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Articles

An Analysis of African Family Expenditure. Part Two: The Chiweshe Reserve

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AN ANALYSIS OF AFRICAN FAMILY EXPENDIUTRE

Part II: Chiweshe Reserve*

by

R. W. M. JOHNSON

Chiweshe Reserve is some 60 miles north-west of Salisbury in the Mazoe district, and is a typical African Reserve in the high veld of Mashonaland. Male absenteeism is fairly high, and agriculture is typically carried out by the older men, the women and children. Land tenure is on a customary basis, and the Land Husbandry Act of 1951 has never been strictly applied. Soil types vary from granite sands to laterite red clays, with a marked difference in agricultural productivity between the two.

The budgets analysed here were drawn from a sample of 120 families whose agricultural activities were fully recorded between October 1960 and September 1961. Food consumption levels were derived from crop production records less sales of produce. Meat consumption levels were derived from cattle slaughter less sales plus cash purchases of meat. Consumer goods purchased by the families were recorded by the research assistants on twice weekly visits. Income was calculated from crops grown and consumed plus sales of produce plus cash remittances from outside the reserve plus any other recorded source of income.

The 120 families were selected on a complete census basis by visiting *every* resident family (in the wet season of 1960/61) in 5 representative villages near the southern end of the Reserve. Family size data was collected on the basis of the number of people who ate the main meal together each day. Out of the original number of 120 households located in November 1960, twenty did not complete residence to September 1961. This left 100 households for the budget study. At the same time, the recorded households are not full-time family units, but residence units, being defined as the rural households which entered production consumption and purchasing activities in the 5 villages for the 12 month period from October 1960 to September 1961. Family sizes fluctuated considerably in this period. (See 4, pp. 85-90.)

Outline of the Statistical Analysis

As in the previous paper on this topic, the cross-section income elasticities are calculated at the arithmetic mean of the data only and changing values of coefficients at different levels of income are not sought. It is assumed that families at different levels of income might exhibit patterns of consumption which might be a useful guide to changes in consumption in the future.

The first hypothesis to be investigated is whether family size affects commodity consumption levels per family independently of family income, i.e.

$$X_i = a_i + b_i Y + e_i S \qquad (1)$$

* This analysis is based on a survey of 5 villages in Chiweshe Reserve carried out by the author in 1960/61. The project was generously financed by the Rockerfeller Foundation. The budgets were estimated from data collected by Messrs. P. Mtisi, A. Mutiti, M. C. Bganya, A. Matewa, G. Chavanduka, G. Sibanda and P. Mavunga. More recently, Mrs. M. J. Woods has provided statistical advice and Miss J. Habgood has carried out the computer calculations.

where X_i = family expenditure or consumption of the ${}_i$th good,
Y = family income
S = family size measured in consumer units.

The data is then converted to per capita units and three further hypothesis examined:

(a) is family income best measured as disposable income after farming expenses are net?

(b) is family income best measured as gross income before farming expenses are deducted?

(c) is the conversion to per capital terms best approximated by consumer units or unweighted persons per family?

The semi-logarithmic form of the basic equation is used for these tests as follows:

$$\frac{X_i}{S} = a_i + b_i \log \frac{Y}{S} \quad (2)$$

Next, the family expenditure data is examined for the bias that would result if no information were available on family size. A simple linear hypothesis, similar to one used by Blyth recently (5) is used:

$$X_i = a + b_i Y \quad (3)$$

and the semi-logarithmic form of equation (3) is calculated for comparative purposes as well, i.e.

$$X_i = a + b \log Y \quad (4)$$

As set out previously, the Engel Elasticity is given by the following ratio in the semi-logarithmic form of the equation:

$$E_i = \frac{b_i}{X_i} \quad (5)$$

while in the linear form of the equation it can be shown that the Engel Elasticity is given by:

$$E_i = b_i \cdot \frac{Y}{X_i} \quad (6)$$

The analysis next turns to the scale hypothesis, that is, whether expenditure per capita does itself vary systematically with size of family. As previously, this hypothesis is tested with the following form of the equation.

$$\frac{X_i}{S} = a_i + b_i \frac{Y}{S} + c_i S \quad (7)$$

Finally, some attention is paid to the algebric forms of the Engle function suggested by Leser [2]. Among others suggested by him, the ratio formulation satisfies the additivity criterion (the weighted sum of the individual income elasticities must be equal to unity) and also satisfies the statistical condition that the residuals of the estimated equation are homoscedastic. The ratio formulation is tested in its linear form and in semi-logarithmic form to examine whether the ratio of expenditure to income is slightly curcilinear as income per family increases, i.e.

$$\frac{X_i}{Y} = a_i + b_i \log Y \qquad (8)$$

and

$$\frac{X_i}{Y} = a_i + b_i Y \qquad (9)$$

For equation (8) the Engel Elasticity is given by the following formula:

$$E_i = {}_1 + b_i \frac{Y}{X} \qquad (10)$$

and for equation (9) the Engel Elasticity is given by:

$$E_i = {}_1 + b_i \frac{Y^2}{X} \qquad (11)$$

The Expenditure Data

The physical output of crops was measured by the research assistants during harvest in 1961, and any sales out of households were reorded at this time. Stocks at the beginning and end of the season were not ascertained. The value of crops retained for consumption was calculated using local market prices. Individual family data was thus available for the consumption of maize, groundnuts, and millet; in the case of maize some purchases were also added in together with milling costs on home-grown grain.

In the case of meat, net slaughter weights were valued at local prices and this was added to purchases of meat.

Bought foods included tea, sugar, margarine, bread, fish, coffee, salt and tinned milk. Some expenditure on beer was recorded, but this would be vastly underestimated. There is the further problem here that a large amount of beer is consumed at social gatherings where no formal exchange takes place.

General household expenses are itemised for poll tax, school fees, bus fares, paraffin, clothes, soap, cooking oil, household goods (towels, utensils, crockery), and all other items.

Other expenditure allocations out of gross income are farming inputs (wages paid, plough parts, bike parts, carts and parts), livestock purchased, cattle tax and fertilizer.

There is a certain element of under-recording throughout the purchased items. Food consumption is probably set a little high because of wastage, seed and grain used for beer, all of which were unrecorded. Changes in food stocks from year to year are thought to be small, although this could be large in a plentiful year followed by a drought year.

The Income Data

Gross income is defined as the sum of the value of crops consumed, the value of meat retained, sales of crops, sales of livestock, recorded sales of beer, wages received in the reserve, other local cash receipts, plus wages or remittances sent from absentee workers.

Disposable income is gross income *less* stock bought, wages paid, cattle tax, fertilizer, ploughs and parts, scotch carts or parts and bicycles or parts.

Family Size Data

Residence within the household (polygamous families are treated as one household) is defined in terms of the days spent in residence in the Reserve. Using the weights set out in the earlier article, the measure of family size used is given by:

$$S = \frac{\Sigma n_j w_j}{365}$$

where n_j = number of days of residence of $_j$th age and sex group

w_j = appropriate weight of $_j$th age and sex group.

Table 1 sets out the main attributes of the sample. Average income and expenditure per household are shown, along with average income and expenditure per consumer unit. The average number of days of residence of men, women and children per family was 2,272 days (Chitowa 3,911) which reduced to 1,571 days in consumer units (Chitowa 2,794 units). On this basis, the number of persons per household was 6.2 and the number of consumer untis per household was 4.3 (Chitowa 10.7 and 7.6). Visitors to households are included.

In summary, the average household account was made up as follows:

Value of produce retained (incl. meat)	sh.	522.6
Sales of farm produce		119.0
Receipts from other services and wages		577.4
Gross household income		1219.0
Farming inputs	—	66.4
Disposable household income		1152.6

Disposable income in Chitowa Purchase Area was Sh. 2250, almost double this amount.

Table 1

AVERAGE FAMILY INCOME AND EXPENDITURE: CHIWESHE RESERVE 1960/61

(shillings)

	Per Family	*Per Consumer Unit*
1. Maize retained	286.5	86.5
2. Groundnuts retained	105.9	31.0
3. Millet retained	63.6	18.5
4. Meat bought and retained	50.9	12.2
All food retained	522.6	151.5
5. Maize bought	50.7	13.0
6. Milling expenses	5.7	1.6
Total maize consumption	342.9	101.1
7. Tea	7.5	2.4

8.	Sugar	45.2	14.2
9.	Margarine	2.6	0.9
10.	Bread	37.8	11.8
11.	Fish	7.0	2.5
12.	Coffee	0.9	0.3
13.	Salt	2.8	1.0
14.	Tinned milk	3.7	1.1
15.	Beer	0.3	0.3
	Total bought food	164.1	49.1
	Total all food	686.8	200.6
16.	Poll tax	25.2	7.1
17.	School fees	68.7	15.2
18.	Bus fares	12.8	4.3
19.	Paraffin	8.9	3.1
20.	Clothes	84.7	25.0
21.	Soap	21.5	6.0
22.	Cooking oil	2.1	0.7
23.	Household goods	1.8	0.4
24.	Other goods	144.4	38.5
	Total bought goods	370.3	100.5
25.	Farm inputs	9.5	1.1
26.	Stock bought	20.6	7.5
27.	Cattle tax	13.4	3.9
28.	Fertilizer	22.9	7.1
	Total household goods	1057.0	301.1
	Total Expenditure	1123.5	320.4
	Disposable Income	1152.6	320.8
	Gross Income	1219.0	340.4

Results

Table 2 sets out the results for the regression of 28 commodity items on gross family income, when family size in consumer units is held constant. Compared with the Chitowa sample of farm households, this data from Chiweshe Reserve shows a far greater ordering by income levels. The multiple correlation coefficients obtained are particularly high for this sort of invesitgation and a large number of the individual items examined reach the 5 per cent level of significance or greater. As an additional independent variable, family size does not add significantly to the goodness of fit of a majority of the individual equations, although some important items like total maize consumption and total food consumption are ordered by family size. Bigger families spend more on school fees, soap and household goods which seem plausible, but it is not entirely clear why bigger families should have higher levels of purchased farm inputs and cattle tax. Large polygamous households tend to be associated with village headmen and/or Master Farmers, and this may be the influence coming through in farm inputs and cattle numbers.

At this stage, a tentative examination of Engel Elasticities indicates that food items are all well below unity and taking 50 to 60 per cent of the extra shilling of income at the arithmetic mean. Margarine, coffee and tinned milk appear to be the luxury foods. Other luxury items appear to be locked up in the category "other expenditure" which includes a large number of odd items, especially consumer durables, which were bought by only a few families in the period analysed. On the basis of the results in Table 2 there appears to be a considerable "savings" element as income rises, but judgement on this should await further analysis.

Table 2

RESULTS OF REGRESSION TESTING INFLUENCE OF FAMILY SIZE

$(X_i = a + b_i Y_G + c_i S)$

		b_i	c_i	E_i	R^2
1.	Maize retained	.1534**	3.06	.652	.453
2.	Groundnuts retained	.0415**	2.92	.478	.176
3.	Millet retained	.0461**	—2.09	.884	.244
4.	Meat bought and retained	.0247	2.07	.592	.056
	All food retained	.2757**	13.22	.643	.559
5.	Maize bought	.0011	14.78**	.027	.173
6.	Milling expenses	—.0001	.57		.073
	Total maize consumption.	.1543**	18.41**	.548	.545
7.	Tea	.0026*	.86*	.431	.162
8.	Sugar	.0179**	.47	.483	.232
9.	Margarine	.0021**	— .33	1.004	.099
10.	Bread	.0202**	— .13	.652	.328
11.	Fish	.0023	— .66	.406	.025
12.	Coffee	.0008**	— .08	1.111	.159
13.	Salt	.0007*	— .07	.306	.041
14.	Tinned milk	.0056**	— .49	1.818	.201
15.	Beer	.0002	— .06	.663	.028
	Total bought food	.0531**	14.84**	.395	.318
	Total all food	.3288**	28.06**	.584	.673
16.	Poll tax	.0069*	— .19	.338	.064
17.	School fees	.0260	10.56*	.461	.120
18.	Bus fares	.0072*	1.78	.683	.117
19.	Paraffin	.0008	.01	.113	.007
20.	Clothes	.0439**	.41	.633	.167
21.	Soap	.0010	1.90**	.058	.096
22.	Cooking oil	.0003	.04	.153	.006
23.	Household goods	.0003	.84**	.025	.159
24.	Other goods	.2729**	—28.60	2.303	.257

	Total bought goods	.3596**	—13.25	1.184	.420
25.	Farm inputs	.0097	12.28**	1.244	.354
26.	Stocks bought	.0083	— 4.29	.493	.017
27.	Cattle tax	.0016	1.42**	.264	.138
28.	Fertilizer	.0331**	3.35*	1.761	.332
	Total household goods	.6884**	14.81	.794	.830
	Total Expenditure	.7412**	30.86	.804	.863

Significance level: 5 per cent *
Significance level: 1 per cent **

Most economic projection work requires income elasticities calculated on a per capita basis, and this is examined next. Table 3 sets out the estimates for the Engel Elasticities only, for the following three per capita hypotheses about the definition of family income and the size of family:

(a) That expenditure per consumer unit is a semi-logarithmic function of *disposable* income per consumer unit,

(b) That expenditure per consumer unit is a semi-logarithmic function of *gross* income per consumer unit,

(c) That expenditure per *person* is a semi-logarithmic function of gross income per person.

In terms of R^2 (goodness of fit) there is very little to choose between these 3 variants of the basic hypothesis. Compared with Table 2, the R^2 levels are slightly lower throughout. On the other hand, the number of individual items which reach the 5 per cent level of significance is greater than in Table 2 and a large proportion of all items expressed on a per capita basis vary in an observable way with changes in income. Improvements in this respect can be seen in tea, fish, salt, beer, bus fares, paraffin, soap and cooking oil.

The estimates of the income elasticities have been increased considerably in moving from Table 2 to Table 3. The three variants in Table 3 do not give markedly different results in this respect, hence it is convenient to discuss these together too. Food items retained within the household now increase proportionately with income (at the arithmetic mean) and food items purchased generally show an expenditure propensity greater than unity. This is highly plausible in view of the fact that the sample includes households on the point of starvation right through to the reasonably affluent.

Table 3

RESULTS OF REGRESSIONS WITH PER CAPITA DATA

$$\left(\frac{X_i}{S} = a + b_i (\log) \frac{Y}{S}\right)$$

		Engel Elasticities (see text)		
		(a)	(b)	(c)
1.	Maize retained	1.071	1.052	1.113
2.	Groundnuts retained	.801	.787	.882
3.	Millet retained	1.099	1.067	1.118

4. Meat bought and retained	1.016	.956	1.127
All food retained	1.008	.985	1.064
5. Maize bought	.277	N.S.	N.S.
6. Milling expenses	.601	.557	.622
Total maize consumption	.961	.938	1.006
7. Tea	1.077	1.097	1.144
8. Sugar	.901	.898	.997
9. Margarine	1.460	1.395	1.399
10. Bread	1.121	1.087	1.159
11. Fish	1.446	1.363	1.542
12. Coffee	1.356	1.286	1.376
13. Salt	1.125	1.053	1.191
14. Tinned milk	1.383	1.302	1.253
15. Beer	2.759	2.723	2.807
Total bought food	.855	.824	.916
Total all food	.970	.946	1.028
16. Poll tax	.376	.452	.502
17. School fees	N.S.	N.S.	.659
18. Bus fares	1.635	1.580	1.700
19. Paraffin	.933	.936	1.060
20. Clothes	1.009	.954	.941
21. Soap	.489	.535	.546
22. Cooking oil	.790	.711	.767
23. Household goods	N.S.	N.S.	N.S.
24. Other goods	1.589	1.500	1.339
Total bought goods	1.098	1.053	1.025
25. Farm inputs	—	N.S.	N.S.
26. Stock bought	—	N.S.	N.S.
27. Cattle tax	—	.648	.732
28. Fertilizer	—	1.664	1.589
Total household goods	1.013	.981	1.027
Total Expenditure	—	.993	1.027

N.S. = Not significant at 5 per cent level.

Over all food, the estimated coefficients are probably not significantly different from unity. It should ge noted that sugar with a coefficient less than unity has a relatively high weighting in the aggregation of bought food. Of the remaining commodities, fares have the highest elasticity, while some of the virtually compulsory items such as poll tax, school fees, soap and cooking oil all have a relatively low income elasticity of demand. In general, no "savings" are apparent in subsistence households when income and expenditure are expressed in per capita terms. Again, this conclusion is consistent with a Lewis type hypothesis[1] that the subsistence family expands food production as necessary to maintain existing numbers of the rural household at a given standard.

The results comparing the disposable income hypothesis (a) with the gross income hypothesis (b) indicate little difference between the choice of independent variable. This is likely to be exploited by the very low level of subsistence farming inputs (5.3 per cent of gross income as defined) in the sample, and the estimated regression coefficients do not reflect the small difference between disposable income and gross income. To maintain consistency with earlier work, gross income is henceforth chosen as the independent variable to be used.

Turning next to the situation where family size data is missing, Table 4 summarises the results of regressing each expenditure item on gross income per household alone.

The two hypotheses compared are:

(a) That expenditure per family on a good is a linear function of gross income per family,

(b) That expenditure per family is a semi-logarithmic function of gross income per family.

Table 4

RESULTS OF REGRESSIONS WITH HOUSEHOLD DATA ONLY

$(X_i = a + b (\log) Y)$

	Engel Elasticities (see text)	
	(a)	(b)
1. Maize retained	668	.724
2. Groundnuts retained	.519	.585
3. Millet retained	.836	.893
4. Meat bought and retained	.653	1 .052
All food retained	.681	.771
5. Maize bought	N.S.	N.S.
6. Milling expenses	N.S.	N.S.
Total maize consumption	.629	.681
7. Tea	.603	.677
8. Sugar	.499	.507
9. Margarine	.807	.710
10. Bread	.648	.678
11. Fish	N.S.	N.S.
12. Coffee	.959	1 .001
13. Salt	N.S.	.372
14. Tinned milk	1 .622	1 .310
15. Beer	N.S.	N.S.
Total bought food	.530	.556

Total all food	.645	.720
16. Poll tax	.327	.429
17. School fees	.693	.936
18. Bus fares	.891	.861
19. Paraffin	N.S.	N.S.
20. Clothes	.640	.789
21. Soap	N.S.	.347
22. Cooking oil	N.S.	N.S.
23. Household goods	.111	N.S.
24. Other goods	2.005	1.707
Total bought goods	1.130	1.108
25. Farm inputs	3.185	2.687
26. Stock bought	N.S.	N.S.
27. Cattle tax	.309	.364
28. Fertilizer	1.539	1.522
Total household goods	.815	.856
Total Expenditure	.832	.870

As in previous analyses with this sample the main expenditure categories are well ordered in terms of gross income, and the goodness of fit does not fall far short of that shown in Table 2. The estimates of the Engel Elasticities are also fairly similar to those set out in Table 2, although slightly higher throughout. The relative position of each good is unchanged and hence a consistent policy decision could be made with the information in Table 4 if no other information were available. The linear function gives slightly better R^2 than the semi-logarithmic function, but slightly lower estimates of the Engel Elasticities. Apparently the different weighting of the extreme observations of gross income in the semi-logarithmic function gives a slightly steeper slope to the curve at the arithmetic mean.

The next hypothesis to be tested was whether "scale" effects were present in the sample of households. Equation (7) was fitted to the 100 households in the sample and the c_i coefficient examined for significant changes in expenditure per head independent of changes in gross income per head. As in the Chitowa sample of households, only a few significant relationships were found in this sample to justify a scale hypothesis. The following expenditure per consumer unit were found to show some relationship with family size: sugar, salt, total bought food, total all food, paraffin, farm inputs and total expenditure. Only farm inputs had a coefficient significant at the 1 per cent level, and its sign was positive contrary to general expectations on food expenditure items. It must be concluded that there is a suspicion of scale effects emerging in this sample of data, though whether a larger sample or even more accurate recording would detect it more frequently is difficult to judge. If these affects are assumed to be present, then the estimated Engel Elasticities in Table 3 are probably a little too high as economies in consumption among large families reduce the rate of increase of consumption with high income when family size and incomes are positively correlated.

Finally, Leser's additive and homoscedastic function (equations 8 and 9) is examined. The estimated regression coefficients are not presented in detail, but Table 5 shows the Engel Elasticities calculated for all those items which reached the 5 per cent level of significance in the regressions. The (a) column shows the elasticities estimated from the linear form of the ratio equation and the (b) column shows the elasticities estimated from the semi-logarithmic form of the ratio function. By expressing the data in the ratio form, the goodness of fit of the estimated equations drops considerably, hence one difficulty with this more "perfect" specification of the Engel curve is a loss of predictive power in the results. In terms of R^2 and the estimated Engel elasticity, the results of the linear and semi-logarithmic forms of the equation are hard to tell apart. One advantage of the semi-logarithmic form is that truncation errors are avoided in computer calculations with ratios, though this can normally be handled by a scaling factor.

The ratio method estimates of the elasticities compare closely with the per capita results set out in Table 3 although they are systematically lower by about 10 points throughout. The ratio estimates do have desirable statistical and theoretical properties which the semi-logarithmic equations of Table 3 do not have, and hence must be considered as being at least as good if not better than the per capita equations. They suggest that the food elasticity in the sample is less than unity, and that of non-food goods is no greater than unity. Finally, there is some indication of "savings" as incomes increase. A final choice between the two methods suggested can only be made on the evidence of further exploratory work with data from under-developed countries.

Table 5

RESULTS OF REGRESSIONS USING LESER'S RATIO METHOD

$$\left(\frac{X_i}{Y} = a + b_i (\log) Y\right)$$

		Engel Elasticities (see text) (a)	(b)
1.	Maize retained	.788	.764
2.	Groundnuts retained	.649	.539
4.	Meat retained and bouhgt	1.311	1.646
	Total food retained	.855	.869
	Total maize consumption	.755	.735
8.	Sugar	.576	.479
10.	Bread	.762	.769 N.S.
13.	Salt	.454	.265
	Total bought food	.645	.610
	Totsl all food	.804	.807
16.	Poll tax	.539	.455
19.	Paraffin	.228	—.165
21.	Soap	.504	.436
22.	Cooking oil	.257	—.077

24.	Other goods	1.394	1.221
	Total bought goods	1.071 N.S.	1.048
25.	Farm inputs	2.074	1.900
27.	Cattle tax	.446	.309
28.	Fertilizer	1.461	1.584
	Total household goods	.898	.892
	Total expenditure	.909	.907

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