Are Intra-household Allocations Efficient?

Jorge M. Agüero

Department of Agricultural and Applied Economics
University of Wisconsin-Madison
427 Lorch Street, Office 305
Madison, WI 53706
USA

jmaguero@wisc.edu
Phone: (608) 262-1242

Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003

Are Intra-household Allocations Efficient? (*)

Jorge M. Agüero

Department of Agricultural and Applied Economics
University of Wisconsin-Madison
427 Lorch Street, Office 305
Madison, WI 53706
USA

jmaguero@wisc.edu
Phone: (608) 262-1242

January, 2003

Abstract

This paper describes two problems when testing the efficiency of intra-household allocations. First, using Monte Carlo simulations I show that the test proposed for efficiency in consumption has a high type-II error, leading to a false acceptance of the hypothesis. Second, I show it is possible that even under asymmetric information the hypothesis of efficiency, incorrectly, cannot be rejected. Finally, I propose a test to account for asymmetric of information.

(*) I would like to thank Brain Gould for allowing me to use the Brazilian survey and Ragan Petrie, Michael Carter and Kenneth West for their comments. All errors are mine.

1. Introduction

How do households allocate resources among members? In recent years an increasing number of studies have tried to answer this question.[1] These studies depart from traditional models where a household is seen as making decisions as if it were one individual, the so-called *unitary models*. The empirical rejection of the unitary model (see Thomas, 1990 and Bourguignon et al., 1993, among others) motivated a shift toward models where household members interact to decide their outcomes.

However, there is no agreement on the nature of the alternative bargaining model to study these interactions. Some papers suggest that household members behave as players in a Nash non-cooperative model in order to allocate resources (Jones, 1983) while others suggest a cooperative approach using a Nash bargaining solution (McElroy and Horney, 1981). But what these new approaches have in common is that, independently of how the household decides to allocate resources, the outcome is assumed to be Pareto efficient.

This efficiency in the allocation of resources rests on two assumptions: symmetric information and full commitment among members. In this paper I critique this efficiency by focusing the analysis on the first assumption. Symmetric information requires that all members have perfect information about the resources owned by the other members. For example, with a married couple the assumption of symmetric information requires that each spouse know exactly how much money their partner has, or at least that there is no cost in getting that information. Household members then cannot hide information, and all resources are taken into account in order to allocate them. However, as I will show later, it is reasonable to think that for each member the incentives to reveal information

[1] See Doss (1996) for a survey of the literature.

about their own income decreases with the bargaining power of the other member(s).

As it turns out, the empirical validation of the efficiency assumption is not clear. Table 1 shows the results of several studies that estimated this hypothesis. It is interesting to note that the hypothesis is rejected when applied to household production in low-income economies but not in rich economies on the consumption/leisure side. I will argue later that this is the case because of the relatively small incentives to hide information on household production versus household consumption. For example, when applied to a French household survey, Bourguignon, Browning, Chiappori and Lechene (1993) show that, although the unitary model can be rejected, it is not possible to reject the hypothesis that intra-household allocations are efficient in the sense of Pareto. However, Udry (1994), using information from rural households in Burkina Faso, shows that, *ceteris paribus*, the intensity in the use of input factors is significantly smaller when the plot is cultivated by a woman versus by a man[2]. This lack of robust evidence in favor of or against the Pareto efficiency hypothesis is the motivation for the present paper.

Table 1
Empirical evidence for the hypothesis of efficienct intra-household allocation

Author	Data	Commodity	Result
Jones (1983)	Cameroon	Production 1/	Rejected
Bourguigon et al (1993)	France	Expenditure	Accepted
Thomas and Chen (1993)	Taiwan	Expenditure	Accepted
Udry (1994)	Burkina Faso	Production 1/	Rejected
Chiappori et al (2002)	USA	Labor supply	Accepted

1/ Household production

The objective of this paper is to evaluate this hypothesis in the allocation of resources

[2] There is some evidence suggesting that Udry's results are sensitive to the specification of the model. See Blanchard (2000).

within households using information from a low-income country such as Brazil with micro level data of consumption of private goods. In this sense, this paper is closer to the approach developed by Bourguignon et al (1993). I took this approach, mostly, because Udry's method to analyze household production requires detailed information on the quality of each plot in order to isolate the effect of gender differences in the control of the plot on factor intensity. This level of information is very difficult to find in datasets for other countries.

In a recent paper Attanasio and Lechene (2002) criticize the use of income to evaluate the hypothesis of efficiency due to endogeneity problems. The problem is even bigger due to the presence of an important number of households with no consumption reported. As I discuss in section 3, these zeros are associated with infrequency of purchases (the survey period is shorter than the purchasing period) rather than tastes. I address the problem of endogeneity using a (efficient) GMM estimator.

I found that the hypothesis of efficient intra-household allocations cannot be rejected for the Brazilian case. However, I discuss how the potential presence of asymmetric information could affect the collection of information in consumption-income surveys. I argue that it is possible that even under asymmetric information the hypothesis, incorrectly, cannot be rejected. I also examine the performance of the test using Monte Carlo simulations. I show that the type-II error of incorrectly accepting the test efficiency hypothesis is very large for this test, therefore putting into question the efficiency result.

The rest of the paper is divided as follows. Section 2 describes a model where agents interact to allocate resources within the household, and I derive testable implications for the hypothesis of efficient allocations. The data used to test this hypothesis is described in section 3 and the econometric methods in section 4. The results are shown in section 5 and the Monte Carlo simulations are discussed in section 6. Finally, the main conclusions are summarized in section 7.

2. A collective model for household behavior

In this section I present a model to describe the allocation of resources within a household. The only assumption is that these allocations are efficient without any further assumption about the decision process. I also derive testable implications from this model.

There are many ways to model this interaction (Bourguignon et al (1993), Attanasio and Lechene (2002)). I present a simple model where there is no altruism in the utility function. This setup, however, does not change the implications of the model. Assume the household consists of two members A and B, and each has preferences over the set of *J* private consumption goods denoted q^A and q^B. These preferences can be characterized by the utility functions $u^A(q^A)$ and $u^B(q^B)$. As in Bourguingon et al (1993, p. 142) I assume that the labor supply of both household members is fixed, either because of rationed labor markets or from some level of separability between leisure and consumption. An allocation (q^A, q^B) is said to be *collectively rational* if it is the solution of the following Pareto problem:

$$(1) \qquad \begin{aligned} &\underset{q^A,q^B}{Max} \quad u^A(q^A) \\ s.t. \quad &u^B(q^B) \geq \overline{u}^B(p, y^A, y^B) \\ &p(q^A + q^B) = y^A + y^B = Y \\ &q^A \geq 0, q^B \geq 0 \end{aligned}$$

where $\overline{u}^B(p, y^A, y^B)$ is the reservation utility of member B and y^A, y^B are individual non-labor income. An alternative formulation for (1) is a two step approach. In the first stage the household members decide how to redistribute income among them:

$$(2) \qquad \begin{aligned} &\underset{\theta^A,\theta^B}{Max} \quad V^A(p,\theta^A) \\ &s.t. \quad V^B(p,\theta^B) \geq \overline{u}^B(p,y^A,y^B) \\ &\qquad \theta^A + \theta^B = y^A + y^B = Y \end{aligned}$$

In the second stage, given the redistribution, each member maximizes his/her own utility subject to their new income θ^i for i={A,B}

$$(3) \qquad \begin{aligned} &V^i = \underset{q^i}{Max} \quad u^i(q^A) \\ &s.t. \quad pq^i = \theta^i \end{aligned}$$

The redistributed income also reflects the decision power of member A and B and from the first stage note that $\theta^i = \theta^i(p,y^A,y^B)$ is a function of prices and non-labor income[3] and note that θ^B=Y-θ^A as defined in equation (2). The set of Marshallian demands derived from problem (3) are:

$$(4) \quad q_j(p,y^A,y^B) = q_j^A + q_j^B = g_j^A(p,\theta^A(p,y^A,y^B)) + g_j^B(p,Y-\theta^A(p,y^A,y^B)) \quad \forall j = 1,..J$$

If for a particular good j we differentiate (4) with respect to y^A and y^B in turn and define η_j to be equal to the ratio of these two derivatives, we obtain:

$$\eta_j = \frac{\partial q_j / \partial y^A}{\partial q_j / \partial y^B} = \frac{\partial \theta^A / \partial y^A}{\partial \theta^A / \partial y^B}$$

which turns out to be independent of j. The left hand side is a ratio of income effects and is observable when estimating a demand function from equations in (4). The right hand side is not observable but is independent of j. Therefore, if the Pareto efficiency hypothesis in the allocation of household resources is satisfied, then for any two different commodities i and j we should observe $\eta_i = \eta_j$. The testable implication derived from the

[3] Chiappori et al (2002) includes other variables called *distributional factors*.

collective model under efficiency is that

$$(5) \qquad \eta_1 = \frac{\partial q_1 / \partial y^A}{\partial q_1 / \partial y^B} = \frac{\partial q_j / \partial y^A}{\partial q_j / \partial y^B} = \eta_j$$

for all *j=2, 3,…,J*. This is the test I will implement using information from Brazilian households. The survey is described in the next section.

3. The Brazilian household survey

To estimate equations in (4) I use the 1995-96 Brazilian *Pesquisa de Orçamentos Familiares* (Survey of Family Budgets). This survey is a new version of the 1974-75 one used by Thomas (1990) and it was also designed to calculate the Brazilian Consumer Price Index. It contains detailed information on expenditures, as well as labor and non-labor income, at household and individual levels. For this paper, I define non-labor income as all income generated by rents, profits, positive transfers, bequests and pensions. All monetary variables in this study are measured in Brazilian *Reais* at September 15, 1996 prices[4].

The survey collects information of more than fifteen thousand households living in urban areas. I restrict our sample to households composed of couples without children yielding a total of 1224 observations because, as mentioned by Bourguignon et al "…children and the expenditure on them may be considered as public goods by both parents" (op. cit. p. 146)[5]. Therefore, I consider in the analysis only the consumption of four private goods: men's and women's clothing, transportation and food[6].

---

4 The exchange rate at that time was 1.02 Brazilian Reais = 1 US$

5 These authors restrict the sample to observations where both members work. The results of this paper do not change if I follow this suggestion.

6 Bourguignon et al used 9 commodities in their estimation while Attanasio and Lechene (2002) estimated an expenditure system for 8 commodities. The selection of these commodities is arbitrary; they only need to be private goods. Note that there is no requirement in the model described in section 2 for the commodities to add up to total expenditure or income.

The clothing expenses category reflects a period of purchases of 90 days before the survey. It excludes shoes and bags, mainly because the questionnaire does not separate these groups by gender. Transportation includes all expenses in the last 7 days and does not include traveling expenditures. The food category includes food consumption at home (for a period of seven days after the beginning of the survey) and away from home (last 7 days) and does not include either alcohol or tobacco.

Table 2 presents some basic statistics of the consumption of these 4 groups. The main feature shown there is the important percentage of households with no consumption for each commodity, although these commodities represent a broad category of goods. This would reflect more a problem of *infrequency-of-purchase* rather than tastes and preferences (i.e, a true corner solution). The problem of infrequency of purchases arises when the extent of the survey period is smaller that the purchase period.

Table 2
Basic statistics of household expenditure

Variables	Share on total expenditure (%)	Percentage of non-zeros	For positive values	
			Mean	Std. Dev.
Men's clothing	3.1	54.8	331.9	426.5
Women's clothing	4.7	59.9	421.9	642.2
Transportation	16.6	76.7	1562.1	2022.2
Food	20.2	95.3	2118.6	2318.3

Note: Monetary variables are expressed in Brazilian Reals at September 15, 1996 prices. Exchange rate: 1.02 Brazilian Reais = 1 US$

For example, consider the case of food. Note that this is a very broad category, in comparison with, say, broccoli. As I mentioned, in the survey, households were asked to fill out a detailed diary of purchases for a period of seven days. If the household bought their food a few days before the survey it would probably not need to buy any food in more than a week. So the lack of food purchases would hardly reflect a desire not to consume food at all, as could be the case for broccoli. Some people just do not like broccoli, which will represent a true corner solution due to tastes and preferences. It is therefore more plausible that the lack of information of food purchases reflects that the household did not need to buy any food during the survey period. This infrequency-of-purchases problem would impose some restrictions in the choice of the econometric methods to estimate the system of expenditure. I will revisit this in section 4.

Table 3
Main characteristics of household members

	Statistics	
Variables	Mean	Std. Dev.
Women		
Wage income	2782.4	6477.0
Non-labor income	1457.9	5863.3
Age	43.5	17.9
Years of schooling	7.9	4.7
Men		
Wage income	7354.3	15381.3
Non-labor income	5655.1	15273.5
Age	47.2	18.4
Years of schooling	7.9	4.9
Age difference	3.7	8.0

Note: Monetary variables are expressed in Brazilian Reals at September 15, 1996 prices. Exchange rate: 1.02 Brazilian Reais = 1 US$

To estimate the hypothesis of efficiency we need information on non-labor income for each member. Table 3 compares these variables for both men and women. Men not only have more labor income, on average, but also more non-labor income. However, the average education level is about the same. Finally, this table shows that women are married to older men, with an average age difference of 3.7 years.

4. Description of the econometric method

In this section I describe the econometric method used to estimate the system of expenditures described in equation (4) and to test the hypothesis of efficient allocations expressed in (4). First, note that I say *system of expenditures* (or *Engel curves*) instead of *system of demands*. The reason for this is the traditional assumption in cross section studies that all households face the same prices (Thomas, 1990). So the set equations in (4) are re-written as:

(6) $$q_j(y^A, y^B) = q_j{}^A + q_j{}^B = g_j^A(\theta^A(y^A, y^B)) + g_j^B(Y - \theta^A(y^A, y^B)$$ j=1, 2,…, J

As mentioned in section 3 the problem of infrequency-of-purchase restricts our choice of the econometric methods. In particular, as showed by Keen (1986) and Pudney (1989) the use of OLS to equation (6) produces inconsistent estimates. The authors discard also the use of a Tobit model because this assumes that the presence of zeros respond to more permanent reasons, such as a true corner solution generated by taste and preferences. As I argued before, the broad definition of our commodities makes more plausible the hypothesis of the infrequency-of-purchases rather that a true corner solution due to tastes in order to explain zero expenditure.

Blundell and Meghir (1986) and Pudney (1989) proposed a Maximum Likelihood estimation of the probability that the household purchases commodity *j* within the survey period to estimate efficiently equation (6). This methodology requires the estimation of a "…very complicated distribution" of an unobservable true rate of consumption of good j. (Pudney, op cit. p.176). Clearly, this goes far beyond the objective of the paper, but fortunately there exists an easier alternative.

Keen (1986) showed that for the particular case where the expenditure function is linear in income (or expenditure), the use of the instrumental variables (IV) applied to equation (6) will yield consistent estimates of the parameters when all the observations (zeros and non-zeros) are used[7]. He also shows that efficiency could be improved in the case of over-identification of the parameters. Keen proposed the use of 3SLS. In this paper I will use instead a (efficient) GMM estimator because it will allow for efficient estimators even without knowing the form of the heteroskedasticity of the errors[8].

To test the efficiency in the allocation of intra-household allocations I need to evaluate relations across equations: the ratio of income effects has to be the same in each equation as shown in (4). This requires the joint estimation of each expenditure function. Hence I will estimate the set of equations (6) using a multi-equation GMM (see Hayashi, 2001).

I will therefore proceed as follows: First, I will test the over-identification of the model using the *J-statistic* (or *Hansen test*). If I cannot reject the null hypothesis of correct identification, then I will test for the linearity of Engel curves. To test this hypothesis I will use the *Distance-statistic* (or *Newey-West test*)[9]. If I cannot reject the hypothesis that the parameters of the nonlinear income terms are zero, then the conditions shown by Keen for a consistent and efficient estimation of Engel curves will be satisfied. Finally, I use the Distance-statistic to test the nonlinear set of hypothesis described in (5). If I cannot reject those restrictions, then the implications of the collective model will be satisfied so I will accept (or not be able to reject) the hypothesis of efficiency in the

[7] The motivation for IV methods comes from the presence of measurement errors. These errors appear because of the need to satisfy the adding-up conditions. This could probably make the reader think that it is important to have a full system of expenditures. But this is not necessarily true. The model described in section 2 requires only private goods, so housing and utilities, for example, cannot be part of the estimation.

[8] As mentioned by Pudney, the drawback of Keen's method is that the predicted valued of the expenditures could be negative. Instead, Pudney proposed a nonlinear estimation. He suggested the use of a cdf log-normal function. This method, however, will not permit a complete identification of the parameters. In particular, the variance of the errors is assumed to be constant and equal to, say, one. Since the purpose of the paper is not on the prediction of expenditure I will assume the problem of negativity to be less important than the heteroskdasticity one.

[9] As shown in Hayashi (2001) the relevant number of observation is not N but NxJ, where J is the number of commodities estimated.

allocation of resources within Brazilian urban households. Otherwise, I reject the hypothesis of Pareto efficiency.

In particular I will use the following parametric expression for the *j-th* Engel curve and the *i-th* observation:

(7) $$q_{ji} = z_i\varphi_j + \beta_{jA}y^A + \beta_{jB}y^B + e_{ji} \qquad \textit{for } j=1, 2, \ldots, J \textit{ and } i=1,2,\ldots,N$$

where z_i includes a constant and a set of demographic characteristics of the members (education and age), y^A and y^B are non-labor income of member A and B respectively, φ_j, β_{jA} and β_{jB} are parameters to be estimated, e_{ji} is the error term and N is the number of observations. The set of restrictions in (5) are expressed as: $\eta_1 = \beta_{1A}/\beta_{1B} = \beta_{jA}/\beta_{jB} = \eta_j$ or equivalently:

(8) $\beta_{1A}\beta_{jB} - \beta_{1B}\beta_{jA} = 0$ for j=2, 3, …, J.

This is the expression I will finally use to evaluate the hypothesis of efficiency; however for ease of understanding I will still call it *ratio of income effects*. The results of estimating the set of equations (7) and testing (8) using the Brazilian data are presented in the following section.

5. Are intra-households allocations in Brazil efficient?

Here I present the results of estimating a set of Engel curves for childless couples in urban Brazil. I use a multi-equation GMM estimator. I try two sets of instruments. In both cases I use a second order polynomial in age and education for male and females. The differences in the set of instruments reside in the choice of regional-level variables added. I first include 10 dummy variables because the survey is divided into 11 metropolitan regions[10]. However, I reject the hypothesis of correct specification using the J-statistic. I then use a set of variables to capture more variability among regions. I replace the 10 dummies with 5 regional-level variables such as GDP per-capita, unemployment rate for male and female, size of urban population and sex ratio[11]. In Table 4, the J-statistic -using these second set of instruments- is 26.4 which is smaller than $\chi^2_{95\%}$ (20) = 31.4. Then I cannot reject the hypothesis of correct specification of equations in (7).

I then test the linearity of the Engel curves. I assume that the nonlinearity in income of the Engel curves can be characterized using the following functional form:

$$q_{ji} = z_i \varphi_j + \beta_{jA} y^A + \beta_{jB} y^B + \delta_{jA}(y^A)^2 + \delta_{jB}(y^B)^2 + \psi_j (y^A y^B) + e_{ji}$$

for j=1, 2, ..., J and i=1,2,...,N. The test shows that I cannot reject H_0: $\delta_{jA}=\delta_{jB}=\psi_j=0$ *for all j=1, 2,...,4*. The D-statistic is 3.3 which is smaller that $\chi^2_{95\%}$ (12) = 21. Then, the Engel curves are linear in income and therefore satisfy the conditions for consistency and efficiency shown by Keen (1986).

I now present the results of the joint GMM estimation of Engel curves in Table 4. The non-labor income variables appear to be positive and significant for most of the commodities. These results are different from Bourguignon et al (1993) where income variables are mostly non-significant. Part of the explanation for the differences could be found in the method used. They use an OLS estimation for the Engel curves which as shown by Keen produces inconsistent and inefficient estimates[12].

---

[10] These 11 regions are: Rio de Janeiro, Porto Alegre, Belo Horizonte, Recife, São Paulo, Brasilia - Distrito Federal, Belém, Fortaleza, Salvador, Curitiba and Goiânia.

[11] Sex ratio is defined as the number of women divided by the number of men in urban areas. This is a more aggregate definition of the one used in Chiappori et al (2002) to estimate labor supply.

[12] The authors claim that their estimation is not different when they used the ML approach suggested by Blundell and Meghir (1986).

Table 4
GMM estimation of household expenditures by commodities

Variables	Commodities Men's clothing	 Women's clothing	 Transp-tation	 Food
Constant	4.967	6.282	21.421	26.780
	(2.318)	(3.016)	(12.809)	(16.316)
Men's age	-0.061	-0.045	0.088	-0.012
	(0.077)	(0.097)	(0.433)	(0.483)
Women's age	0.001	-0.106	0.200	0.197
	(0.083)	(0.105)	(0.464)	(0.519)
Men's age squared 1/	-0.002	0.001	-0.065	-0.028
	(0.007)	(0.009)	(0.043)	(0.044)
Women's age squared 1/	-0.003	0.006	-0.050	-0.061
	(0.008)	(0.010)	(0.048)	(0.052)
Men's years of schooling	-0.035	-0.013	-0.528	-0.596
	(0.094)	(0.119)	(0.525)	(0.665)
Women's years of schooling	-0.096	-0.003	-0.893	-0.593
	(0.099)	(0.139)	(0.556)	(0.717)
Men's non-labor income	0.020	0.008	0.186	0.177
	(0.014)	(0.018)	(0.079)	(0.098)
Women's non-labor income	0.055	0.082	0.432	0.410
	(0.033)	(0.051)	(0.196)	(0.227)
Number of observations	1224			
J-statistic	26.38			
$\chi^2(20)$	31.41			

1/ Parameters are multiplied by 10
Notes: Asymptotic standard errors in parentheses. Instruments: a constant, a second order polynomial in age and education (male and female) and 5 regional variables: population, GDP per-capita, sex ratio, female and male unemployment

Our parameters of interest are the ratio of income effects across equations. Women's income seems to have a bigger impact on expenditure that men's income. A point estimate of this ratio for food is 2.3 similar to the ratio for transportation. I then evaluate the hypothesis of efficiency of intra-household allocations using the Distance-statistic. The test requires *J-1* restrictions on the parameters. The actual value of the test is 1.2 which is smaller than the critical value $\chi^2_{95\%}(3) = 7.8$. This evidence does not allow us to reject the null hypothesis that the income effects are equal in all equations. The testable implication of the collective model described in section 2 cannot be rejected by the data. These results are similar to the ones presented in Table 1. It suggests that, at least for urban households, regarding the consumption of goods, the intra-household allocations follow the patterns described by efficient outcomes.

Does this mean then that each member has truthfully revealed their income? Consider the following examples. First, suppose a household member received an inheritance from her family. If the bargaining power of her partner is very high most of the money she received will end up being used by her partner. In this case she will not have any incentive to reveal the existence of the inheritance or, if this is not possible, she will declare an amount as an inverse function of her partner's bargaining power.

Second, suppose one of the household members is having an extramarital affair. Would this person have incentives to reveal all of his/her income sources? Most probably not. If he/she did so, his/her partner could easily ask about the missing income, leading the person to lie and be pressured to show goods that reflect the missing income. Here, the lack of incentives is independent of the bargaining power but not, of course, of the amount of money spent on goods related to the affair.

This fact could play an important role if adultery is quite common. Anthropological studies describe adultery as the main reason for divorce in South American cultures (Betzig, 1989). A study of sexual conduct in the city of São Paulo reveals that the average number of sexual partners that married men have in a year is 1.45. This is equivalent to saying that half of married men are monogamous and the other half are not[13].

The examples and the anthropological studies suggest that household members could have incentives to lie and hide information from their partners and in a survey. For instance, in the Brazilian survey used in this paper the questionnaire is filled in most

[13] See Child (1999 p. 207).

cases when both members are present[14]. Therefore all the reported income in a survey would be equal to the total income the household actually uses to allocate among members; that is, there would be no income lost because all the *reported income* is used. But the information about the true income is kept private. In this case scenario it is very possible that the test for efficiency in the intra-household allocation could not be rejected.

One way to model the asymmetry of information departs from the problem stated in equation (1), by assuming the existence of goods purchased by member A and that are not revealed to member B. This could occur because the incentive for a household member to reveal his/her true income decreases with his/her bargaining power, as I mentioned before. Let c^A be the consumption of good c that is hidden by member A and let p_c be its price. So problem (1) can be replaced by:

$$(9) \qquad \begin{aligned} &\underset{q^A, c^A, q^B}{Max} \quad U^A(u^A(q^A), v(c^A)) \\ s.t. \quad & u^B(q^B) \geq \bar{u}^B(p, y^A, y^B) \\ & p(q^A + q^B) + p_c c^A = y^A + y^B = Y \\ & q^A \geq 0, c^A \geq 0, q^B \geq 0 \end{aligned}$$

and under the assumption of separability of q^A and c^A I can solve (9) in two stages

First stage

$$\begin{aligned} &\underset{c^A, m^A}{Max} \quad U^A(V(p, m^A), v(c^A)) \\ s.t. \quad & p_c c^A + m^A = y^A \\ & c^A \geq 0, m^A \geq 0 \end{aligned}$$

Second stage:

$$\begin{aligned} & V(p, m^{A*}) = \underset{q^A, q^B}{Max} \ u^A(q^A) \\ s.t. \quad & u^B(q^B) \geq \bar{u}^B(p, m^A, y^B) \\ & p(q^A + q^B) = y^B + m^{A*} \\ & q^A \geq 0, q^B \geq 0 \end{aligned}$$

Here m^A is the *revealed income* and y^A is the true income which is observable only when m^A=y^A, if so, member A does not hide income. Note that the second stage has the same structure as equation (1). Hence, we cannot reject the hypothesis of efficiency even

[14] Instituto Brasileiro de Geógrafia e Estatística (1997)

when the revealed income is different from the true one, because the test derived from the second stage is not able to discriminate between the true and the revealed income.

Now, the solution of the first stage implies: $m^{A*}=m(p_c\ ,\ y^A)$. If member A hides income from member B then the revealed income (m^{A*}) is correlated with prices p_c. Under the null hypothesis that the true income is equal to the revealed one ($m^A=y^A$), a regression of m^A on p_c defined as[15]:

(10) $$m^A = \alpha + \lambda p_c + e$$

will show $\lambda=0$. I reject the null hypothesis if $\lambda \neq 0$ and then the behavior of member A is compatible with (9). These are testable implications. The problem is to find which prices could be included in p_c, Once these prices are identified I can estimate equation (10) using the urban Brazilian sample to test if one member hides income. This is part of my future research[16].

The fact that household members have incentives to hide income from both their partners and the surveys could be the reason why the hypothesis of efficient allocations is not rejected in consumption studies but is in household production. In the latter case the test is to evaluate, for example, whether crop yields differ when controlled by men or women of the same household in the same year. Udry (1994) shows that households can increase total production if they reallocate their labor and inputs (fertilizers). In this case, as well as in Jones (1983), the variables used in the analysis are less affected by asymmetric information. It is clear that it is physically more difficult to hide production. Also, if the household sells their production in the market, there arises a need for the

[15] The variable e is an orthogonal error term.

[16] Another alternative could be to compare the consumption behavior of singles and married individuals with similar characteristics as a way to estimate possible biases in the report of income

goods to be transported. This is usually more costly if done separately by men and women, so the chances to hide revenues are lower.

In the next section I take a different, but complementary, approach to evaluate the way the efficiency of intra-household allocation of consumption goods is tested. I explore the performance of the test using Monte Carlo simulations; in particular I look at the type-II error of the test. A high type-II error would imply an incorrect acceptance of a false hypothesis.

6. A Monte Carlo experiment

In this section I present a Monte Carlo simulation to evaluate the performance of the Distance-statistic in order to test the hypothesis of efficient intra-household allocations described in (7). Let me start by defining the model. I will generate artificial data satisfying the following properties:

$$
\begin{aligned}
& q_{ji} = y_i'\beta_j + e_{ji} \\
(11) \qquad & y_i = x_i'\gamma_j + u_i \\
& E(x_i e_{ji}) = 0
\end{aligned}
$$

for $i=1,2,\ldots,N$ and $j=1,2,\ldots,J$; where q_{ji} represents expenditure on commodity j by household i, $y_i=[1\ y_i^A\ y_i^B]$ represents members' A and B non-labor income, x_i is a Lx1 vector of truly exogenous variables (including a constant), $\beta_j=[\alpha_j\ \beta_{j1}\ \beta_{j2}]$ and γ_j are conformable vectors of parameters to be estimated and e_{ji} and u_{ji} are iid normal errors. This model describes a problem of endogeneity of the y_i's variables so I use x_i as instruments. As in previous sections, the parameters of interest are the ratio of income effects β_{11}/β_{12} and β_{21}/β_{22}.

For the simulations I assume that J = 2, N = 1224 as in our Brazilian sample and L=6. The x_i variables are a constant and L-1 draws from a uniform distribution. The parameters γ_j are collected in matrix Γ computed as:

$$\Gamma' = \begin{bmatrix} 0.3 & 1.8 & -0.01 & 0.7 & 0.24 & 0.9 \\ 0.6 & 0.79 & -0.02 & 0.5 & 0.56 & 0.1 \\ 2.0 & 2.5 & 1.0 & 1.6 & 3.0 & 4.0 \end{bmatrix}$$

The error terms e_{ij} and u_{ij} are drawn from independent standardized normal distributions. The variables y_i and q_{ji} are generated as described in (8). I set the intercepts α_1=3.0 and α_2=2.5 and the income effects as β_{21}=0.178, β_{22}=0.41 and β_{11}=0.02, replicating, respectively, the parameters obtained for food and men's clothing expenditure in Table 4. Then, the ratio of income effects (β_{21}/β_{22}) for commodity 2 (food) is η_2=0.43 and will remain fixed in all the simulations.

I allow β_{12} to vary in order to evaluate different alternatives of the true parameters. I start by setting β_{12} =0.046 so $\eta_1 = \eta_2 = 0.43$. For each value of β_{12} I calculate the true ratio of income effects for equation 1 (η_1), the percentage difference between the two ratios: $(\eta_1/\eta_2 - 1)*100$ and the percentage of 10,000 replications in which the Distance-statistic exceeds the $\chi^2_{95\%}(1)$ level, where the parameters α's and β's are estimated by multi-equation (efficient) GMM method[17]. These results are reported in Table 5.

When the two ratios are equal (row 1 in Table 5), the percentage of rejections is close to the theoretical levels, suggesting a very low type-I error (i.e. rejecting a true hypothesis). However, as we move away from the equality of income effects, the rejections of the null hypothesis do not increase rapidly enough. For example, when the

[17] As expected, in any of the simulation, I could not reject the null hypothesis of correct specification using the J-statistic (Hansen test).

differences between η_1 and η_2 is 5% (row 2) the rejection of the null hypothesis of efficient allocations is around 4% but when one ratio is 5 times the second one (row 8), the rejection of Ho is still small: only 4.2% of the time. This could be taken as an indication that the type-II error, accepting a false hypothesis, is high for this test. Therefore, the results I obtained in the last section would be incorrect: I could be wrongly accepting the hypothesis of efficient allocation when we should be rejecting it.

Table 5
Monte Carlo simulations for the rejection of the hypothesis of efficient intra-household allocations

Simulations	β_{12}	True Ratios		Rejections of the hypothesis of efficient allocations (%)
		Equation 1 (η_1)	Equation 2 (η_2)	
(1) Equal ratios:	0.046	0.432	0.432	3.79
Different ratios:				
(2) 5%	0.044	0.453	0.432	3.92
(3) 25%	0.037	0.540	0.432	3.78
(4) 50%	0.031	0.648	0.432	3.86
(5) 75%	0.026	0.755	0.432	3.71
(6) 2 times	0.023	0.863	0.432	3.77
(7) 3 times	0.015	1.295	0.432	4.09
(8) 5 times	0.009	2.159	0.432	4.17
(9) 10 times	0.005	4.317	0.432	4.22

Note: Table shows percentage of 10,000 replications of a sample size equal to the actual sample (1224 obs) in which the Distance statistic exceeds the $\chi^2_{95\%}(1)$ level. The percentage of different ratios are with respect to the true ratio of equation 2

Finally, I should make clear that these simulations, although very illustrative, are by no means conclusive. However, this evidence definitively suggests further research on the performance of the test in order to avoid wrong inferences.

7. Conclusions

Recent studies of household decisions moved away from models where the household is seen as a monolithic entity toward models where household members interact to allocate resources. These new approaches vary in the way they model these interactions, but all assumed that the outcome is efficient: that is, all resources are used. In this paper I study whether or not the intra-household allocation of resources is efficient and point out some flaws in the way this hypothesis has been tested in the allocation of private consumption goods.

I followed the literature and applied the test to an urban Brazilian survey, estimating Engel curves for broad good categories. In the estimation I consider the criticism of endogeneity of income or total expenditure and the fact that many households report no consumption due to the infrequency-of-purchase problem. I address these two problems using GMM methods that allow us to get consistent and efficient estimates of the parameters of interest. As in the rest of the literature, I could not find evidence to reject the hypothesis of efficient allocations of consumption goods.

However, this assumption of efficiency requires both asymmetric information and full commitment among members. I focused here on the former and showed that when the bargaining power of one member is high his/her partner has incentives to hide her own income sources. Also, if one of the members has an extramarital affair, as the anthropological evidence shows for the Brazilian case, the incentive to hide income sources persists independently of the bargaining power of the other member, affecting therefore the reports in surveys. I also claimed that these incentives are smaller in household production. Finally, I carried out Monte Carlo experiments to evaluate the performance of the test suggested by the literature. I showed that the type-II of the econometric test is high, so the actual methodology tends to incorrectly accept a false hypothesis of efficient allocations. These issues motivate future research to find better ways to evaluate this hypothesis.

References

Attanasio, O. and V. Lechene (2002). “Tests of Income Pooling in Household Decisions.” Manuscript. Oxford University.

Betzig, L. (1989). “Causes of Conjugal Dissolution: A Cross-cultural Study.” *Current Anthropology*. 30(5): 654-676

Blundell, R. and C. Meghir (1987). “Bivariate Alternatives to the Tobit Model.” *Journal of Econometrics*, 34: 179-200

Blanchard, E. (2000) “Testing the Pareto Efficiency of Intra-Household Resource Allocation: Reexamination of Results from Burkina Faso.” Manuscript. University of Wisconsin-Madison.

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’Économie et de Statistique*, 29, 137–156.

Chiappori, P.A., B. Fortin and G. Lacroix (2001) “Marriage Market, Divorce Legislation and Household Labor Supply.” *Journal of Political Economy*, 110: 37-72

Child, R. (1999) “Contribution of Social Sciences to the Understanding of the HIV/AIDS Epidemic and the Organization of Responses Against it.” *AIDS in Latin America and the Caribbean: A Multidisciplinary Approach*. FUNSALUD

Doss, C.R. (1996) “Testing Among Models of Intrahousehold Resource Allocations.” *World Development*, 24(10): 1597-1609.

Hayashi, Fumio (2001) *Econometrics*. Princeton University Press, 683 p.

Instituto Brasileiro de Geógrafia e Estatística (1997). *Pesquisa de Orçamentos Familiares 1995-1996. Primeiros Resultados*. IBGE, 249p.

Jones, C. (1983) “Mobilization of Women’s Labor for Cash Crop Production: A game Theoretic Approach.” *American Journal of Agricultural Economics*. 65(5): 1049-54

Keen, M. (1987) “Zero Expenditure and the Estimation of Engel Curves.” *Journal of Applied Econometrics*, 1, 277-286

MacElroy, M.B and M.J. Horney (1981). “Nash Bargained Household Decisions.” *International Economic Review*. 21:31-44.

Pudney, S. (1989) *Modeling Individual Choice. The Econometrics of Corners, Kinks and Holes*. Basil Blackwell, 349p.

Thomas, D. (1990) “Intra-Household Resource Allocations: An Inferential Approach.” *Journal of Human Resources*, 25, 635-664

Thomas, D. and C.L. Chen (1993) “Income Shares and Shares of Income: Empirical Tests of Models of Household Resource Allocations.” Mimeo, RAND.

Udry, C. (1994). “Gender, Agricultural Productivity and the Theory of the Household.” *Journal of Political Economy*. 104, 1010-1046.