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Looking for Boy-Girl Discrimination in Household Expenditure Data

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The ability to test for discrimination in the allocation of goods between boys and girls is hampered by a lack of data on intrahousehold distribution. The analysis presented here allows inferences about intrahousehold allocation to be made from household-level expenditure data. For a given level of income, families with children will spend less on adult goods in order to purchase children's goods. If household purchasing favors boys over girls, smaller expenditures on adult goods would be made by families with boys as compared with those with girls. A method for determining "adult" goods is described, and the procedure for detecting gender bias is applied to data from Côte d'Ivoire and Thailand. The data show no evidence of discrimination between boys and girls in Côte d'Ivoire, and a small and statistically insignificant bias in favor of boys in Thailand.

How commodities are allocated among the members of a household has recently occasioned a good deal of interest. Assessments of poverty and income distribution based on *household* incomes or expenditures will be misleading if allocation within the household is unequal. The position of women and girls has been of particular concern, and there is a considerable amount of empirical evidence, much of it from the Indian subcontinent, that documents discrimination against females (see in particular Bhagwati 1973; Sen 1984; Sen and Sengupta 1983; Miller 1981; Bardhan 1982; and Kynch and Sen 1983; as well as survey papers by Behrman 1987 and Harriss 1987). Much of the evidence is concerned with measurements of nutritional outcomes, mortality, and health status rather than with the direct allocation of goods by gender.

The difficulty in trying to determine the intrahousehold allocation of goods is that household budget surveys, the obvious source of data, record consumption not of individuals but of households. And while attempts can be made to

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observe who gets what, this presents both practical and conceptual difficulties. The direct observation of allocations, for example at meals, is intrusive and likely to affect the behavior of the people being observed. There are also important goods and services that are consumed jointly, such as housing, sanitation, and water supply, and it is difficult or impossible to decide whether all household members enjoy equal access to these "public" goods.

Nevertheless, household expenditure data can be used to make at least some inferences about the allocations to different types of individuals. In this article, I propose one possible procedure that appears to yield sensible results in practice. I focus on allocations to children and on whether there is discrimination in favor of boys. The starting point, somewhat paradoxically, is expenditures on goods that are *not* consumed by children, such as alcohol, tobacco, and adult clothing, items that appear in most household surveys. Imagine three households, the first consisting of a married couple with no children, the second of a married couple with a female child, and the third of a married couple with a male child. The two children are the same age, and the households are otherwise identical, with the same income, occupation, place of residence, and so on. If we compare expenditures on nonchild goods by the three households, we should expect the first to spend more on adult goods than the other two. The children require food, clothing, and other items, and the money to supply them has to come from the same total for all three households. The reduction in expenditure on adult goods reflects the additional needs of the children, and the fact that there has been a reduction in the amount of income available for nonchild expenditures. The question that is important for determining gender bias is whether the reduction in adult-goods expenditure is larger for the household with the female child or larger for the household with the male child. If the latter is true on a systematic basis, it would seem that households are diverting more resources to male children than to female children.

In practice, even the largest household surveys are not large enough to allow us to find groups of households that are identical in all respects but the gender of their children. In consequence, factors other than gender have to be controlled for statistically, in this case by using regression analysis. In this article I use household survey data from the Côte d'Ivoire and Thailand to relate expenditure on various adult goods to household characteristics and then test whether there is gender bias in favor of male children. As might be expected, the results for both countries show that the presence of additional children does indeed reduce household expenditure on adult goods. In the Côte d'Ivoire, the reduction is estimated to be the same for boys and girls. For rural Thailand, there is some evidence of a preference in favor of boys, but the effect is neither very large nor very strongly significant in a statistical sense.

The following section explains the procedure in more detail, and the subsequent two sections present results for the Côte d'Ivoire and Thailand. The only major addition to the procedure outlined above is the need to check that the selection of adult goods is a reasonable one. This requires that a number of statistical tests be carried out before calculating the boy-girl comparisons. The final section considers an alternative statistical procedure for determining a set of adult goods.

I. Methodology

I start from a general expression that relates household expenditure on good i to the household's budget and other relevant characteristics:

$$(p_i q_i) = f_i(x,n,z,u) \; , \tag{1}$$

where $p_i q_i$ is expenditure on good i, x is household total expenditure, or "outlay," n is a vector that characterizes the demographic composition of the household, z is a vector of other household characteristics, and u is a term that represents unobservable taste variation. I shall be working with survey data collected within a single year, so I make the standard assumptions and ignore price variation across households. For the purposes of this study, the vector n will be taken to be a list of the number of people in each of several categories defined by gender and age, so that n_r denotes the number of people in the household in the rth category.

Holding everything else constant, the effect of an additional person of type r is given by the partial derivative $\partial(p_i q_i)/\partial n_r$. Since I will be concerned mostly with the case in which r refers to a child and i refers to an adult good, and in which the effect on purchases is essentially an income effect, it is convenient to relate the effect of an additional person to the effect of an increase in the budget. Income effects are given by the marginal propensities to spend, $\partial(p_i q_i)/\partial x$, and the ratio of $\partial(p_i q_i)/\partial n_r$ to $\partial(p_i q_i)/\partial x$ tells us by how much the total budget would have to be increased to generate the same additional expenditure on good i as would the addition to the household of one more person of type r. If i is an adult good and r is a child, the ratio would be negative; additional children act like decreases in income for adult goods. As is often the case, it is simpler to work not with sums of money but with dimensionless ratios, and to this end I define the "outlay equivalent ratios," π_{ir}, by

$$\pi_{ir} = \frac{\partial(p_i q_i)/\partial n_r}{\partial(p_i q_i)/\partial x} \cdot \frac{n}{x} \quad . \tag{2}$$

These π-ratios are simply the outlay changes that are equivalent to the additional person expressed as a ratio of total household expenditure per person. For example, if good i is tobacco and n_r is the number of female children in the household, a value of π_{ir} of -0.3 means that the addition of a girl to the household has the same effect on tobacco expenditures as a 30 percent reduction in total household expenditures per person.

The π-ratios can be used to give simple answers to questions about adult goods and gender bias. Consider first the question of whether a particular group of goods can be legitimately treated as adult goods. When an additional child enters the household, it brings additional needs, so that expenditure on all adult goods can be expected to fall. This effect acts exactly like a reduction in income, so that the reductions in expenditures on individual adult goods ought to be in proportion to the marginal propensities to spend on each. If 10 percent of additional income is spent on adult clothes and 5 percent on alcohol, then an additional child should reduce expenditures on adult clothes and alcohol in the ratio of 2 to 1. Put another way, the reduction in expenditure on adult clothes divided by the marginal propensity to consume adult clothes should be the same as the reduction in expenditure on alcohol divided by the marginal propensity to consume alcohol. But this simply means that the two goods have identical π-ratios. In general, all adult goods should have the same π-ratios for an additional child of any gender or age.

The procedure followed here is to take a list of possible adult goods, calculate the π-ratios for each child and adult age and gender group, and test whether the ratios for the children are the same for all the goods. When a suitable group of goods has been found, the π-ratios for boys are compared with those for girls; if the boy ratios are more negative than the girl ratios, there is a supposition that boys get more than girls.

In order to calculate the π-ratios, estimates are required of marginal propensities to consume and of the effects of household demographic structure on expenditures. The simplest way to obtain these is to specify an empirical Engel curve that can be estimated on household survey data. Here, I use the following specification:

$$(3) \quad w_i = p_i q_i / x = \alpha_i + \beta_i \ln(x/n) + \eta_i \ln n + \sum_{1}^{J-1} \gamma_{ij}(n_j/n) + \delta_i \cdot z + u_i \quad .$$

This type of Engel curve is an extension of that first advanced by Working (1943) and proposes a linear relation between the share of expenditure of each good and the logarithm of total outlay. The demographic structure of the household is incorporated through the ratios (n_j/n), where n is the total number of household members. Note that if there are J categories of people, the demographic structure of households can be summarized by only $J-1$ ratios. Total household size appears both as the deflator of total outlay x and in its own right in the term $\ln n$. Previous work with this sort of Engel curve has shown that household expenditure patterns can often be well explained by the logarithm of household per capita expenditure. The additional term in the logarithm of household size allows for the possibility that the pattern of expenditures is not invariant to changes in the size of the household, even when household structure and household per capita outlay are held constant. The vector z contains a number of dummy variables that allow for possible effects of other household characteristics, such as location, region, nationality, or education.

Equation 3 can be used to calculate expressions for the effects of additional outlay and additional people on the expenditure on each good. If the results are substituted into equation 2, we obtain the following expression for the outlay equivalence or π-ratios:

$$\pi_{ir} = \frac{(\eta_i - \beta_i) + \gamma_{ir} - \sum_{1}^{J-1} \gamma_{ij}(n_j/n)}{\beta_i + w_i} \quad . \tag{4}$$

Equation 4 holds only for $r = 1, \ldots, J-1$, that is, for the first $J-1$ demographic categories, while for the Jth, the formula for π_{ij} is the same but without the γ_{ir} term. Estimates of the ratios are obtained by replacing the parameters with their estimates and replacing w_i and the (n_j/n) ratios with their values at the sample mean of the data. Having calculated the π-ratios, I test the hypothesis that they are equal,

$$H_0: \pi_{ir} = \pi_{jr} \quad , \tag{5}$$

for all i and j that refer to adult goods and for all r that refer to children.

The econometric procedures used here are conceptually quite straightforward. Given a household survey, and a provisional list of adult goods, equations like equation 3 are estimated for each good. The technique is ordinary least squares, and all households are included, whether or not they purchase the good. In general, changes in household composition will influence not only the amount that people purchase but whether they purchase at all. By including nonpurchasing households, both types of effects are captured. If we are interested in whether girls get less than boys, it is of secondary importance whether girls get none and boys get some or whether both get some but girls get less. According to equation 4, the coefficients are functions of the parameters estimated from the ordinary least squares regressions, so that their standard errors can be calculated, at least approximately, from the estimated variances and covariances of the regression estimates. The formulas for doing this are not given here but can be found in Deaton (1987) or in Deaton, Ruiz Castillo, and Thomas (forthcoming).

The procedure for testing the hypothesis in equation 5 is again a very simple one: I calculate the difference of the estimated π-coefficients from their mean and test whether the resulting deviations are jointly significantly different from zero. Again, the basic requirements for calculating the test are the variances and covariances of the estimated π-ratios; these are used to form a test statistic which, under the null hypothesis, has a large sample X^2-distribution with degrees of freedom equal to one less than the number of adult goods. The formulas are given in the references cited above.

II. Results from Côte d'Ivoire

The first set of data is taken from the 1985 Living Standards Survey of Côte d'Ivoire. A description of the survey and the sampling methodology is given in Ainsworth and Muñoz 1986. Although this survey is an unusually rich one, the calculations in this article could be replicated with any household budget survey containing data on consumers' expenditures. The 1,563 households in the sample are a simple random sample of the population of households in the country. Seven commodities in the Ivorian survey are plausible candidates for adult goods: adult clothing, adult shoes, fabric for adult clothing, alcohol, tobacco, meals taken away from home, and entertainment. The fabric is the material used to make the *pagnes* that are worn by many adult Ivorians. Meals taken away from home and entertainment may also be consumed by children, at least on occasion, but if so, the empirical tests should detect the fact.

Engel curves like those specified in equation 3 were estimated for expenditures on each of the seven categories as well as for expenditures on the group as a whole. Eight demographic types were distinguished: the number of males and females in each of the four age groups, 0–4 years, 5–14 years, 15–55 years, and over 55. Dummy variables for location were also included, with the country divided into Abidjan, other urban, East Forest and West Forest, and the Savannah. A dummy variable was also added for farm or nonfarm households. The results show that the shares of clothing, shoes, and tobacco fall as total expenditure increases, while those of fabric, alcohol, entertainment, and meals away from home all increase. All of the goods are estimated to be "normal" goods, that is, expenditure on each increases with the total budget.

Somewhat surprisingly, the urban dummy variables have negative effects, so that there is less expenditure on adult goods in Abidjan and the other towns than in the countryside, even when the total budget and other factors are controlled for. Changes in total household size, with expenditure per person held constant, act so as to decrease total expenditure on these adult goods. The good that makes the largest contribution to this effect is tobacco, although it is hard to see why smoking should be subject to these sorts of economies of scale!

The main interest here is in the effects of the demographics, and these can be conveniently assessed by looking at the estimated π-coefficients displayed in table 1. Note first the estimated standard errors at the foot of the table. These are often quite large relative to the π-ratios themselves, and their size must be borne in mind when interpreting patterns in the ratios.

The first four rows of table 1 give the π-ratios for children; if the adult goods are correctly defined, that is, if children do not consume them directly, these coefficients ought to be negative. All but three of the 32 estimates are so, the exceptions being adult fabric for small children of both sexes and eating out for small boys. It may be supposed that "adult" fabric is sometimes bought for children, while the eating-out effect, if indeed it is real, may reflect more complex substitution patterns in behavior. (The same sort of issue arises in the Thai results considered in the next section.) For all of the other pairings of children and adult goods, expenditure falls when an additional child is added to the household, and the π-coefficients lie between 0 and -1.0. The test statistics for the equality of the π-ratios are given in the left side of table 2; all are well within the conventional range of significance. There is therefore no

Table 1. *Outlay Equivalence Ratios for Adult Goods, Côte d'Ivoire, 1985*

Gender and age[a]	Adult clothing	Adult fabric	Adult shoes	Alcohol	Tobacco	Meals out	Entertainment	All adult goods
				π-ratios				
Children								
M 0–4	−0.01	0.37	−0.23	−0.58	−0.89	0.27	−0.42	−0.12
M 5–14	−0.67	−0.35	−0.21	−0.69	−0.71	−0.37	−0.41	−0.49
F 0–4	−0.20	0.41	−0.24	−0.33	−0.45	−0.21	−0.30	−0.22
F 5–14	−0.39	−0.12	−0.45	−0.39	−0.45	−0.62	−0.37	−0.48
Adults								
M 15–55	1.30	0.79	1.63	−0.19	1.88	0.91	0.74	0.81
M > 55	−0.74	0.33	−0.28	1.45	1.06	−0.47	−0.98	0.16
F 15–55	0.32	−0.14	0.17	−0.39	−0.41	−1.33	−1.07	−0.71
F > 55	−1.14	−0.97	−0.69	−1.24	−1.29	−1.33	−0.99	−1.21
				Standard errors				
M 0–4	0.46	0.35	0.33	0.38	0.74	0.32	0.40	0.20
M 5–14	0.32	0.25	0.23	0.27	0.52	0.22	0.28	0.14
F 0–4	0.43	0.33	0.30	0.36	0.69	0.30	0.37	0.19
F 5–14	0.33	0.25	0.23	0.27	0.53	0.23	0.29	0.14
M 15–55	0.31	0.22	0.23	0.22	0.54	0.20	0.25	0.13
M > 55	0.45	0.35	0.32	0.39	0.75	0.31	0.39	0.20
F 15–55	0.27	0.20	0.19	0.22	0.43	0.19	0.23	0.11
F > 55	0.53	0.40	0.37	0.44	0.85	0.37	0.46	0.23

a. M = male; F = female.
Source: Deaton (1987).

evidence in the top half of table 1 to suggest that the choice of adult goods is incorrect.

Nor do these results suggest any real difference in the overall treatment of boys and girls. The relevant figures for the test are the top four figures in the last column of table 1; these relate to total adult expenditures and show the reductions corresponding to boys and girls in the two age groups. If boys were favored over girls, we should expect the π-ratios for adult goods as a whole to be bigger negative numbers for boys than for girls; adults must (or are willing

Table 2. *Wald Tests for Equality of π-ratios across Adult Goods, Côte d'Ivoire*

Gender and age	Children: Test	Children: p-value		Adults: Test	Adults: p-value
Males 0–4	7.12	0.31	Males 15–55	39.21	0.00
Males 5–14	3.87	0.69	Males > 55	27.98	0.00
Females 0–4	3.69	0.28	Females 15–55	45.98	0.00
Females 5–14	2.41	0.88	Females > 55	2.08	0.91

Note: Test statistics are asymptotically distributed as χ^2 with six degrees of freedom under the null hypothesis that the π-ratios are the same over all seven goods.
Source: Deaton (1987).

to) give up more of their own consumption to accommodate the favored male children. As it is, the two coefficients for the older male and female children are nearly identical, while those for the younger groups show, if anything, a bias toward girls, a result that confirms the earlier evidence in van der Gaag (1986). As we shall see below, none of these differences is statistically significant.

The third and fourth sets of rows of table 1 present the outlay equivalent ratios for adults. For these coefficients, the theory does not predict any specific sign pattern except that, if some adults have access to adult goods, *some* of the π-ratios should be positive. The table shows a mixture of outcomes. For adult males 15–55 years old, all but one of the ratios are positive, and all but the negative one—for alcohol—are significantly different from zero. It is clear that prime-age adult males have access to adult goods. In total, adding an additional such male to a household increases expenditures on adult goods as much as does an 81 percent increase in total outlay per member. None of the other groups of adults is similarly favored. Adult females show positive π-coefficients for only two adult goods, clothes and shoes, while for the other commodities, an additional female has the effect of reducing household expenditure. Old men appear to do rather better than adult females; they have large positive π-coefficients for alcohol and tobacco and have a small positive net effect on adult goods expenditures as a whole. Given these results, it is perhaps not surprising that old women do worst of all in terms of access to these goods; all the coefficients are negative and most are quite large.

Note that these differences do not *necessarily* reflect bias against females in the allocation of goods as a whole; it is conceivable that preferences vary by gender and age, so that old women in the Côte d'Ivoire, while receiving little in the way of these goods, may be well taken care of in other respects. Data on household expenditures as a whole are not well-suited to separating these two hypotheses. Indeed, that preferences are likely to be different for boys and girls is the reason we cannot look for discrimination by examining the consumption levels of goods consumed by boys and girls but instead follow the more indirect route of looking at the effects of additional children on expenditure on adult goods.

For completeness, the Wald statistics for the four adult groups are shown on the right side of table 2. All groups register rejections of equality except for old women. The strong rejection for adult women may at first sight seem surprising, but it reflects, not the presence of *positive* coefficients in table 1, but the marked inequality in the *negative* coefficients. Equality in the adult π-coefficients is a less interesting hypothesis than is equality for children, but the rejections confirm that these procedures are capable of detecting adult and child effects, thus strengthening the acceptances on the left side of table 2.

The significance of gender differences for both adults and children can be tested by comparing the π-coefficients by gender as well as by commodity. The easiest way to do this is to test the equality by gender of the original regression

Table 3. *F-tests for Equality of π-ratios by Gender, Côte d'Ivoire*

Adult good	*Children*	*Prime adults*	*Old adults*	*All groups*
Degrees of freedom	3	1	1	7
Adult clothing	0.19	7.43/(s)	0.31	2.55
Adult fabric	0.17	11.33/(s)	16.54/(s)	3.84/(s)
Adult shoes	0.23	32.57/(s)	0.64	11.18/(s)
Alcohol	0.36	0.44	21.14/(s)	0.38
Tobacco	0.87	15.55/(s)	4.18/(s)	5.28/(s)
Eating out	0.42	79.44/(s)	2.99	27.22/(s)
Entertainment	0.97	32.90/(s)	0.00	11.03/(s)
All	0.93	93.74/(s)	19.63/(s)	31.33/(s)

Note: (s) indicates that the null hypothesis of equality is rejected at the 5 percent level.
Source: Deaton (1987).

coefficients for the Engel curve (equation 3). The results are given in table 3. The first column shows that none of the coefficients is significantly different between boys and girls, thus confirming the assertion that there is no evidence of favoritism toward boys in the reaction of expenditure on any adult good to the presence of an additional child. By contrast, the coefficients on prime-age males in the Engel curves are all larger than those on prime-age females, and the differences are significant for all the goods except alcohol. For old people, the coefficient for old men is always positive, and therefore larger than the implicit zero coefficient for the omitted category of women over 55 years of age, and the difference is significant for fabric, alcohol, and tobacco. The last column in the table shows the test for equality of gender effects overall; these essentially reflect the results for adults. These formal test statistics therefore confirm the impressions that come from the examination of the π-ratios in table 1.

In summary, the response of expenditures on adult goods to additional children shows no evidence of a bias in favor of male children. Among the adults, however, there is far from equal access to the adult goods examined here; adult males get more than adult females, who register positive effects only for clothes and shoes. Old men get less than do young men but appear to consume alcohol and tobacco, while old women seem to get none of these goods.

III. Results from Thailand

The data for Thailand come from the 1980–81 Socioeconomic Survey. The sample is divided into municipal areas, sanitary districts, and villages, which correspond to urban, small town, and rural areas, respectively. In this study, I confine myself to the 5,835 village households covered in the survey, which are a random sample of all Thai village households.

It is more difficult for the Thai survey than for the Ivorian to find obvious candidates for adult goods. As before, the survey records expenditure on tobacco, alcoholic drinks, and food taken away from home, but there are no other immediately obvious candidates. Expenditures on clothing and footwear are distinguished by the gender of the user, but not by age, so that for example we have "men's and boys' clothing," rather than adult clothing and children's clothing, which was the division in the Ivorian data. Nevertheless, I use the four categories men's and boys' clothing, women's and girls' clothing, men's and boys' footwear, and women's and girls' footwear, together with the other three categories, although it is clear in advance that all of these goods cannot be expected to pass the tests for a legitimate group of purely *adult* goods.

When estimating the Engel curves for Thailand, I distinguish ten age and gender categories: age groups of 0–2, 3–4, 5–14, 15–60, and over 60 years for each gender. The regressions also contain the age and educational level of the household head, together with a range of regional and seasonal dummy variables. The estimated π-ratios are shown in table 4. Ratios are calculated for each of the seven goods and for two aggregates, the first containing all seven goods and the second containing only the last three, that is, excluding the clothing and footwear categories which are known to contain some children's goods. Despite the problems with these categories, nearly all the π-ratios for the children are negative. Most of the exceptions are the obvious ones—boys from 5–14 have positive coefficients for mens' and boys' clothing and footwear, as do girls from 5–14 for women's and girls' clothing and footwear. Note that boys under 4 have a negative π-ratio even for men's and boys' clothing and footwear, as do very young girls for women's and girls' clothing and footwear. Presumably the negative income effect of the child outweighs the small positive requirement for the commodity. The only other positive numbers are those for girls from 3–4 for male and female clothing and for both groups of young boys for tobacco. None of these estimates is significantly different from zero.

The tests for the hypothesis that all these are adult goods are given in the

Table 4. *Outlay Equivalence Ratios for Adult Goods, Thailand, 1980–81*

Gender and age	*Clothing*		*Footwear*						
	Male	*Female*	*Male*	*Female*	*Tobacco*	*Alcohol*	*Meals out*	*All adult goods*	*Last three goods*
				Children					
M 0–2	−1.13	−3.12	−2.22	−1.88	−0.32	−0.50	−0.52	−0.89	−0.47
M 3–4	−0.05	−0.73	−1.00	−2.98	0.14	−0.01	−0.89	−0.54	−0.52
M 5–14	1.38	−0.89	0.45	−1.98	0.01	−0.25	−0.50	−0.21	−0.34
F 0–2	−1.21	−2.05	−1.47	−1.39	−0.22	−0.07	−0.38	−0.63	−0.30
F 3–4	0.60	0.16	−0.95	−1.42	−0.11	−0.51	−0.42	−0.23	−0.36
F 5–14	−1.78	0.72	−0.95	2.58	−0.05	−0.29	−0.26	−0.27	−0.22
				Adults					
M 15–60	5.83	−0.49	3.57	−1.71	0.15	−0.28	−0.64	0.37	−0.40
M > 60	2.72	−1.46	0.83	−1.13	0.15	−0.38	−0.34	−0.02	−0.24
F 15–60	−0.01	3.29	−0.26	3.25	−0.14	−0.20	−0.66	0.04	−0.47
F > 60	0.12	−0.48	−0.18	−0.51	0.00	−0.22	−0.54	−0.32	−0.37

Note: M = male; F = female.
Source: Deaton (1987).

Table 5. *Wald Tests for Equality of π-ratios across Adult Goods, Thailand*

	Children					Adults			
	Broad aggregate		*Narrow aggregate*			*Broad aggregate*		*Narrow aggregate*	
Gender and age	*Test*	*p-value*	*Test*	*p-value*	*Gender and age*	*Test*	*p-value*	*Test*	*p-value*
M 0–2	17.8	0.012	1.1	0.786	M 15–60	63.8	0.000	61.2	0.000
M 3–4	42.0	0.000	27.4	0.000	M > 60	117.9	0.000	7.1	0.068
M 5–14	63.8	0.000	28.0	0.000					
F 0–2	10.2	0.176	1.5	0.677	F 15–60	67.2	0.000	29.6	0.000
F 3–4	13.1	0.070	4.1	0.250	F > 60	127.3	0.000	116.0	0.000
F 5–14	47.4	0.000	6.5	0.092					

Note: M = male; F = female. Test statistics are asymptotically distributed as χ^2 with six (broad aggregate) or two (narrow aggregate) degrees of freedom under the null hypothesis that the π-ratios are the same over all seven goods.

Source: Deaton (1987).

left side of table 5. The hypothesis is generally rejected, although not for the two youngest groups of girls and the youngest group of boys. For the narrow aggregate, the hypothesis that these goods are not consumed by girls can be accepted for all three age groups, but the rejection for boys is repeated for the two oldest groups, even though the test statistics are a good deal smaller. These rejections are not unexpected given the dearth of adult goods in the survey, and given the results in table 4. However, the results mean that the question of gender bias has to be approached rather more carefully than was the case for the Côte d'Ivoire. Note finally from the right side of table 5 that, once again, it is easy to reject the hypothesis that the π-ratios are the same for all goods for *adults*. Adding an adult to the household has effects on the expenditure on these goods that cannot be reproduced by giving the household more money.

The summary outlay equivalent ratios for all seven of the goods and for a group composed of the last three (tobacco, alcohol, and food taken away from home) are contained in the last two columns of table 4. Although the π-ratios for all seven goods include not only the negative income effect of children on adult goods expenditure, but also the positive effect of children's needs for clothing and footwear, the effect should be the same for boys as for girls, so that the π-ratios should still be the same if there is no gender discrimination. As it is, both columns tell the same story. All the π-ratios are negative, and with one exception (the age group 5–14 for the broad aggregate), the figures are more negative for boys than for girls. According to these figures, households devote about 20 percent less to their under-five-year-old children if the children are girls than if they are boys. Of course, these are only point estimates, and the standard errors are large enough that the differences are not statistically significant.

The tests for gender effects corresponding to those presented for Côte d'Ivoire in table 3 are not shown explicitly, but the results can be summarized as follows. For the youngest age group (those under 3), there are no significant gender differences for any of the goods or for the aggregates. For the next group, there are differences in the tobacco and meals-out equations, but the aggregate differences are not statistically significant. Finally, for children aged 5–14, and apart from the obvious clothing effects, there are significant gender differences in the meals-out equation, which carry through to the narrow aggregate. The gender differences that are apparent in the last column of table 4 come mostly from differences in the equation for food eaten away from home. The addition of a girl to the household causes expenditure in this category to fall by less than does the addition of a boy. By itself, this effect is generally statistically significant, although it is not sufficient to generate a significant effect when all the adult goods are taken together.

Although the π-ratios for adults are not my main concern, it is worth looking briefly at the results presented in the bottom panel of table 4. The signs of the clothing and footwear figures are very much as expected, with men using men's goods and women using women's. But once again, the effects are hardly equal. The π-ratios for men on men's goods are larger than the π-ratios for women on women's goods, while the negative effects of additional men on women's purchases is larger (negative) than the negative effects of additional women on men's purchases. As was the case for the Ivorian figures, these differences may simply reflect taste differences, but they are interesting nevertheless. The other notable feature of the adult π-ratios in table 4 is the large number of negative signs for tobacco, alcohol, and meals out. Apart from men buying tobacco, additional adults seem to *decrease* expenditures on these supposedly adult goods. These estimates suggest that the technology of consumption may be more complicated than can be represented by matching individuals to goods. For example, in Thailand, particularly in Bangkok, people purchase a great deal of cooked food in restaurants or from street vendors. It would not be surprising if many of these purchases are made by people who live alone or in small households where there are no economies of scale to food preparation. These hypotheses could explain the negative effect of additional adults on food eaten outside the household. The negative π-ratios for alcohol are less easily explained.

While these results are rather mixed, the methodology of this article still seems to be useful even for the more difficult case presented by the Thai survey. The outlay equivalence ratios are generally sensible and reproduce the expected patterns of association between goods and people. A really convincing test of gender bias among children requires the construction of a group of adult goods that survives the various statistical tests. This is difficult to do for Thailand, where even the obvious adult goods, like alcohol and tobacco, do not generate clear-cut patterns. For one good, meals taken away from home, the results show a reduction in expenditures associated with additional boys that is larger than the reduction associated with additional girls. It is possible that this result reflects a general preference toward boys, although at this stage the inference is little more than conjecture. A few of the Engel curves show significant differences between boys and girls, but the significance levels are never very impressive, particularly given a sample containing 5,835 households.

IV. An Alternative Procedure for Finding Adult Goods

The main practical difficulty in using the methods of this article lies in finding a group of adult goods. Once a list has been established, the calculations for gender bias are very simple, requiring essentially one ordinary least squares regression and some *F*-tests. Some surveys will have a longer list of plausible adult goods than others, but the test procedures still have to be carried out. Although conceptually straightforward, the tests used in this study are quite complex to calculate in practice, so that an alternative and simpler procedure would have its attractions. There is also a question of robustness, of how much the results depend on the choice of functional form and on the particular techniques used for testing. In this section, I suggest a simple alternative procedure that can be used to test whether a group of goods can reasonably be accepted as adult goods. The procedure does not yield estimates of gender bias, so it is a complement to the preceding analysis, not a replacement for it.

The basic idea is the same, that expenditure on adult goods depends on number of children only through income effects. Given this, children affect only the total expenditure allocated to adult goods, not the allocation within the adult-goods group once total group expenditure is given. That they do not do so can be shown to be formally equivalent to the equality of the π-ratios that was the basis for the tests presented in the methodology section of this article (see Deaton, Ruiz-Castillo, and Thomas, forthcoming). This alternative way of looking at the problem also suggests an empirical procedure. The expenditure on each adult good is regressed on total expenditure for all adult goods. If all members of the group are genuine adult goods, the age and gender of children should play no part in the regression, a hypothesis that can be easily tested by an *F*-test.

In practice, there is a complication that must be taken into account. When there are only a few adult goods, there is a danger that regressing one on the total will be very like regressing something on itself. More formally, there is a spurious correlation between the variables being explained and the main explanatory variable, in this case total adult expenditure. For example, if a household spends an abnormally large amount on meals taken away from home, the chances are that the household will also have an abnormally large total of adult expenditure. The resulting correlation will cause bias in ordinary least squares regression. The solution is to use two-stage least squares estimation. At the first stage, total adult expenditure is regressed on total household expenditure and on the other variables in the regression. The predicted values from this first stage are then used in place of total adult expenditure in the original regression.

The procedure is applied to the same Ivorian data used in section II above. To keep things as simple as possible, and to provide a cross-check on the previous results, I use linear functional forms. The expenditure on each good is regressed on a constant, total expenditure on adult goods, the same regional and farm dummies as before, and the number (not ratio) of people in each of

Table 6. *F-tests for Exclusion of Demographics, Côte d'Ivoire*

	Children excluded		*Adults excluded*	
Adult good	*Test*	*p-value*	*Test*	*p-value*
Adult clothing	0.44	0.78	8.19	0.00
Adult fabric	0.96	0.43	2.67	0.03
Adult shoes	2.58	0.04	4.35	0.00
Alcohol	0.51	0.73	2.40	0.05
Tobacco	2.52	0.04	7.96	0.00
Meals out	0.45	0.77	1.39	0.24
Entertainment	1.03	0.39	0.81	0.51

Source: Deaton (1987).

the eight age and gender classes. The *F*-tests for the exclusion of the child and adult variables are shown in table 6. (Technically, these are not strictly *F*-tests since, with two-stage least squares, only asymptotic distributions are valid; even so, the use of *F*-statistics is asymptotically correct and is unlikely to be misleading in finite samples.) Like the test results shown in table 2, these figures do not suggest any problems with the hypothesis that these seven goods can be regarded as adult goods. Although the *p*-values for two of the categories are a little below the 5 percent level, the other five are easily within the acceptable range, so that the overall picture is as positive as before. As was the case for the original tests, the results for adults are quite different, and there are several sharp rejections. Note that the null hypothesis being tested here is not that adults do not consume adult goods but that they do so in ways that cannot be reproduced by an increase in total expenditure.

The similarity between these results and those presented in section II suggests that the findings are quite robust and that the choice of adult goods is indeed legitimate. The simplicity of the methods of this section also makes it attractive to consider these tests as a way of conducting preliminary tests on a list of possible adult goods. The methods of section I can then be used to test for possible gender bias.

REFERENCES

Ainsworth, Martha, and Juan Muñoz. 1986. "The Côte d'Ivoire Living Standards Survey: Design and Implementation." Living Standards Measurement Study Working Paper 26. World Bank Development Research Department. Washington, D.C.

Bardhan, Pranab. 1982. "Little Girls and Death in India." *Economic and Political Weekly* 17: 1448–50.

Behrman, J. R. 1987. "Intrahousehold Allocation of Nutrients and Gender Effects." University of Pennsylvania Department of Economics. Philadelphia. Processed.

Bhagwati, Jagdish N. 1973. "Education, Class Structure, and Income Equality." *World Development* 1: 21–36.

Deaton, Angus. 1987. "The Allocation of Goods within the Household: Adults, Children, and Gender." Living Standards Measurement Study Working Paper 39. World Bank Development Research Department. Washington, D.C.

Deaton, A. S., Javier Ruiz-Castillo, and Duncan Thomas. Forthcoming. "The Influence of Household Composition on Household Expenditure Patterns: Theory and Spanish Evidence." *Journal of Political Economy.*

Harriss, B. 1987. "The Intrafamily Distribution of Hunger in South Asia." Queen Elizabeth House. Oxford, England. Processed.

Kynch, Jocelyn, and A. K. Sen. 1983. "Indian Women: Well-being and Survival." *Cambridge Journal of Economics* 7: 363–80.

Miller, Barbara. 1981. *The Endangered Sex: Neglect of Female Children in Rural North India.* Ithaca, N.Y.: Cornell University Press.

Horton, Susan, and B. D. Miller. 1987. "The Effect of Gender of Household Head on Expenditure: Evidence for Low-income Households in Jamaica." Toronto: Department of Economics, University of Toronto. Processed.

Sen, A. K. 1984. "Family and Food: Sex Bias in Poverty." In A. K. Sen, ed., *Resources, Values, and Development.* Cambridge, Mass.: Harvard University Press.

Sen, A. K., and Sunil Sengupta. 1983. "Malnutrition of Rural Children and the Sex Bias." *Economic and Political Weekly* 18 (May): 855–64.

van der Gaag, Jacques. 1986. "Intrafamily Allocation of Goods and the Cost of Children: Engel versus Rothbarth and Beyond." The World Bank Development Research Department. Washington, D.C. Processed.

Working, Holbrook. 1943. "Statistical Laws of Family Expenditure." *Journal of the American Statistical Association* 38: 43–56.