 12484 household-by-survey wave osbervations respectively. Standard errors in parentheses are clustered at the village level. *, **, and *** denote significance at the 10, 5, and 1% levels respectively. The system of equations, for young and old households, is estimated simultaneously in a seeming unrelated regression model. Log household expenditure instrumented by log household income with first stage F-statistics 80.32 ($p < 0.001$) and 185.27 ($p < 0.001$) for the young and old subsamples respectively. All equations include state-by-survey wave fixed effects; controls for household head age, education literacy, and indigenous descent; controls for the number of household members of each gender in ages brackets 0-5, 6-9, 10-12, 13-15, 16-18, and 19 or older; and controls for the village-level marginalization index and migrant share.

Table 5: Unitary and Collective Test Results by Household Head Age

	(1)	(2)	(3)	(4)
Panel A: All Households				
Unitary test statistic	133.23***	133.43***	141.71***	147.66***
Collective test statistic	20.07*	20.10*	20.22*	20.39*
Panel B: Households with Younger Heads				
Unitary test statistic	145.88***	145.97***	153.84***	130.65***
Collective test statistic	19.97*	20.08*	19.86*	17.72
Panel C: Households with Older Heads				
Unitary test statistic	91.22***	91.90***	90.84***	94.37***
Collective test statistic	12.43	12.28	12.87	13.48
Linear in log expenditure	×		×	
Quadratic in log expenditure		×		×
Consumption interacted with state-by-survey wave fixed effects			×	×

Notes: Test results in column 1 are based on estimates reported in tables 3 and 4. Test results in columns 2-4 are based on estimates from augmented regressions (not shown) that include quadratic log expenditure terms (columns 2 and 4) and interactions between the log expenditure and the state-by-survey wave fixed effects (columns 3 and 4). These specifications follow the spirit of the linear and quadratic almost ideal demand systems discussed in section 2.

Table 6: Unitary and Collective Test Results by Household Backwardness

	(1)	(2)	(3)	(4)
Panel A: All Households				
Unitary test statistic	133.23***	133.43***	141.71***	147.66***
Collective test statistic	20.07*	20.10*	20.22*	20.39*
Panel B: Households with Low Backwardness Scores				
Unitary test statistic	145.14***	145.65***	156.09***	151.03***
Collective test statistic	25.65**	26.09**	25.35**	25.03**
Panel C: Households with High Backwardness Scores				
Unitary test statistic	87.93***	88.65***	87.14***	90.64***
Collective test statistic	11.52	11.54	11.86	12.41
Linear in log expenditure	×		×	
Quadratic in log expenditure		×		×
Consumption interacted with state-by-survey wave fixed effects			×	×

Notes: Test results are generated by estimating equations 3 and 4 (columns 1 and 2) augmented with interactions between the log expenditure terms and the state-by-survey wave fixed effects. The backwardness index is defined as the simple average of three standardized variables: the age gap between spouses, the household head's education and the husband's age.