ANALYSIS AND PROJECTION OF THE
DEMAND FOR SUGAR IN EAST AFRICA*

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The purpose of this paper is to attempt to measure the effects of
various variables on sugar consumption in East Africa and to
project consumption to 1970 by an analysis of time series data.
The study was prompted by several policy considerations.
Tanganyika and Kenya in their published plans for the years 1964-
1969 and 1964-1970, respectively, have indicated a substantial
increase in sugar production[1], and one sugar factory is under
construction and there are plans for two more in Uganda. At
present East Africa is nearly self sufficient in sugar production
and the substantial increase in production envisioned by 1970 will
involve a large exportable surplus, perhaps about 100,000 tons.
At present East Africa has a 10,000 ton quota under the Commonwealth
Sugar Agreement and marketing arrangements must be made for the
balance of exports. The magnitude of the problem depends on how
fast internal consumption can be expected to grow. Uganda now has
a large exportable surplus and the problem of marketing will be
particularly acute for Uganda manufacturers. Suggestions have
been made concerning various ways to stimulate internal consumption,
among them a proposal for lowering the price to the consumer. An
analysis of the effect of price on consumption could aid in
determining whether such a policy would be effective.

The economic literature is filled with attempts to measure
demand and supply elasticities using time series data for the more
developed economies. To the author's knowledge no such attempt has
been made using East African data. The analysis of sugar consumption
in this paper illustrates the many problems which are likely to
arise in an analysis of the consumption of any commodity in East
Africa. The major problems occur because of the limited choice
of different types of price indices, the unreliability of data, and
the relatively short span of time for which any consistent time
series are available. Two conspicuous constraints on many types
of analysis are the lack of a consistent series for gross domestic
product before 1954 and the lack of any series for disposable income
for any of the East African countries.

The demand for sugar in East Africa is more amenable to
statistical analysis than the demand for many other commodities
in East Africa because of the existence of a fairly reliable
series

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1. See Government of Kenya, Development Plan 1964-1970, Nairobi,
Government Printer,1964 pp.51-52 and The United Republic of Tangan-
yika and Zanzibar, Tanganyika Five Year Plan for Economic and Social
Development, 1st July 1964-30th June, 1969, Volume I, Dar-es-Salaam
Government Printer, 1964, p.26.

on consumption and because of the nature of the supply function. In East Africa the supply of sugar effectively has been perfectly elastic with respect to price. The governments have always stood ready to import sugar from outside of East Africa and sell it in the local market at the prevailing (fixed) internal price. Thus all changes in consumption can be attributed to factors affecting the demand schedule for sugar consumption.[2]

The factors affecting the demand for sugar can be grouped into three categories: (1) disposable incomes, (2) the retail price of sugar, and (3) miscellaneous factors which result in a rising time trend of sugar consumption. Despite the fact that data on these factors are sparse and cover only a relatively short period of time, it was felt that a useful attempt could be made to measure the strength and relative effects of the various factors affecting sugar consumption.

A. The Data and the Model.

The gross domestic product at factor cost for the three East African countries for the years 1954-1963 is shown in Table III-1. In order to arrive at disposable income we subtracted all direct taxes, import duties, and excise taxes from gross domestic product at factor cost. The justification for subtracting export and import duties is that these duties have their incidence directly upon the consumer and thus theoretically must be regarded as having a similar effect on consumption patterns as direct taxes. In the case of import duties, it is generally true that the world supply of exports is in elastic supply with respect to the relatively small East African market while demand tends to be relatively inelastic with respect to price. With exports it seems reasonable to assume that the overall supply of exports is relatively inelastic with respect to price (although the supply of individual export commodities may not be so) and that demand is relatively elastic, the price of exports being set in most cases by the world market, independently of East African supplies.

One should also subtract corporate savings and depreciation and net transfer payments by households from gross domestic product at factor cost in calculating disposable income. Unfortunately, however, no reliable data on the magnitude of these items exist, and they were not taken into account.

The disposable income estimate should be deflated by some sort of price index to arrive at an estimate of _real_ disposable income. The only appropriate price indices which are available are:

    (1) The cost of living index (excluding rent): Kampala,
    (2) The index of retail prices in African markets: Kampala,
    (3) The price index for gross domestic product at factor cost: Uganda,[3]
    (4) The cost of living index (excluding rent): Nairobi,
    (5) The wage earner's index of consumer prices (retail price index): Nairobi,
    (6) The wage adjustment index: Nairobi,
    (7) The cost of living index (excluding rent): Dar-es-Salaam, and
    (8) The retail price index of goods consumed by wage earners in Dar-es-Salaam.

2. Technically, this means that the sugar demand schedule for East Africa is identifiable. See T.C. Koopmans, "Identification Problems in in Economic Model Construction," _Econometrica_, Vol.17 (1949), pp.125-144.

3. See Uganda Government, _The Real Growth of the Economy of Uganda , 1954-1962_, Entebbe, Government Printer, 1964, p.46.

The disposable income estimates were not deflated by the cost of living indices ((1),(4) (7) above) nor by the wage adjustment index((6) above) - which is merely the Nairobi cost of living index with the effects of price increases on alcohol and tobacco removed - because much of the rise in these indices may be attributed to increased import duties and to a rise in the cost of services. Since the effects of import duties on disposable income is taken into account by subtracting duties from gross domestic product at factor cost, it would not be appropriate to further deflate income by this factor. The calculation of the cost of living indices does not allow for changes in the quality of services although much of the rise in the cost of these services may be attributed to improvements in quality. For these reasons, the cost of living indices would tend to over-deflate disposable income. Another objection to the cost of living indices is that they are based largely on the expenditure patterns of middle income range European civil servants. The bulk of the income earned in Uganda and Tanganyika is earned by peasant farmers with very different expenditure behaviour.

The Uganda price index for gross domestic product at factor cost would be inappropriate since it is heavily weighted to show the changes in export prices. In view of these difficulties with the various other price indices, we elected to use the retail price indices in Kampala, Nairobi, and Dar-es-Salaam for the respective countries of Uganda, Kenya and Tanganyika. These indices, shown in Table III-1 are heavily weighted in favour of locally produced food crops. One of the disadvantages of these indices is that they measure urban retail price fluctuations which may not reflect rural price changes. In view of these difficulties, we decided to calculate estimates of both deflated and non-deflated disposable incomes. These are also shown in Table III-1.

The retail prices of sugar in the urban centers, Kampala, Nairobi, and Dar-es-Salaam, of the three East African countries shown in Table III-1 indicate a similar pattern of change. This has been mostly due to similar changes in the excise duty on sugar (See Table III-2). Retail prices in rural areas differ from those in the urban centers by an amount depending on the distance from the nearest sugar factory or, in the case of Kenya, depending on the distance from the nearest railhead, but increases and decreases in rural retail prices correspond in magnitude to those of urban prices. Economic theory tells us that the demand for a commodity is not dependent so much on the absolute price but rather the price of that commodity relative to the prices of all other commodities which compete for the consummer's purchases. Accordingly, the price of sugar was deflated by the retail price indices (See Table III-1).

The miscellaneous factors other than prices and income which affect the demand for sugar are difficult to measure. They include improvements in transportation and distribution facilities, changing habits, and increased knowledge. It was assumed that these factors would evidence themselves in a general overall rising trend of sugar consumption apart from changes in price and income. Accordingly, the basic equation used to determine the demand for sugar consumption was

$$(I) \qquad x = a_1 + a_2 \cdot z_2 + a_3 \cdot z_3 + a_4 \cdot z_4$$

where

x is a measure of sugar consumption

z_2 is a measure of disposable incomes

z_3 is a measure of the retail price of sugar, and

z_4 is a time variable .

The demand equation was fitted using conventional least squares regression techniques for each country. Ten observations were available in the case of Uganda and Kenya. Only nine observations were available in the case of Tanganyika since the 1963 sugar consumption in Tanganyika, which was abnormally low because of serious disruptions in the distribution system[4] was excluded.

The analysis was preformed under several different assumptions.

1. Two assumption on price and income elasticities and on the rate of increase over time were tested, namely
   a) that the price and income elasticities of demand for sugar consumption decrease with increasing levels of sugar consumption, and that the increasing trend in sugar consumption results in a constant absolute increase in per capita consumption over time; and
   b) that the price and income elasticities are constant and the trend factors result in a constant percentage increase in consumption per unit of time.

If the first of these assumptions is used then the regression equation may be written

(II) $y = a_1 + a_2 \cdot \log_e w_2 + a_3 \cdot \log_e w_3 + a_4 \cdot w_4$

Where

(III) y = sugar consumption
w_2 = disposable income
w_3 = the retail price of sugar
w_4 = time

Under the second assumption the demand equation may be written

(IV) $\log_e y = a_1 + a_2 \log_e w_2 + a_3 \log_e w_3 + a_4 w_4$

where the variables w_2, w_3 and w_4 have the same meaning.[5]

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4. The new Kilombero factory in Tanganyika unexpectedly found it necessary to shut down in February of 1963 due to luck of supplies of ripe cane. The Tanganyika government, caught off guard, attempted to make up the deficit by importation through its co-operative marketing organization Cosata. There were substantial delays in delivery until June. In the meantime, reserve stocks were depleted and many consumers, especially in southern Tanganyika went without sugar for long periods of time.

5. Let $\delta y/\delta w_2$, $\delta y/\delta w_3$, and $\delta y/\delta x_4$ represent partial derivatives.

From equation (a) one obtains the following:

Income Elasticity $= \dfrac{\delta y}{\delta w_2} \cdot \dfrac{w_2}{y} = \dfrac{a_2}{y}$

Price Elasticity $= \dfrac{-\delta y}{\delta w_3} \cdot \dfrac{w_3}{y} = \dfrac{-a_3}{y}$

Rate of increase of sugar consumption per unit of time $= \dfrac{\delta y}{\delta x_4} = a_4$

From equation (b) one obtains the following:

Income Elasticity $= \dfrac{\delta y}{\delta w_2} \cdot \dfrac{w_2}{y} = a_2$

Price Elasticity $= \dfrac{-\delta y}{\delta w_3} \cdot \dfrac{w_3}{y} = -a_3$

Percentage rate of increase of sugar consumption per unit of time $= \dfrac{\delta y}{\delta x_4} \cdot \dfrac{1}{y} = a_4$

(2)   Sugar consumption and disposable incomes were measured
      a)   on an aggregate or total basis, and
      b)   on a per capita basis by dividing the aggregate figures
           by population estimates for each year.

Aggregate and per capita incomes are both given in Table III-1
while Table III-3 contains aggregate and percapita estimates of
       sugar consumption. If per capita data are used, this involves
an implicit assumption that population growth in and of itself
does not influence per capita sugar consumption, i.e., given
the change in per capita sugar consimption between any two years
caused by per capita income, the retail price, and trend factors, a
ten per cent rise in population results in exactly a ten per cent rise
in total sugar consumption. Whereas if aggreagate data are used that
same ten per cent increase in population may give rise to less than
a ten per cent increase in consumption, depending on the magintude of
the coefficient a_4 of the time variable. The influence of population
is included in the time variable.[6]   If
population tended to increase more rapidly among the poorer segments
of the population per capita consumption might fall even after the
effects of changes in per capita incomes, price, and time have been
considered.

(3)   Two assumptions regarding the deflation of prices and income by
the retail price index numbers were considered:

      a) Incomes were both deflated and non-deflated, and
      b) The retail price of sugar was both deflated and non-deflated.

An increase in the general price level given constant money incomes
and a constant retail price of sugar, will decrease real incomes _/, One
would expect a downward adjustment in consumption due to the real income
effect and a rise in consumption due to the price effect. Neglecting
to deflate incomes or the retail price assumes some sort of extreme
money illusion, but because of our lack of confidence in the retail price
index numbers we felt that better fits might be obtained if price and
income data were not deflated. In addition the use of several alternative
measures might enable one to reduce the degree of multicollinearity
between the independent variables.

      All of the above assumptions were tested and this entailed
sixteen different regressions for each country. The fit of each
regression was determined by the coefficient of determination and the
effect of each variable on consumption was tested to determine whether
the effect was significantly different from zero.

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6. Because of the nature of the population data, the inclusion of a
population variable as well as a time variable in the demand
equation would be redundant since the population data for all three
countries is based on a constant percentage rate of increase
determined from the inter-censal rate of increase as determined from two
censuses which were held in each country.   Thus there is a perfect
linear correlation between the natural logarithm of population and
time. The coefficients of the time and population variables would be
indeterminate and the matrix of the normal equations would be
singular.

      _/   and decrease the relative price of sugar.

B) Regression Results.

There seemed to be little difference whether the assumption of constant elasticities was used or the assumption of declining elasticities was used. The significance levels and the coefficients of determination were about the same for all regressions under each of the assumptions, Since the assumption of constant income elasticities and a constant rate of increase over time permit an easy translation of the coefficients of the regression equations into price and income elasticities and the percentage rate of increase over time, we will confine our discussion to the results obtained under this assumption.

Table III-4 contains the regression which gives the best fit (the highest coefficient of determination) for each country when consumption and income are measured on a per capita basis and when they are measured on an aggregate basis. The regressions resulting in the second best fit are given also

   a) if the best fitting regression contains negative price or income elasticities,
   b) if the second best fitting regression contains less correlation among the independent variables, or
   c) If the second best fitting regression has significant variables which are not significant in the best fitting regression.

All regressions not included in Table III-4 either give substantially the same or poorer results, i.e., poorer fits, more correlation among the independent variables, negative price and income elasticities, fewer significant variables, or some combination of these.

None of the regressions indicate that either price or income effects are significantly different from zero, although for Tanganyika, the income elasticity coefficients are barely not significant with a 5 per cent critical region. If the critical region is increased to 10%, significance is obtained for many of the Tanganyika income coefficients. The general lack of significance is in spite of the fact that the price and income elasticities for some of the regressions are quite large and the coefficients of determination are very high with the exception of the Uganda regressions where consumption and income are measured on a per capita basis. The price and income coefficients, however, have very large variances due to the small number of degrees of freedom and the presence of correlation among the independent variables. The small number of degrees of freedom is caused by the lack of data. In every case where the income elasticity is above 0.3, there is significant correlation between income and time. That is incomes have been rising over time, and it is impossible to separate out statistically the effects of income and time. The income regression coefficients and the time regression coefficients are not efficient estimates of the true coefficients, and if the true time coefficient is large, it may inflate the income coefficient or vice versa because the two variables move together. The price elasticities are quite small except in the case of Kenya where they are above 0.4. This again is probably due to a high degree of correlation between price and time, in this case a negative correlation between price and time. The correlation is barely not significant.

The time variable is always significant for Kenya and Tanganyika and never significant for Uganda. The lack of significance for Uganda is due to a high variance of the time regression coefficient resulting from a poor fit if a per capita basis is used and from a very high degree of correlation among all the independent variables if an aggregate basis is used.

C. Interpretation of the Results.

It seems that the only independent variable which has any significance in any of the regressions is time. The trend factors are highly significant while the effects of the retail price of sugar and disposable incomes are very weak. The fits obtained by using a regression containing only time as an independent variable are nearly

as good as the fits obtained by including all three independent
variables in the regression. The addition price and income variables
does not substantially improve the fits.
Income and price-elasticities are relatively high only when there is
a high degree of correlation
between those variables and time. Before we conclude, however,
that incomes and the retail price of sugar have no significant
influence on sugar consumption, let us consider the possible sources
of downward bias in the price and income elasticities.

Bias may be caused by serially correlated error terms. In
order to test for serial correlation we used the von Neuman ratio.[7]
The results were negative in all cases. Thus serial correlation
cannot be regarded as a serious problem.

A second source of bias may be due to errors in the independent
variable. Least squares estimates are not biased only if all errors
occur in the dependent variable. Certainly, there are fairly significant
errors in the estimates of disposable incomes, one of the independent
variables. This tends to impact a downward bias to the income
elasticities. There are no errors in the retail price of sugar
except in so far as there are errors in the price index which is used
to deflate the price of sugar. However, the deflation of the retail
price of sugar does not result in very different price elasticity
estimates from those obtained when price is not deflated.

Thirdly, the nature of the retail price index used to
deflate disposable incomes and the retail price of sugar may
contribute to downward bias in the estimates of income and price
elasticity. These index numbers are subject to wide fluctuations
due to temporary food shortages in the major towns. There is
reason to believe that fluctuations in prices in the rural areas are not
nearly so great. If this is so, then per capita incomes and retail
prices would be overdeflated when the retail price index is high
and under-deflated when the retail price index is low. The fluctuations
in deflated incomes and retail prices would be exagerated. There is
no systematic difference in the magnitudes of the income and price
elasticities, however, if price and incomes are deflated on the one
hand and not deflated on the other. This leads one to suspect that
this effect is probably not very important.

The sources of bias do not seem to be very strong. Thus it
is probably safe   to say that the income and price in any
year do not significantly affect per capita sugar consumption at
least over the range of income, price, and time covered by the data.
This conclusion is bolstered by several observations. Most of the
sugar consumed in East Africa is used for sweetening the habitual cups
of tea and other drinks by the ordinary peasant and in home beer
making. There is no close substitute for these purposes except
jaggery (gur) which is produced in small quantities in East Africa.
The price elasticity is probably small for this reason. Since the
habit of tea drinking and beer drinking seems to be deeply ingrained,
one of the last things dropped from the peasants budget is probably
sugar. Since the food consumption habits of most peasants are usually
simple and notoriously stable in East Africa, it is likely that increases
in income do not immediately give rise to increases in sugar consumption.
A large part of any increase in incomes is likely spent on such things
as clothing, radios, ciggarettes, bicycles, petrol, etc., relative
luxury goods. These observations, it must be emphasized, are only
casual and are not supported for the most part by any careful
sociological study or long term budget survey.

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7.   The von Neuman ratio is $N\Sigma(u_t - u_{t-1})^2/(N-1)\Sigma u_t^2$
      where u_t is the deviation of the observation at time t
      from the regression line. The value of the ratio is $2N/(N-1)$
      if there is no serial correlation in the residuals. The distribut-
      ion of the von-Neuman ratio depends on the value of N. Tables
      may be found in B.I. Hart, "Significance Levels for the Ration
      of the Mean Square Successive Difference to the Variance,"
      Annals of Mathematical Statistics, Vol.13 (1942),
      p.446, and are reprinted in R. Ferber and P.J. Verdoorn, Research
      Methods in Economics and Business, New York, the Macmillan
      Company, 1962, Appendix, Table 15, p.556.

Although changes in sugar consumption may be relatively unaffected by price and income for any given year, this is not to say that if income rises over a long period that consumption would be the same as if income did not rise over the same period. Per capita (non-deflated) disposable incomes have risen steadily over the period 1954-1963 for Kenya and over the period 1954-62 for Tanganyika at respective average annual rates of 2.8 per cent and 2.9 per cent per annum. Per capita sugar consumption has risen at an average annual rate of 4.8 per cent for Kenya and 5.1 per cent for Tanganyika. On the other hand per capita (non-deflated) disposable incomes have changed very little for Uganda over the period 1954-63, and the average annual rate of per capita sugar consumption has only been 1.7 per cent. The difference in rates of increase of consumption for Kenya and Tanganyika may be due to the consistent rises in disposable incomes which are lacking in Uganda. These observations may be reconciled with our earlier conclusions if we hypothesize that

a) there is a lagged reaction to income changes, i.e. an income change in year t has its effects on consumption in years t +1, t+2. t+3, etc., or

b) any initial change in income is viewed as temporary and some basic consumption patterns are not changed until the change in income had been maintained for several years.

The second of these hypotheses seems reasonable in an East African context. Patterns of spending especially on food items tend to be stable, extra incomes initially go on the relative luxury goods mentioned above, but if the higher income patterns are maintained, then habits and life styles regarding food consumption may change. The first of the hypothesis above may be true if higher levels of income are associated with higher investment in transport and distribution facilities. As these improved facilities come into operation, the increased availability to the consumer may stimulate consumption.

Neither of these hypotheses could be tested adequately with the limited data available. We attempted some regression with consumption depending on incomes of the previous year, but the fits were extremely poor and some of the price and income elasticities were negative.

D. Projections

A projection based on a regression equation will not necessarily be as unreliable and have the same biases to which the individual elasticity coefficients are subject. A lack of reliabilitty due to multi- colinearity for example, is not nearly so important in making projections since although it might be difficult to separate out the effects of each of two or three variables in an equation, the total effect is estimated much more accurately. A projection based on a regression with multicolinnearity present will be relatively accurate if the variables are expected to move approximately at the same relative rates in the future as has been the case in the past. If the regression coefficients for price and income are under-estimates because increases and decreases in the estimates of prices and income exceed variations in the actual values of prices and incomes, then that part of the variation in consumption which should be attributed to income and price will actually be attributed partly to the time variable. If the time variable is included in the projection equation, these effects will be included to some extent in the projections.

The projections, however, will be subject to the same biases as the regression coefficients if there are errors in the independent variables. These biases may tend to cancel out among the different coefficients or they may reinforce each other in making projections.

/ increase of.

For example, if price and income elasticities are both subject to
downward bias, then if income is expected to rise and price is expected
to rise, the biases will tend to cancel each other out. Since the
projections below are based on an assumption of rising incomes and a rising
retail price of sugar, and since the income and price elasticity estimates
are probably biased downward if anything, the projections are probably
not subject to any reinforcement of the biases   :   ; of the
individual regression coefficients .

In order to make projections of the total consumption of sugar
for Kenya, Uganda, and Tanganyika, we made the following assumptions:

(1)   Gross domestic product will increase at an annual rate of 6.5
per cent in terms of current prices, and, alternatively at 4.5
per cent.
(2)   Population rates of growth per annum will be
        a) 2.5 per cent in Uganda
        b) 3.0 per cent in Kenya, and
        c) 2.2. per cent in Tanganyika. [8]
(3)   The retail price indicies will rise at the rate of 1 per cent
per annum in all three East African countries.[9]
(4)   Because of gradual increases in excise taxes, the retail price
of sugar will rise at the rate of 2 per cent per annum in all three
countries.
(5)   The sum of export duties, import duties, and direct taxes (x)
will rise along with GDP according to the following regression equations:
        (a) x = 17.064 + .804 GDP for Uganda, and
        (b) x = -6.738 + .924 GDP for Kenya and Tanganyika,[10]
where all taxes and GDP are measured in £ millions.

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8. The rate of population growth assumed in the Kenya six-year develo-
pment plan (1964-70) is 3.1 per cent, and that assumed in   Tanganyika
is 2.2. per cent. See Government of Kenya, op.cit., p.129 and The
United Republic of Tanganyika and Zanzibar, op.cit., p.8.
The rates above also compare with the intercensal rates of population
growth of 2.5 per cent in Uganda (1948-59), 3.2. per cent in Kenya (1948-62),
and 1.75 per cent in Tanganyika (1948-57) as estimated by J.G.C. Blacker,
"Population Growth in East Africa, "Economic and Statistical Review,
No.3. September, 1963, pp.vii-xii.

9. A 6.5 per cent rate of growth in gross domestic product with
a 1 per cent rate of growth in prices implies roughly a 5.5. per cent
rate of growth in real incomes. The Kenya plan (op.cit., p.129)
envisions a rate of growth in real output of 5.2. per cent and in the
Tanganyika plan (op.cit. p.8) a rate of growth of 6.7 per cent.

10.   Regression equations were determined for the three East African
countries using the data from Table III-1. The rate at which taxes
have been growing relative to GDP has been considerably lower in the
case of Tanganyika than in the cases of Uganda and Kenya. Since the
current Tanganyika plan envisions a much greater effort than that
reflected in past rates of growth, it was felt that taxes would have
to grow at a much faster rate than previously. Hence we used the
Kenya regression to project Tanganyika's revenues from direct taxes
and import and export duties.

The results of the projections using the above assumptions are shown in Table III-5. The following criteria were used in selecting from Table III-4 the regression equations for making the projections:
   a) Goodness of fit.
   b) Amount of correlation. among independent variables and
   c) High income elasticities of demand.
The reasons for using the first two criteria are obvious. The third criterion was choosen because the assumptions on which the projections were made imply that incomes will grow faster in the future than in the past, especially for Uganda. Because we feel that high continuous rates of growth of income are likely to have some lagged effects on consumption, the income elasticity coefficient should be given some prominence despite its lack of significance in regressions based on recent data.

For Uganda, all the regressions for which income and consumption are measured on a per capita basis were rejected for use in projections both because of the poor fits and because of the very low income elasticities. For Uganda, then we chose the first of the two regressions for which measurement is on an aggregate basis because[3] we felt the slightly better fit outweighed the slight difference in the income coefficient and the degree of correlation among the independent variables.

For Kenya, we chose the per capita equation giving the best fit, mainly because of the high income elasticity. The fit of the aggregate equations are slightly better but not much so. The other per capita equation has less correlation between income and time but the income elasticity is lower than that of the projection equation.

For Tanganyika, the equation based on per capita consumption and income data was chosen. The per capita equation has a slightly higher income elasticity and slightly less correlation between income and time, and the fit is the same as the aggregate equation.

The percentage rate of growth of total sugar consumption according to the projection equation is determined according to the following formula if consumption and income are measured on an aggregate basis:

$$
\begin{array}{l}
\text{Percentage rate of} \\
\text{growth according to} \\
\text{the projection} \\
\text{equation}
\end{array}
=
\begin{array}{l}
\text{Rate of growth of income variable} \\
\text{X} \\
\text{income elasticity } (a_2) \\
+ \\
\text{Rate of growth of retail price} \\
\text{of sugar} \\
\text{X} \\
- \text{price elasticity } (a_3) \\
+ \\
\text{Trend rate of growth } (a_4 \times 100)
\end{array}
$$

If consumption and income are measured on a per capita basis then rate of population growth must be added to the right hand side of the above equation.

The projections in Table III-5 are fairly sensitive to the assumptions made concerning the future growth rate of GDP, there being a difference of 5 to 12 per cent in the 1970 projections under the two different assumptions. The percentage rate of growth of total sugar consumption for Uganda to be expected over the period 1963-1970 is greater that the 4.2. per cent rate of growth experienced over the period 1954-1963. The percentage rate of growth in total consumption for Tanganyika should be roughtly about the same in the period 1962 -1970 as the 6.9 per cent rate of growth over the period 1954-1962. On the other hand, the rate of growth for Kenya over the period 1963-1970 will probably be somewhat less than the 7.9 per cent rate of growth experienced during the period 1954-63 but a bit.

greater than the 6.1 per cent growth rate of the period 1956-63. The years 1954-56 were ones of exceptional growth in sugar consumption. For East Africa as a whole the growth rate of sugar consumption should be about 8.8 per cent for 1963-70, higher than the 5.8 per cent rate for 1954-63. The year 1963 was a relatively bad year, however, and a comparison of the periods 1954-1962 and 1962-1970 results in respective growth rates of 6.4 per cent and 7.9 per cent.

E. Conclusions

The major factors affecting the growth of per capita sugar consumption are those which evidence themselves gradually over time rather than current incomes and the current price of sugar. Rising incomes probably do cause rises in consumption but the effects seem to be dissipated over a number of years so that they evidence themselves as a rising trend rather than a very clear correlation between incomes in a given year and consumption in that year. Other possible trend factors are (1) gradual improvement in communications and distribution facilities, (2) a change in the habit of using jaggery (gur) as a substitute for sugar, and (3) changing income distribution favoring low income households which tend to have higher individual income elasticities.

A major stimulus to high levels of sugar consumption is continuous availability. Where roads are bad or non-existent and where railroads are non-existent, shipments into an area tend to be sporadic because trips by lorry or human porterage will only be worthwhile if a full load or near full load can be carried, if items with a high value relative to weight can be carried at the same time, or if weather conditions are favourable. Because of storage difficulties due to bulkiness and perishability neither households nor traders will carry large inventories of these items to meet the continuous demand between shipments, but find it worthwhile to stock rather more easily stored commodities. Furthermore, consumption cannot be easily postponed as is the case with more durable types of consumer items. Besides transport communications, factors affecting the continuous availability of sugar supplies are the state of development of other sorts of communications and the number and size of distribution channels. Good communications and distribution facilities enable orders to be filled quickly if there are unexpected changes in demand or disruptions in the usual sources of supply. If there are long delays in filling such orders, some consumption will not be postponed and will be lost. Thus improvements in communications and distribution tend to increase the share of income spent on sugar and similar items even though per capita incomes may remain constant.

If the income elasticities of sugar consumption for low income earners are higher than the income elasticities of high income earners, and if the low income earners increase their share of total income then per capita sugar consumption will rise even in the absence of an increase per capita incomes. There is some evidence that such a shift in income distribution has been taking place in East Africa during the period analysed. Between 1954 and 1962, African per capita income in Kenya increased by about 24 per cent while non-African per capita income increased by something less, about 19 per cent. For the same period in Uganda non-African per capita income decreased by about 23 per cent while African per capita income decreased by only one per cent. African incomes comprise about 51 per cent in Kenya and about 77 per cent in Uganda of total incomes (including subsistence).[11]

11. See D. Ghai,"Some aspects of Income Distribution in East Africa", East African Institute of Social Research,Paper EDRP 52, Kampala, 1964, pp. 12 and 14.

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The main policy implication of our results is that a
price change is likely to have fairly little effect on the consumption
of sugar. A reduction in price will have little effect on
eliminating the pressure to find export markets for sugar if
production proceeds as planned. The East African countries, however,
can expect a faster rate of growth of local consumption than in
the past which will take up some of the projected excess production.

TABLE III- 1 (a)

Price and Income Data: Uganda

Year	Gross Domestic Product [a] (£ mill.)	Disposable Income [b] (£ mill.)	Retail Price Index	Deflated Disposable Income (£ mill.)	Population ('000)	Disporable Income Per Capita (£)		Retail Sugar Price (∅)	
						Deflated	Non-Deflated	Deflated	Non-Deflated
1954	128.73	119.71	139	86.12	5,749	14.98	20.82	37	52
1955	140.18	129.79	115	112.86	5,896	19.14	22.01	50	57
1956	141.58	131.11	113	116.03	6,046	19.19	21.69	45	51
1957	146.72	136.20	103	132.23	6,199	21.33	21.97	64	60
1958	146.39	134.67	103	130.75	6,356	19.80	21.19	56	60
1959	148.97	136.61	107	127.67	6,513	19.60	20.97 ·	56	60
1960	152.12	139.12	98	141.96	6,677	21.26	20.84	61	60
1961	157.33	143.97	123	117.05	6,845	17.10	21.03	49	60
1962	156.71	142.97	98	145.89	7,016	20.79	20.23	64	63
1963	176.10*	158.12*	100	158.12	7,190	21.99	21.99	63	63

TABLE III- 1 (b)

PRICE AND INCOME DATA: KENYA

Year	Gross Domestic Product[a] (£ mill.)	Disposable[b] Income (£ mill.)	Retail Price Index	Deflated Disposable Income (£ mill.)	Deputation (1000)	Disposable Income Per Capita (£)		Retail Sugar Price (¢)	
						Deflated	Non-Deflated	Deflated	Non Deflated
1954	158.02	140.25	90	168.37	6,733	22.97	20.68	70	58
1955	180.54	160.14	95	181.98	6,993	26.02	22.90	69	61
1956	193.15	171.42 1	57	150.89	7,209	26·43	23.78	62	56
1957	205.91	184.32	100	199.05	7,432	26·67	24,80	70	65
1958	208.10	185.52	100	200.34	7,652	26.11	24.24	62	58
1959	214.79	191.60	101	204.92	7,880	25.87	24.31	63	59
1960	225.51	203.06	103	213.74	8,115	26.34	25.62	62	59
1961	224.70	201.90	105	208.14	8,353	24.92	24.17	64	62
1962	244.09	219.10	108	219.10	8,595	25.49	25.49	65	65
1963	259.96*	233.73*	108	233.73	8,847	26.42	26.42	65	65

TABLE III- 1 (ɔ)

Price and Income Data: Tanganyika

Year	Gross Domestic Product [a] (£ mill.)	Disposable Income [b] (£ mill.)	Retail Price Index	Deflated Disposable Income (£ mill.)	Population ('000)	Disposable Income Per Capita (£)		Retail Sugar Price (∅)	
						Deflated	Non-Deflated	Deflated	Non-Deflated
1954	141.65	129.17	114	143.8	8,304	16.20	15.56	57	55
1955	146.74	133.69	113	150.6	8,454	16.68	15.85	63	60
1956	152.42	141.55	111	162.0	8,605	17.69	16.45	70	65
1957	162.36	150.90	119	161.0	8,759	17.23	17.23	70	70
1958	167.09	155.28	125	157.8	8,916	16.59	17.42	64	67
1959	177.11	164.14	116	179.8	9,076	18.64	18.09	66	64
1960	186.22	172.46	127	172.5	9,237	17.45	18.67	56	60
1961	188.66	174.88	126	176.3	9,421	17.51	18.56	58	61
1962	203.28	188.07*	127	188.1	9,607	18.30	19.58	60	64

NOTES AND SOURCES TO TABLE III-1

A. Notes.:

a. Monetary and Non-monetary Gross Domestic Product at Factor Cost.

b. Obtained by subtracting direct taxes, import duties, and export duties from GDP. Since the fiscal year in all three East African countries runs from June to June, it was assumed that the amount collected during each of the calendar years spanned by a fiscal year was one half of that collected during the fiscal year.

*   Provisional estimates.

B. Sources:

(1) Retail price indices from the Economic and Statistical Review (Quarterly), Table G.2.

(2) Retail sugar prices for 1963 supplied by the East African Common Services Organization, The Treasury.

(3) Tanganyika estimates of Gross Domestic Product, export and import duties and direct taxes for 1961 and 1962 from Government of Tanganyika, Budget Survey 1963-1964, Dar-es-Salaam, 1963, pp.3 & 20.

(4) Kenya estimates of Gross Domestic Product, export taxes, direct taxes, and import duties for 1962 and 1963 from Government of Kenya, Economic Survey 1964, Nairobi, 1964 pp.5 & 50.

(5) Uganda estimates of Gross Domestic Product, export taxes, import duties and direct taxes for 1962 and 1963 from Uganda Government, Background to the Budget, 1964-65, Entebbe, 1964, pp. 1 & 40.

(6) All other data for Uganda from Uganda Government, Statistical Abstract (Annual), Tables UB2, UM9, UN2, and UO4.

(7) All other data for Kenya from Government of Kenya, Statistical Abstract (Annual), Tables 12, 124(a), 131(a), and 136.

(8) All other data for Tanganyika from Government of Tanganyika, Statistical Abstract (Annual), Tables C.2, P.1, P.17, Q.1, and R.2.

TABLE III-2

Sugar Excise Duty: Uganda.

(Sugar excise duties have been the same in Kenya and Tanganyika as those in Uganda except for very brief periods).

Duty per Cwt.
(112 pounds)

From	To		Duty per Pounds
1946	April, 1954	Shs. 2/24	Shs. /02
April, 1954	May, 1957	5/60	/05
May, 1957	Jan., 1958	16/80	/15
Jan., 1958	May, 1958	15/14	/13.5
May, 1958	May, 1961	8/96	/08
May, 1961	July, 1962	12/23	/11
July, 1962	June, 1963	15/86	/14.2
June, 1963	-	17/92	/16

Sources: Laws of Uganda - 1953, Ordinance No. 18;
1954, Ordinance 9; 1957, Ordinance No. 12;
1958, Ordinance Nos. 10 and 25; 1961, Ordinance No.10;
1962, Ordinance No ; 1963, Act No. 40

TABLE III-3

Sugar Consumption: East Africa

Year	Total ('000 tons)			Per capita (lbs)		
	Uganda	Kenya	Tangan-yika	Uganda	Kenya	Tangan-yika
1954	50.1	48.8	33.8	19.5	16.1	9.1
1955	55.4	54.1	37.1	21.0	17.3	9.8
1956	57.1	64.0	39.5	21.2	19.9	10.3
1957	57.0	67.7	41.1	20.6	20.4	10.5
1958	61.4	69.8	40.6	21.6	20.5	10.2
1959	63.8	77.2	46.8	22.0	22.0	11.6
1960	62.5	86.8	49.6	21.0		12.0
1961	72.0	92.0	53.2	23.6	24.7	12.7
1962	65.7	98.8	57.7	21.0	25.7	13.5
1963	72.7	96.6	52.0	22.6	24.5	12.1

TABLE III-4
Regression Results

Country and Basis of Measurement of Consumption and Income ***	Income Variable Deflated	Price Variable Deflated	a_1	Income Elasticity a_2	Price Elasticity $-a_3$	Annual Per Cent Trend Increase a_4x100	Coefficient of Determination (R^2)	Significant Correlation between Independent Variables
Uganda Per Capita	No	Yes	3.28682	-.20	.08	1.6**	.507	Price and Time .69
	Yes	Yes	3.12782	.00	.08	1.5**	.500	Price and Time .69 Price and Income .91
Uganda Aggregate	No	Yes	10.89885	.80**	.14	2.4	.935	Price and Time .69 Price and Income .69 Income and Time .92
	No	No	10.96521	.81**	.14	2.4	.926	Price and Time .66 Price and Income .69 Income and Time .92
Kenya Per Capita	No	Yes	3.39241	.45	.46	3.7*	.936	Income and Time .84
	Yes	Yes	3.81773	.27	.44	4.5*	.931	None
Kenya Aggregate	No	Yes	11.31517	.27	.44	7.8*	.978	Income and Time .97
	Yes	Yes	13.71899	-.12	.52	6.3*	.977	Income and Time .96
Tanganyika Per Capita	Yes	No	2.22355	.82**	.18	3.4*	.985	Income and Time .68
Tanganyika Aggregate	Yes	No	10.52862	.84**	.17	3.7*	.985	Income and Time .69

* Coefficient Significant using a 5 per cent critical region. t test used to determine significance.

** Coefficient significant with a 15 per cent critical region using t test of significance.

*** Units of measurement as follows: (1) consumption - per capita lbs, aggregate '000 tons, (2) income - per capita £, aggregate £, (3) price ∅, and (4) time- 1959 = 0, 1963 = 9.

TABLE III-5

SUGAR CONSUMPTION

Projection to 1970.

Country	Rate of growth of GDP	Projection Equation	1970 Projected Sugar Consumption ('000 tons)	Percentage rate of growth from projection equation
Uganda	6.5	$x = 10.89885 + .80z_2 - .14z_3 + .024z_4$	122.20	7.1
	4.5		110.74	5.6
Kenya	6.5	$x = 3.39241 + .45z_2 - .46z_3 + .037z_4$	181.17	7.6
	4.5		171.77	6.8
Tanganyika	6.5	$x = 10.52862 + .84z_2 - .17z_3 + .037z_4$	112.90	7.6
	4.5		99.41	6.0