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STAGES OF DEVELOPMENT AND INTERNATIONALLY-AGREED
TRADE POLICIES.

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I. Summary

1. The central question to be considered is
whether differences in stage of development, among the many
developing countries in Africa, Asia, and Latin America,
should be recognized as a basis for differences in inter-
nationally-agreed trade and aid policies affecting them.

2. A country's stage of development is a concept
with several dimensions, not simply its per capita income.
Moreover, any single indicator of development is subject to
definitional and statistical inaccuracies. Gross domestic
product per capita in particular suffers from unavoidable
difficulties in estimating subsistance production, defini-
tional ambiguities in less developed economies, and biases
in using official exchange rates to convert national estimates
into a common currency. Therefore a country's stage of
development is represented in this paper by its composite
ranking, among a group of 48 developing countries, with re-
spect to four statistical indicators: (a) gross domestic
product (GDP) per capita, (b) share of GDP produced in non-
agricultural sectors, (c) energy consumption per capita,
(d) adult literacy rate.

3. Substantial differences in stage of develop-
ment do exist among developing countries. Countries near
the top of the list overlap with some of the poorest
European countries. Countries in the upper quarter have a
median per capita GDP four times that of countries in the
lower quarter, as well as twice as high a share of non -
agricultural product, energy consumption eighteen times as
great, and adult literacy six times as favorable. African
countries, including Uganda, Tanganyika, and Kenya, tend to
be concentrated in the bottom half of the list, and Latin
American countries in the top half, with Asian and Middle
Eastern countries distributed throughout the list. There is
a statistically significant difference between the median
ranking of 35 for all African countries and 9 for all Latin
American countries. There is almost a significant difference between
Latin America and Africa. Thus there are objective grounds
for special concern for   African countries, and to
a lesser extent Asian countries, relative to Latin America.

4. Dependence on total exports, as measured by
the ratio of exports to GDP, is only weakly correlated with
stage of development among the developing countries. The
direction of the correlation, moreover, is that countries
at a lower stage of development tend to be less dependent
on total exports. This relationship is maintained even
after adjustment for differences in size, as measured either
by population or by total GDP. Thus internationally-agreed
policies promoting total exports of all kinds from develop-
ing countries would have broadly similar effects on countries
at widely different stages of development, and if anything,
would tend to favor countries at a higher stage.

5. Dependence on primary exports, as measured by
the ratio of primary to total exports, is however clearly
and significantly correlated with stage of development among
developing countries. Countries at a lower stage of develop-
ment tend to be more dependent on primary exports. Thus

internationally-agreed policies improving markets for primary
exports would be especially favorable to countries at a
lower stage of development. Such policies would tend to
narrow inequalities among developing countries as well as
to promote accelerated development for all primary ex-
porters.

6. Uganda, Tanganyika, and Kenya, as compara-
tively small countries at a lower stage of development,
therefore have particular interest in internationally-
agreed policies promoting primary exports. Such policies,
even though extended non-preferentially to all countries,
would automatically give relatively greater assistance to
most African countries. Policies promoting exports of
tropical agricultural products would of course be especially
desirable. On the other hand, existing preferences for
some developing countries in access to markets in developed
market economies and centrally planned economies are
believed to be on balance unfavorable to East African ex-
ports. Thus all things considered, Uganda, Tanganyika,
and Kenya seem to have most to gain from internationally-
agreed policies promoting primary exports, especially of
tropical products, on a non-preferential basis.

7. At the same time, Uganda, Tanganyika, and
Kenya, along with other African countries at a lower
stage of development, probably would benefit little in the
near future from measures improving access to developed
and centrally planned markets for semi-manufactured and
manufactured products. The benefits of non-preferential
measures would accrue largely to developing countries at a
higher stage of development. Preferential measures,
varying in the degree of preference according to stage of
development, are conceivable, but would be awkward to ad-
minister, would open the door to preferences on political
grounds, and might still be ineffective in the near future.

8. Industrialization in countries at a lower
stage of development, such as Uganda, Tanganyika, and Kenya,
seems more likely to be promoted in the near future by
means of (a) import substitution in the domestic market,
and (b) preferential trade arrangements with other develop-
ing countries to provide larger markets for import substitutes.
Preferential trade arrangements are already internationally
accepted in the form of full customs unions, but preferences for
selected products traded among a limited number of develop-
ing countries would in some cases be more constructive.
Thus Uganda, Tanganyika, and Kenya may have much to gain
from international acceptance of a wider variety of pre-
ferential trade arrangements among developing countries.

9. Presently discussed schemes of financial sup-
port for developing countries suffering from export fluc-
tuations would have provided moderate benefits in the
past to Uganda, Tanganyika, and Kenya. Alternative schemes
related to primary exports rather than total exports, and
assessing contributions on the basis of stage of develop-
ment as well as export volume, would be more favorable.

10. Financial aid to developing countries is
bound to be based on a variety of criteria, of which stage
of development is only one. However, there is a strong case
for easier terms on financial aid to countries at a lower
stage of development, because of their greater difficulties
in expanding exports and the longer time needed to approach
a stage of self-sustaining growth. Thus Uganda, Tanganyika,
and Kenya, like most other African countries, have particular
interest in international agreement to raise the proportion
of grants and delayed-repayment loans in financial aid to
countries at a lower stage of development.

that the individual a_i are now allowed to vary. Then

$$(5) \qquad C_R = \sum_{j=1}^{m} c_{Ij} \cdot b_j$$

is the minimum total transport cost where

$$(6) \qquad c_{Ij} = \min_i c_{ij}, \quad \text{for} \quad j = 1,\ldots,n$$

Furthermore

$$(7) \qquad G_2 = C_{EA} - C_R$$

is the additional savings in transport costs which can be obtained by a reallocation of amounts supplied among the various points of supply (assuming that the total amount supplied is given) so that each point of demand receives its allotted amount from the point of supply where transport costs are the cheapest. The sum

$$(8) \qquad G = G_1 + G_2$$

is the total savings in transport costs which may be obtained both by allowing free movement of sugar across all borders and by allowing a reallocation of production among the various factories which manufacture sugar.

III. Application.

Our analysis centered on the year 1970. The estimated production of sugar in East Africa for the year 1970 is given in Table I. The maximum estimates differ from the minimum estimates largely because the production levels of four new

Table I.

Estimated Sugar Production and Consumption in East Africa for the Year 1970 ('000 long tons)

	Estimate of Consumption	Maximum Estimate of Production	Maximum Surplus	Minimum Estimate of Production	Minimum Surplus
Tanganyika	103	165	62	115	12
Kenya	171	205	34	98	-73
Uganda	111	180	69	160	49
Total East Africa	385	550	165	373	-12

Source: East African Common Services Organisation.

factories now in the planning stage are extremely uncertain, and there is the possibility that two minor producers in Tanganyika will engage in large scale expansions. In addition

to the gross estimates of production in Table I, we obtained
maximum and minimum estimates for each of the twelve factories
expected to be in operation by 1970 from the East African
Common Services Organization and the Tanganyika Ministry of
Commerce and Industry.

Estimated consumption for the year 1970 is also shown
in Table I. These estimates were based on an assumed rate
of growth of consumption of 8% in Kenya, 8% in Tanganyika, and
6% in Uganda.[3] These estimated rates of growth were determined
on the basis of the findings of Viton and Pignalosa (1).
The East African Common Services Organization, the East
African Railways and Harbours, and the Ministry of Commerce
and Industry in Kenya supplied estimates of consumption
by locality in all three territories for previous years.
The quality of these estimates varied, and some estimates
were in terms of sugar consumed in and around major population
centres while other estimates were in terms of administrative
areas (some containing more than one major population centre).
Using population data from (2) and (3) and a knowledge of the
relative prosperity and economic activity of each population
centre, consumption of sugar in an administrative district
was allocated to each population centre so that all consumption
estimates were in terms of population centers (towns of about
5000 population or more). The estimates of past consumption
of each population center and surrounding area were converted
into percentages of total consumption within the country in
which the center was located. These percentages were applied
to the total consumption estimates of each country fo 1970
to obtain estimates of tons of sugar consumed for each popula-
tion center for 1970.

Several problems arose in trying to determine the costs
of transporting sugar between each of the twelve factories
and each population center. Two producers in Uganda and two
in Tanganyika have negotiated special rates with the East
African Railways and Harbours. All other producers transport
their sugar by rail and by the East African Railways and
Harbours road services at higher rates. Furthermore the
Railways and Harbours administration is considering a change
in the rate structure so that rates correspond more closely
with costs. One major change which is being considered
is a modification of the taper. (The taper refers to a
declining average charge per mile as distance increases.)

5. The Uganda rate of growth was assumed to be lower
    because a large part of the population has a diet consist-
    ing mostly of steamed plantains (matoke) which has a
    high sugar content.

The present taper is such that the charge for each additional
mile declines with distance. The Railways and Harbours
administration, however, calculates that the actual cost
of each additional mile is the same regardless of distance,
although there is an initial cost of loading and handling
which means that the average cost per mile declines with
distance.

In view of these considerations, we assumed that by
1970 at least all East African sugar producers will have
negotiated special rates for the rail and road services
and that the taper will be modified to reflect the Railways
and Harbours estimates of their actual costs. In order
to obtain estimates of rates which would approximate the
rates under these assumptions, we calculated two regression
lines with total transport charge per ton as the dependent
variable and distance in miles as the independent variable,
using the special rates quoted in (4) for rail services
and road services as separate samples. The regression
equations provided estimates of road and rail charges with
the following properties:-

(1) The charge for each additional mile is constant
and the average charge per mile falls with distance.

(2) Assuming a random distribution of traffic over
the sample distances, the expected total revenue
obtained using the rates estimated from the re-
gression lines is equal to the expected total
revenue obtained under the special rates[4].

(a) $$R = w. \sum_{i=1}^{n} y_i = n.w.\bar{y} = T.\bar{y}$$

where $\bar{y}$ is the sample mean of the special rates. If y_i' for
$i = 1,...,n$ are the rates estimated by the regression
equation for the specially rated routes, then expected
total revenue using the estimated rates is :-

(b) $$R' = w. \sum y_i'$$

The rate y_i is calculated from the regression equation

(c) $$y_i' = a + b.x_i$$

where the regression coefficient a is determined from
the normal equation. (Footnote continued on next page)

4. Proof. Let T be the total annual traffic over the
sample distances x_i for $i = 1,...,n$ with sample rates
y_i for $i = 1,....n$. Let w_i, a random variable, be
the number of tons of traffic over the route with dis-
tance x_i. If $E(w)$ is the expected value of w_i, then
since the w_i are all similarly distributed $E(w_i) = w$.
The expected total transport revenue using the special
rates is

(d) $\quad a = \bar{y} - b.\bar{x}$

where $\bar{x}$ is the sample mean of the specially rated
distances. Substituting (c) and (d) in (b), we obtain

(e) $\quad R' = w. \sum (\bar{y} - b.\bar{x} + b.x_i)$

$\qquad = T.\bar{y} - b.T.\bar{x} + w.b. \sum x_i = T.\bar{y}$

From (b) we see that $R = R'$. Q.E.D.

The first property modifies the taper to correspond more closely
with costs, and the second property ensures that the expected
total revenue on the basis of the estimated rates equals total
costs, assuming that the traffic is randomly distributed over
all specially rated routes and that the special rates are expected
to cover total cost.

In order to determine the number of points of supply and
demand, a certain amount of aggregation was performed. Factories
which were within thirty miles of each other were combined into
one point of supply. The transport costs from the factories
which were combined to form an aggregated point of supply were
averaged and the average used as the transport cost from the
aggregated point of supply to each point of demand. In order
to reduce the number of points of demand, we took advantage of
the following theorem:

Theorem 1. If x^*_{ij} for $i = 1,\ldots,n$ and $j = 1,\ldots,m$ minimize
C in (1) subject to (2) and (3), then these same values of the
x_{ij} minimize

(9) $\quad C^o = \sum_i \sum_j (c_{ij} + \alpha_i + \beta_j). x_{ij}$

subject to (2) and (3).

This theorem means that any constant can be added to any row or
any column of the transportation cost matrix (c_{ij}) and the
solution remains invariant.

Proof. We may write (9) as follows:-

(10) $\quad C^o = \sum_i \sum_j c_{ij}.x_{ij} + \sum_i \alpha_i.(\sum_j x_{ij}) + \sum_j \beta_j.(\sum_i x_{ij})$

From (1) and (2), we have

(11) $\quad C^o = C + \sum_i \alpha_i.a_i + \sum_j \beta_j.b_j$

Thus C^o is equal to C plus a constant. Q.E.D.

It became apparent in calculating transport costs from each
factory to each population center that how often the difference
in transport costs to one population center, say center A, and
to another population center, say center B, from each point
of supply was the same. That is, $c_{iA} = c_{iB} + \beta$ for $i = 1,\ldots,n$.

This occurred whenever in order to transport sugar from
any factory to point A, it was always necessary to first
travel through point B. The transport cost matrix could
then be transformed by adding the constant β to the B
column while leaving the optimal solution to the transport-
ation problem invariant. The result was two identical
columns in the transportation cost matrix. In other words,
the cost from each point of supply to both points of demand
A and B was the same. It is relatively easy to show that
under these circumstances the two points of demand may be
combined into one. In this way we were able to reduce the
number of points of demand from about 60 to 48.

If an area is a net importer, then it is necessary to
add a fictitious source of supply so that the total amount
demanded equals the total amount supplied. The amount supplied
by the fictitious source of supply is equal to the difference
between estimated internal consumption and estimated internal
production. In order to determine the transport cost from
the fictitious source of supply, we estimated the cost of
transport between the nearest port of entry and each point of
demand. If an area is a net exporter, one must add a fictitious
source of demand. In order to determine the transport cost to
the fictitious source of demand, we estimated the transport
cost from each point of supply to the nearest port of exit.

Having accumulated all the necessary data, we calculated
G_1, the savings possible from a policy of complete integration
as opposed to a policy of national autarky, assuming that the
minimum production estimates for each factory for the year
1970 are satisfied. We also determined G_2, the additional
savings which are possible if the minimum total production
estimate for East Africa for the year 1970 is reallocated
among firms. Then we calculated G_1 and G_2 assuming that the
maximum production estimates for the year 1970 are satisfied.

The above analysis contains several implicit assumptions.
One is that there is an even flow throughout the year between
all points of supply and all points of demand. Although
production schedules in the past have been uneven, a steady
flow can be achieved by holding sufficient stocks at each
factory. In order to compensate for fluctuations in demand,
stocks may be held by dealers at each point of demand.
Another assumption is that the product is homogeneous.
Although differences in quality are probably insignificant
as far as the East African consumer is concerned, for the

export market, quality can be a crucial factor. In working out
the solutions to the transportation problems, however, it turned
out that in most instances the factory at Wami River in Tanganyika,
which is geared to producing raw sugar, was an exporter in suf-
ficient quantity to satisfy the present East African obligations
under the Commonwealth Sugar Agreement. It is not unreasonable
to assume that some market can be found for all other sugar
exported regardless of the quality. A third implicit assumption
is that under national autarky (no movement of sugar across
territorial boundaries) the transport costs will be minimized
within each territory, and with complete integration total trans-
port costs will be minimized on an East African basis. If the
divergencies from an optimal pattern of distribution are about
the same in either case, however, the estimate of savings will
not be substantially affected.

IV. Method of Solution.

In order to determine G_1 and G_2 for maximum and minimum
production estimates, itw was necessary to solve eight defferent
transportation problems, the largest having 48 points of demand
and 9 points of supply. Since an electronic computer was not
readily available, we decided to solve them by hand. We devised
a simple and fast method of computation, making use of the follow-
ing theorem:-

Theorem 2. Let (x^*_{ij}) represent a set of values for the variables
x_{ij} for $i = 1,\ldots,n$ and $j = 1,\ldots,m$. The theorem falls into two
parts:

(a) If (x^*_{ij}) satisfies

$$(12) \qquad \sum_i x^*_{ij} = b_j \quad \text{for } j = 1,\ldots,m$$

then (x^*_{ij}) is an optimal solution to the transportation problem
(minimizes (1) subject to the restrictions in (2) and (3)) if
and only if there exists a set of number α_i for $i = 1,\ldots,n$
such that

$$(13) \qquad \text{If } c_{ij} + \alpha_i > \min_i(c_{ij} + \alpha_i), \text{ then } x^*_{ij} = 0$$

$$\text{If } c_{ij} + \alpha_i = \min_i(c_{ij} + \alpha_i), \text{ then } x^*_{ij} \geqq 0, \quad \text{and}$$

$$(14) \qquad \sum_j x^*_{ij} = a_i \quad \text{for } i = 1,\ldots,n$$

are satisfied.

(b) If (x^*_{ij}) satisfies (14), then (x^*_{ij}) is an optimal solution
to the transportation problem if and only if there exists a set
of numbers β_j for $j = 1,\ldots,m$ such that

If $\quad -c_{ij} + \beta_j < \max_j(-c_{ij} + \beta_j)$, then $x_{ij}^* = 0$

(15) If $\quad -c_{ij} + \beta_j = \max_j(-c_{ij} + \beta_j)$, then $x_{ij}^* = 0$

and (12) are satisfied.

The above theorem states that if it is possible to find a set of numbers α_i and a solution (x_{ij}^*) which satisfy (12), (13), and (14), then (x_{ij}^*) is an optimal solution to the transportation problem. Furthermore, if (x_{ij}^*) is an optimal solution to the transportation problem, then there exists a set of numbers α_i such that (12), (13), and (14) are satisfied. Our algorithm consists of finding successive approimations to the numbers α_i and solutions (x_{ij}^*) which satisfy (12) and (13) but not necessarily (14). When a solution is reached (14) is satisfied as well.

The algorithm may be described as follows:-

(a) Let (x_{ij}^t) be the solution at stage t in the algorithm, and let α_i^t be the values of the α_i for $i = 1,\ldots,n$ at stage t.

Initially let the α_i^o be arbitrary for $i = 1,\ldots,n$.

Let $\min_i(c_{ij} + \alpha_i^o) = c_{Ij} + \alpha_I^o = \beta_j$

Then set $\qquad x_{ij} = \begin{cases} b_j, & \text{if } i = I \\ 0, & \text{otherwise} \end{cases}$

(b) Define the following quantities:-

$$\beta_j^t = \min_i (c_{ij} + \alpha_i^t) \quad \text{for } j = 1,\ldots,m$$

$$E_i^t = \sum_{j=1}^{m} x_{ij}^* - a_i \quad \text{for } i = 1,\ldots,n$$

$$E_{I'}^t = \max_i \left| E_i^t \right|$$

Then follow either of the two steps below, whichever is appropriate.

(b.1) If $E_{I'}^t < 0$, define the set $\gamma(I')$ as follows:

$$\gamma(I') = \left\{ j \mid x_{ij}^t > 0 \right\} \text{ for at least one } i \neq I'$$

Set $\quad \Delta = \min_{j \in \gamma(I')} (c_{I'j} + \alpha_{I'}^t - \beta_j^t)$

$$= c_{I'J} + \alpha_{I'}^t - \min_i (c_{ij} + \alpha_i^t)$$

$$= c_{I'J} + \alpha_{I'}^t - c_{I''J} - \alpha_{I''}^t$$

(b.2) If $E_{I'}^t > 0$, define the set $\gamma(I')$ as follows:

$$\gamma(I') = \left\{ j \mid x_{I'J} > 0 \right\}$$

Set

$$\Delta = \min_{i \neq I'} \quad \min_{j \in \gamma(I')} \quad (c_{ij} + \alpha_i^t - \beta_j^t)$$

$$= \min_{i \neq I'} \quad \min_{j \in \gamma(I')} \quad (c_{ij} + \alpha_i^t - c_{I'j} - \alpha_{I'}^t)$$

$$= c_{I''J} + \alpha_{I''}^t - c_{I'J} - \alpha_{I'}^t$$

(c) In order to determine the α_i and the x_{ij} at stage $t + 1$ set

$$\alpha_i^{t+1} = \begin{cases} \alpha_{I'}^t + \Delta \, , & \text{if } E_{I'}^t > 0 \\[2mm] \alpha_{I'}^t - \Delta \, , & \text{if } E_{I'}^t < 0 \end{cases}$$

$$\alpha_i^{t+1} = \alpha_i^t \qquad \text{for } i \neq I',$$

and set

$$x_{ij}^{t+1} = x_{ij}^t \qquad \text{for } j \neq J$$

For $j = J$, use one of the following four rules, whichever is applicable:

In order that the system approach equilibrium,
the asking prices must be altered. We assume that the
supplier at point I' who has one of the largest excess
demand or excess supply is the first to modify his
asking price $\alpha_{I'}^t$. If the supplier at point I' has an
excess demand ($E_{I'}^t > 0$), he raises his asking price by an
amount Δ sufficient to cause buyers from at least one point
of demand to ask for sugar from a supplier at some point
other than I'. In order to determine Δ, one looks at
all points of demand from which buyers ask for sugar
from the point I'; this is the set $\gamma(I')$. For each of
these points of demand, we determine the minimum rise in
price which will cause buyers from that point to go
elsewhere because the asking price plus transport cost
is lower. Then we set equal to the least of these minimum
rises in price. When the asking price at point I' is
raised by Δ, buyers from the point of demand J begin
to ask for sugar from point I'' instead of I', thus reducing
the excess demand at I'. Now if the supplier at point I'
has an excess supply, he lowers his asking price by an
amount Δ. In this case one determines Δ by first
looking at all points of demand from which buyers are
asking for sugar from points other than I'; this is the
set $\gamma(I')$ for the case where $E_{I'} < 0$. Then for each of
these points of demand, we determine the reduction in
asking price necessary to cause buyers to switch to the
point of supply I'. The asking price is lowered by
which is the minimum of these reductions in asking price.
Then buyers from the point of demand J switch from the
point of supply I'' to the point of supply I', thus re-
ducing the excess supply at I'. At all times during
the process, buyers at each point of demand ask for sugar
from the point of supply for which the asking price α_i^t plus
transport cost c_{ij} is the lowest. That is, the conditions
set by (13) are always satisfied. When $E_i = 0$ for all
points of supply, an equilibrium has been reached since
there are no excess demands and no excess supplies.
At this point total transport cost (1) is minimized and
the conditions (2) and (3) are satisfied. The four rules
(c.1) through (c.4) insure that no point of supply switches
from an excess demand to an excess supply or from an excess
supply to an excess demand at any one stage in the process.
This helps prevent cycling although cycling is not eliminated
and may occur whenever $\Delta = 0$, i.e., whenever a supplier may
get rid of a surplus or make up a deficit through no re-
duction in the asking price. In performing the algorithm

by hand, however, it is relatively easy to choose the proper
point of supply in order to break the cycle.

In performing the algorithm above it is simpliest to
work at all times with the matrix whose entries are
$c_{ij} + \alpha_i^t - \beta_j^t$ for $i = 1,\ldots,n$ and $j = 1,\ldots,m$. Since
the conditions in (13) are always satisfied, according
to the definition of β_j^t, we have

$$c_{ij} + \alpha_i^t - \beta_j^t \geq 0 \text{ for all } i \text{ and } j, \text{ and}$$
(15)
$$\text{if } c_{ij} + \alpha_i^t - \beta_j^t > 0, \text{ then } x_{ij}^t = 0.$$

One may infer from (15) that the final α_i^t and β_j^t are nothing
more than the shadow prices or the optimal solution to the
dual of the transportation problem. Only if the asking price
α_i^t or the price at the source of supply plus transport cost
is equal to the demand price β_j^t or price at the source of
demand is sugar transported from point i to point j.
If the price at the source of supply i plus transport cost
is greater than the price at the source of demand j, then
no sugar is transported from point i to point j, i.e., $x_{ij} = 0$.
The condition (15) also implies that the final x_{ij}
do indeed minimize
transport cost. Thus the algorithm provides a solution to
the primal problem and the dual problem simultaneously.

The computations were further simplified by setting
any of the entries in the matrix which were larger than their
row minimums by some specified amount equal to an arbitrarily
large number M and neglecting these entries in the matrix
during the computational procedure. At the end of the pro-
cedure, the final α_i were added to the original entries in
the transportation cost matrix and a new solution (x_{ij})
determined. If this solution satisfied (12), (13), and (14),
it was an optimal solution. Otherwise the final α_i were used
as the initial α_i for a new round of computations.

There was one final shortcut. In order to facilitate
solving the East African transportation problem (with a 48
by 9 transport cost matrix), we used the final asking prices
α_i of the smaller transportation problems involving Kenya,
Uganda, and Tanganyika as initial asking prices for the
larger problem.

Using the above algorithm and its modifications, we were able to solve the large 48 by 9 transportation problems in a few hours each. The algorithm is very efficient for computation by hand as it is readily amenable to ad hoc. changes in the rules which on heuristic grounds would seem to lead to a faster solution.

One may derive an algorithm similar to the one above by operating on bid prices. That is, buyers at each point of demand set an initial bid price of β_j^o, and each supplier offers his whole amount supplied a_i to the point of demand where the bid price less transport cost is the highest. Those points of demand which are oversupplied lower their bid prices and those points which are undersupplied raise their bid price. A solution results whenever bid prices are such that no point of demand has an excess supply or an excess demand. This algorithm takes advantage of part (b) of Theorem 2. During the whole computational procedure conditions (14 and (15) are satisfied and when the optimal solution is reached, equation (12) is satisfied.

Either of the algorithms which we may devise , the one operating on asking prices and the other operating on bid prices, may be viewed as a market mechanism in which, if equilibrium is reached, transport costs are automatically minimized. In the one case, the amounts demanded from each point of supply adjust through variations in the asking price. In the other case, the amounts supplied to each point of demand adjust with variations in the bid price.

V. Results and Conclusiions.

Table IV summarizes the results of the calculations.

Table I

	Minimum Production Estimates for 1970 Realized	Maximum Production Estimates for 1970 Realized
Savings in transport costs if production of each factory as estimate (G_1)	£249,391	£9,107
Savings in transport costs if production of each factory allowed to vary (G_2)	£58,990	£342,729
Total possible savings in transport costs ($G=G_1 + G_2$)	£308,381	£351,836
Estimated total transport costs under autarky ($C_K + C_P + C_U$)*	£1,263,360	£1,858,080
Total possible savings as percentage of estimated total transport costs under autarky	24	19
Total value of production (at the East African producer price of £46 per ton)	£17,296,000	£25,438,000
Total possible savings as a percentage of the total value of production	2	1

Footnote: see next page.

Footnote: * Actually $(C_U + C_T + C_K)$ as we calculated it
differs from the actual transport costs by a constant
which depends on the way in which points of demand are
consolidated. This constant is included in the
estimate in the table. In addition, the costs of
loading and offloading are not included in the
transport cost matrix but have been added to produce
the estimate in the table above.

The total possible savings in transport costs are about the
same whether minimum or maximum production estimates hold.
The source of savings is vastly different, however. If the
minimum estimates hold most of the savings occur with a
reorganization of the distribution channels. If the maximum
estimates hold, most of the savings occur because of a
reallocation of production among the firms. Since the maximum
estimates are based on the assumption that the newer ventures
will go ahead as planned, this leads one to suspect that the
relative rates of expansion should be quite different if the
maximum savings in transport costs is to be achieved.

The estimates of total possible savings in Table I do
not take into account differences in production costs.
If there is a difference in production costs among various
factories, then the possible savings will be much greater.
The total possible savings ignoring differences in production
costs, however, represents about 17 per cent of the 1962/63
estimated Uganda government recurrent and capital expenditures
on roads. (See (2).

One must keep in mind that the savings in Table I are
based on the assumption that all of the producers will
negotiate special rates with East African Railways and
Harbours by 1970. If the present official rates were
used, the possible savings would perhaps be about 20 per
cent greater.

Finally, there is the question of who will benefit from
the possible savings in transport costs. Since the total
possible savings is such a small proportion of the total
value of production, the possible difference in price to the
consumer is almost negligible. If the savings resulted in
a higher effective price to the producer, then it would most
likely mean a significant increase in profits. Alternatively,
the governments could raise the sugar excise duty and rake off
the savings as increased government revenue.

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