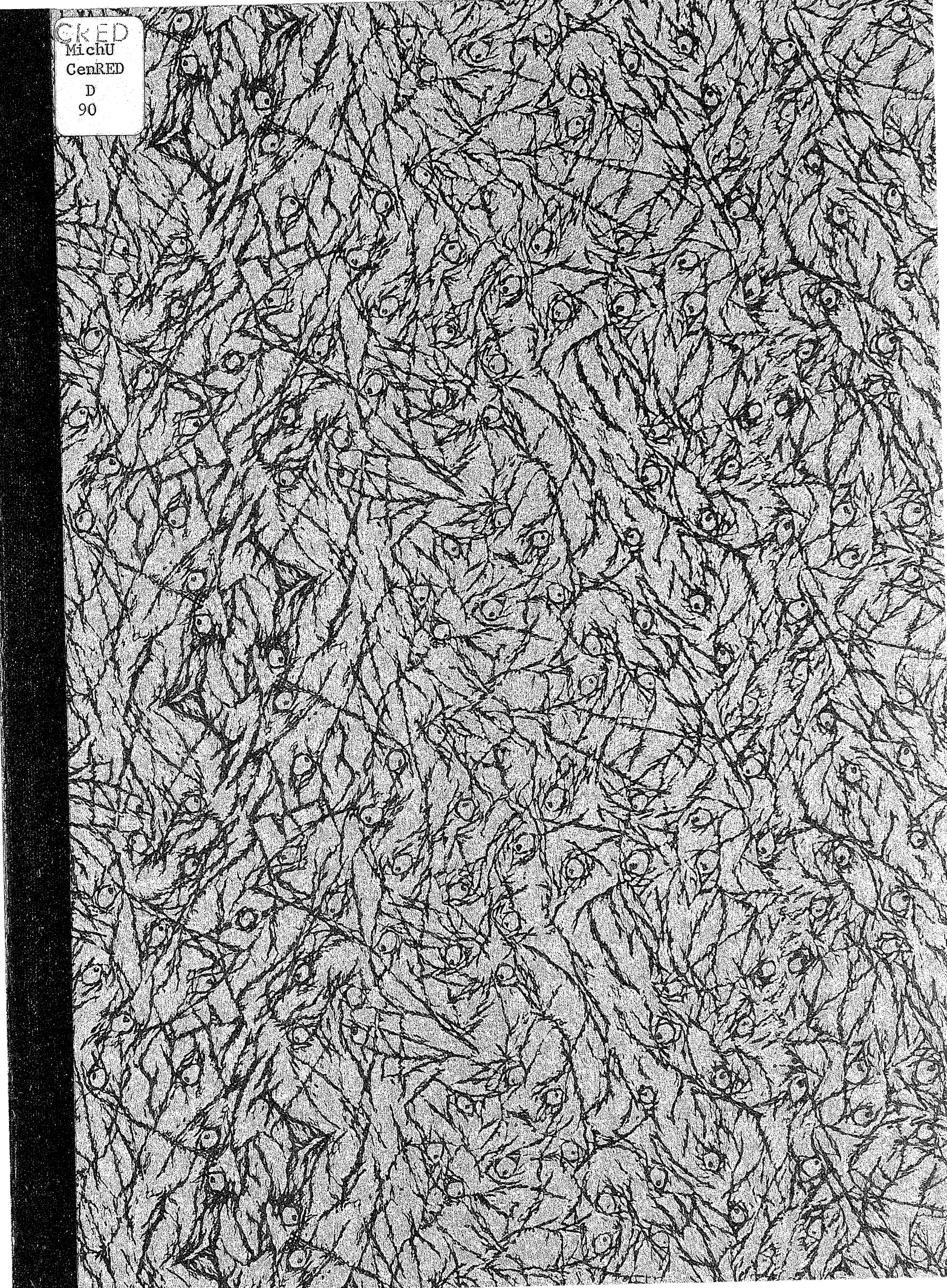

A MODEL OF MEAT VERSUS LIVE-ANIMAL EXPORTS FROM UPPER VOLTA

by

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ABSTRACT

This paper develops a theoretical model of livestock and meat exports from Upper Volta. The model is depicted graphically, showing the existence of jointly-determined unique equilibrium levels of live-animal and meat exports given costs and relevant demands for meat and offals. The model shows how conditions leading to a greater proportion of meat to live-animal exports are self-braking because of the interrelationship of domestic and export markets and explains the observation of declining meat exports in periods of rising prices. The cause of this phenomenon is shown to be the price of non-tradable by-products of cattle slaughtered in Upper Volta for export as meat.

The paper examines the impact of a series of exogenous effects on meat exports. The most important policy conclusion is that exogenous changes favoring either mode of export tend to be restricted in their effect by the self-braking nature of the system. The greatest likelihood for promoting increased meat exports from Upper Volta appears to be increasing the capacity to process and export offals and decreasing the transportation costs of meat relative to live animals.

RESUME

Ce rapport développe un modèle théorique de l'exportation de la viande et des animaux vivants de la Haute Volta. Le modèle montre graphiquement l'existence des points unique d'equilibre déterminés simutanément pour l'exportation de la viande et celle des animaux vivants, étant donnés les coûts et les demandes respectifs pour la viande et les abats.

Ce modèle montre dans quelles conditions les mechanismes conduisant à une plus forte exportation de viande que d'animaux vivants sont autofreinés, dans la mesure où il existe des interdépendances entre les marchés nationaux et les marchés d'exportation. Il explique aussi, l'observation d'une dimunution des exportations de viande pendant des periodes de hausse des prix de celle-ci. Ce phenomène résulte de la necessité d'écouler sur place les abats des animaux tués en Haute-Volta.

Le document examine l'impact d'une serie d'effets exogènes sur les exportations de viande. La plus importante conclusion politique réside dans le fait que les variations exogènes favorisant l'un ou l'autre mode d'exportation tendent à être réduites automatiquement, de par la nature même du modèle. Les politiques les plus susceptibles, cependant, de favoriser les exportations de viande voltaïque semblent être d'accroitre la capacité de transformation et d'exportation des abats et de decroitre les coûts de transport de la viande par rapport à ceux des animaux vivants.

A MODEL OF MEAT VERSUS LIVE-ANIMAL EXPORTS FROM UPPER VOLTA

Introduction

One of the poorer countries of the world, Upper Volta,[1] gains nearly one-half of its foreign exchange[2] from the export of meat and livestock. However, these exports have declined in recent years (Herman and Makinen, 1980). One way for Upper Volta to gain more from its shrinking exports of meat and livestock is to increase the proportion of meat relative to live cattle exported, hence raising the domestic value added. This paper develops a theoretical model of how Voltaic exports are allocated between live-animal and meat exports. The model shows how conditions which might be expected to lead to the dominance of one mode of export do not necessarily do so, but are self-braking, leaving both modes to coexist profitably. It also shows what kinds of investments and policy changes could aid Upper Volta in raising meat exports. Its results are applicable to not only Upper Volta, but also to other inland cattle-producing countries of West Africa (e.g. Mali, Niger, and Chad).

Upper Volta is a land-locked country climatically well-suited to the production of livestock. To its south are several coastal countries (Liberia, Ivory Coast, Ghana, Togo, and Benin) which are unable to raise livestock because of tse-tse fly-infested forest regions. These coastal countries, at the same time, have large, relatively-rich, and, increasingly, urban populations which have a high demand for animal protein. Ivory Coast is by far the greatest importer of Voltaic livestock.[3] Thus there is a flow of livestock and meat from north to south in West Africa that has a long history (Herman and Makinen). Traditionally, cattle and small ruminants have been trekked southward to be slaughtered at the point of consumption.

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[1] Per capita GNP in 1978 was $160, ranking Upper Volta thirteenth lowest (IBRD, 1980).

[2] Also, Upper Volta gains a large portion of its total tax revenues from international livestock transactions.

[3] Ivory Coast took 72 percent of cattle exports, virtually all meat exports, and 87 percent of small ruminant exports from Upper Volta in the period 1966-1977 (Staatz, 1980).

The building of the Régie de Chemin de Fer Abidjan-Niamey (RAN) rail line from Ouagadougou, Upper Volta to Abidjan, Ivory Coast (Map 1) has not only allowed faster shipments of Voltaic livestock to Ivory Coast, but has provided a means by which Upper Volta can capture a greater proportion of the total value added in meat production, by shipping chilled meat in refrigerated rail cars southward. This allows the slaughtering of cattle to take place in Upper Volta, with the resultant gain in foreign exchange.[1]

In the years 1963 to 1971 meat exports from Upper Volta to Ivory Coast flourished; over 1,000 metric tons were shipped each year (Herman and Makinen, p. 148). By 1977, however, meat shipments to Ivory Coast had dropped to 189 metric tons, only 19 percent of previous levels. Part of this decrease was doubtless due to the effects of the 1968-72 Sahelian drought, which also reduced live-cattle exports in 1977 below 1963-71 levels. However, the decrease in live-cattle exports was less severe: the 1977 level of live-cattle exports was 32 percent of the 1963-71 annual average (Herman and Makinen, p. 138).

Similar proportionally-larger declines in meat exports occurred in other West African meat-surplus countries. Mali's live-cattle exports dropped to 49 percent of 1967-71 levels by 1977, whereas meat exports ceased altogether (Delgado, pp. 352 and 359). Ivory Coast meat imports from Mali, Upper Volta, and Niger dropped to 15 percent of 1963-71 levels by 1977, while live-cattle imports maintained 89 percent of previous levels (Staatz 1980, pp. 39 and 43).

At the same time, retail meat prices in coastal markets were rising, as shown in Table 1. These observations led to the following questions:

(1) How could the two modes of export coexist, in the absence of external constraints?

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[1]There are additional reasons Upper Volta would like to increase meat exports: Modern capital-intensive slaughterhouses, with capacities far exceeding local needs, have been constructed in Ouagadougou and Bobo-dioulasso in recent years; the Voltaic government would like to use this excess capacity for meat exports. Of course, the construction costs of these facilities are sunk costs, and cannot be used as an economic justification for expansion of meat exports. Also, Upper Volta would like to increase its production of fattened cattle, as opposed to traditional range-fed cattle, since fattened cattle yield superior carcass weights and higher quality meat. However, fattened cattle are not well suited to live long-distance transport.

(2) Why would meat exports decline more than proportionally to live-animal exports in the 1971-1977 period, especially in the face of rising retail beef prices?

The following exposition shows how the two modes of export may coexist, why the expansion of either mode tends to be self-braking, and why a decline in the proportion of exports in the form of meat in the face of rising retail prices is not only possible, but would be expected.

TABLE 1

Indexes of Retail Meat Prices in Coastal Markets
(1967 = 100)

	Beef with Bone		Red Meat
Year	Ivory Coast	Ghana	Liberia
1967	100	100	100
1971	113	109	106
1974	156	122	133
1975	191	142	168
1977	243	422	183

Source: Delgado, p. 361.

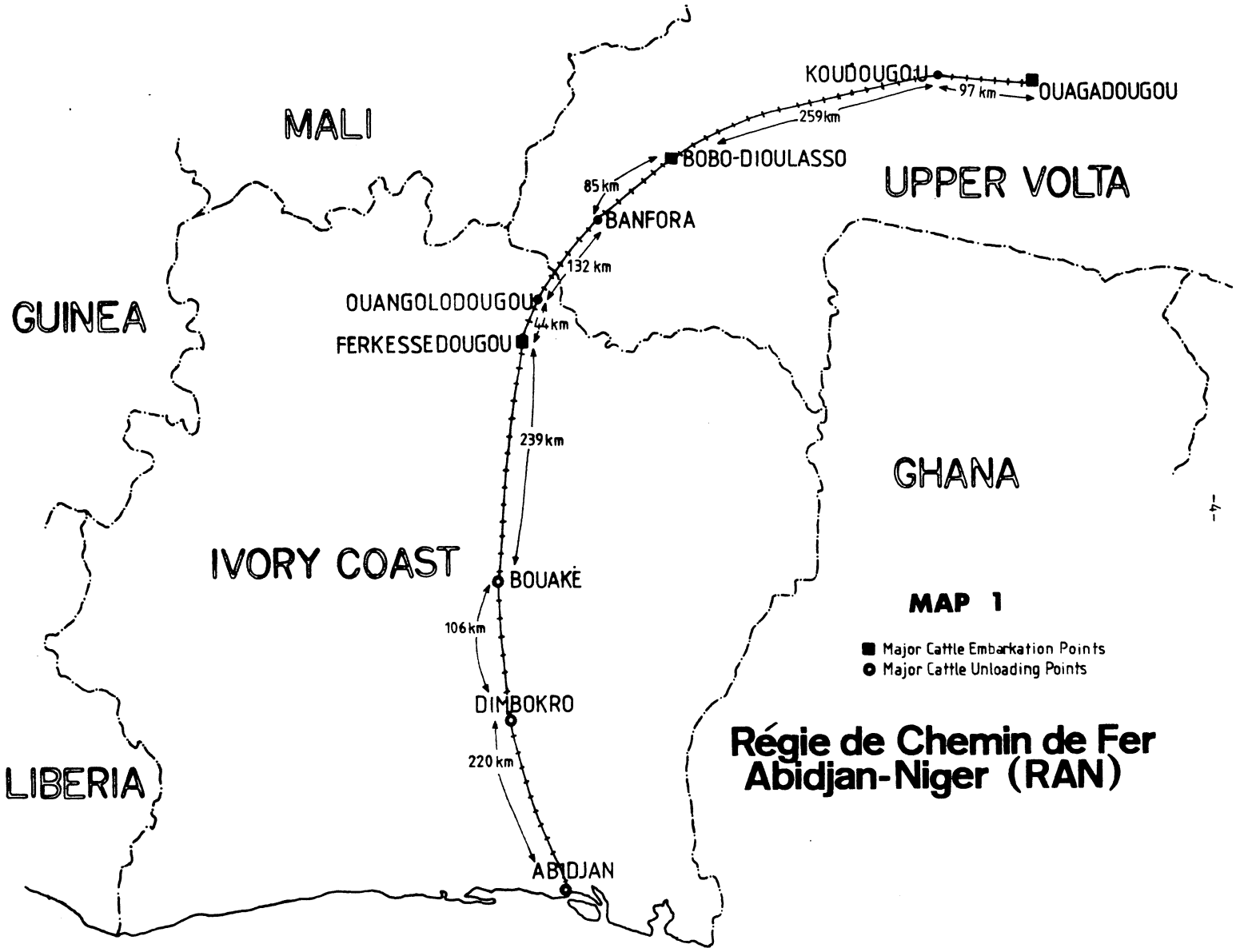
Costs of Meat and Live-Cattle Exports

It is the peculiar character of relative costs of meat and live-cattle exports from Upper Volta that produces the self-braking effect. To deliver meat slaughtered in the North to Abidjan,[1] a meat exporter must count the following costs: the dressing out proportion of the animal (carcass weight divided by live-weight); the shrinkage[2] of the refrigerated carcass during transit; the purchase price of the animal;

---

[1] Abidjan is currently the only southern market where Upper Volta has the option of exporting meat or live-cattle because of the RAN rail line. If rail connections are built to other southern markets or refrigerated trucking is perfected, meat exports to other markets will become possible and this same analysis would apply.

[2] Shrinkage refers not only to natural weight losses in transit of meat and live animals, but also to other losses in transit due to spoilage, condemnation, and theft.


MALI
UPPER VOLTA
GUINEA
GHANA
IVORY COAST
LIBERIA
KOUDOUGOU
97 km
OUAGADOUGOU
259km
BOBO-DIOULASSO
85km
BANFORA
132 km
OUANGOLODOUGOU
44km
FERKESSEDOUGOU
239km
BOUAKE
106km
DIMBOKRO
220 km
ABIDJAN
MAP 1
Major Cattle Embarkation Points
Major Cattle Unloading Points
Régie de Chemin de Fer
Abidjan-Niger (RAN)

the cost of slaughter; and the cost of transportation south. To deliver live-cattle to Abidjan an exporter must account for: the shrinkage of the whole animal shipped (including, along with weight loss, the probability of cattle dying en route, which requires that they be sold at a much-reduced price); the purchase price of the animal; and the cost of transportation south. When exporting meat, only the carcass is delivered to southern consumers; the fifth quarter, or edible offals, must be sold at the point of slaughter. When live cattle are sent south, of course, both the carcass meat and edible offals may be sold there. This difference in place of sale of the fifth quarter turns out to be the important factor making meat exports self-braking.

For meat and live-cattle exports to coexist in the long run, the margins earned in both activities must be equal, assuming free entry and allowing for risk. The margin earned by slaughtering an animal in the north and shipping the meat south to Abidjan is given by the equation:

$$M_M = DW_{LN}(1-L_M)P_{MA} + F_N P_{FN} - W_{LN}P_{LN} - C_M \qquad (1)$$

$$\begin{bmatrix}\text{Margin earned} \\ \text{shipping meat}\end{bmatrix} = \begin{bmatrix}\text{Receipts from} \\ \text{meat sold in} \\ \text{Abidjan}\end{bmatrix} + \begin{bmatrix}\text{Receipts from} \\ \text{fifth quarter} \\ \text{sold in North}\end{bmatrix} - \begin{bmatrix}\text{Purchase price} \\ \text{of animal}\end{bmatrix} - \begin{bmatrix}\text{Slaughter} \\ \text{and transfer} \\ \text{costs}\end{bmatrix}$$

where

M_M = net margin earned in shipping the meat to Abidjan;

D = dressing-out proportion of the animal (the carcass weight divided by the liveweight);

W_{LN} = liveweight of the animal in the North;

L_M = shrinkage of the refrigerated carcass during transit; expressed as a proportion of the original carcass weight;

P_{MA} = wholesale price per kg of meat in Abidjan;

F_N = weight of the fifth quarter in the North;

P_{FN} = average price per kg of the fifth quarter in the North;

P_{LN} = price per kg liveweight of the animal in the North; and

C_M = costs of slaughtering the animal in the North and shipping the meat to Abidjan. (This includes the cost of capital.)

Equation (1) states that the margin earned from shipping meat is equal to the value of the meat that arrives in Abidjan $[DW_{LN}(1-L_M)P_{MA}]$ plus the value of the fifth quarter sold in the North $[F_N P_{FN}]$ less the purchase price of the animal in the North $[W_{LN}P_{LN}]$ and the costs incurred

in slaughtering the animal and shipping the carcass to Abidjan [C_M].

Similarly, the margin earned by shipping a live animal south to Abidjan is given by the equation:

$$M_L = DW_{LN}(1-L)P_{MA} + (1-L_F)F_N P_{FA} - W_{LN}P_{LN} - C_L \quad (2)$$

[Margin earned shipping live animal] = [Receipts from sale of animal in Abidjan] - [Purchase price of animal] - [Transfer costs]

where

M_L = net margin earned shipping the animal to Abidjan;

L_L = shrinkage of carcass during shipment to Abidjan, expressed as a proportion of its original weight.

L_F = shrinkage of fifth quarter during shipment to Abidjan, expressed as a proportion of its original weight.

P_{FA} = average price per kg of the fifth quarter in Abidjan;

C_L = transfer cost of exporting the animal to Abidjan (including capital cost); and

D, W_{LN}, P_{MA}, F_N, and P_{LN} are as defined earlier.

Equation (2) states that the margin earned exporting an animal from the North to Abidjan is equal to the amount received in Abidjan for the animal's carcass [$DW_{LN}(1-L_L)P_{MA}$] and for its fifth quarter [$(1-L_F)F_N P_{FA}$][1] less the purchase price of the animal in the north [$W_{LN}P_{LN}$] and the costs incurred in exporting the animal to Abidjan [C_L].

Assuming that cattle merchants in Upper Volta may choose between shipping live animals southward or shipping meat, in long-run equilibrium the two margins must be equal for the activities to coexist; if the margin for one is greater than the other, there will be a shift toward that kind of export and away from the other. Hence, meat and live-animal exports are equally profitable when $M_M - M_L = 0$; or, combining equations (1) and (2) when:

$$M_M - M_L = DW_{LN}P_{MA}(L_L - L_M) + F_N[P_{FN} - (1-L_F)P_{FA}] - (C_M - C_L) = 0 \quad (3)$$

[Gain or loss from slaughter in north] = [Difference in shrinkage] + [Difference in fifth quarter receipts] - [Difference in transport and slaughter costs]

[1] In practice, the seller receives a single amount for the live animal that includes both the value of the carcass and the value of the fifth quarter.

In a given period of time when transportation costs are unchanging, the size of the first element on the righthand side of equation (3) will be constant. It can be reasonably assumed that the first element on the righthand side of equation (3) is constant as well. It will be shown that the second element, the loss in receipts from the fifth quarter, is the equilibrating factor that leads to the coexistence of the two kinds of exports and brakes any expansion of meat exports.

The second element on the righthand side of equation (3) is usually regarded as a loss in receipts to the slaughter of animals in the North, since Northern slaughter adds significantly to the supply of edible offals there, depressing prices. At the same time, the supply of edible offals in the south is reduced by Northern slaughter, but this has little influence on prices in the Abidjan market since imports from Upper Volta make up only a small part of total supply there. Thus, the more animals slaughtered in the North, the lower P_{FN} is likely to be, relative to P_{FA}; hence, the larger the second element of equation (3) will be, and meat exports will be relatively less profitable than live-animal exports.

Thus, there are three possible scenarios for Upper Volta's meat/live-cattle exports:

(1) The difference between offal prices in the North and Abidjan is so great that the condition given by equation (3) can never hold; implication: only live-animal exports are profitable, there are no meat exports.

(2) The difference in North-Abidjan offal prices is such that $M_M = M_L$ and equation (3) equals zero; implication: meat and live-animal exports coexist, with any exogenous disturbance favoring either export method causing changes in relative offal prices which, in turn, push the system back to equilibrium.

(3) The difference in North/Abidjan offal prices is so small that the condition given in equation (3) always holds; implication: meat exports are more profitable than live-animal exports, there are no live-animal exports.

It is the third scenario which held at least through 1977. Given this, it is interesting to explore how exogenous changes would affect the meat/live-animal export ratio, be they uncontrolled changes or changes in policy.

Diagrammatic Presentation

One additional assumption will allow the model expressed by equation (3) to be presented as a series of four interconnected graphs. It is assumed that the price of edible offals in Abidjan is proportional to the price of meat in Abidjan.[1] That is:

$P_{FA} = \gamma P_{MA}$, where γ is a constant.

The effect of a change in γ on the system is discussed below.

(a) Quantity of Voltaic Meat Exported to Ivory Coast

The demand for Voltaic meat in Ivory Coast may be regarded as perfectly elastic, given the existence of competing meat and cattle from Mali and Mauritania and chilled South American and European beef.[2] Fish is also a close substitute for meat in Ivory Coast. Hence, the demand curve for Voltaic meat in Abidjan (D_{MA}) is drawn as a horizontal line in quadrant I of Figure 1, at price OJ. The supply curve for Voltaic meat in Abidjan (S^{V}_{MA}) is upward sloping, reflecting the competition present among Voltaic meat exporters.[3] As diagrammed, the equilibrium quantity of meat exported is OF.

(b) Relation Between Edible Offals Available in the North and Meat Shipped to Abidjan

The supply of edible offals in Upper Volta as a by-product of slaughter for meat may be given as some quantity arising from the slaughter of animals for domestic consumption (F_o) plus an amount that varies directly with the quantity of meat exported to Abidjan (αQ^{V}_{MA}). Thus, in quadrant IV of Figure 1, the curve R_{FN} has a slope of α and an intercept at point C, where $OC = F_o$.

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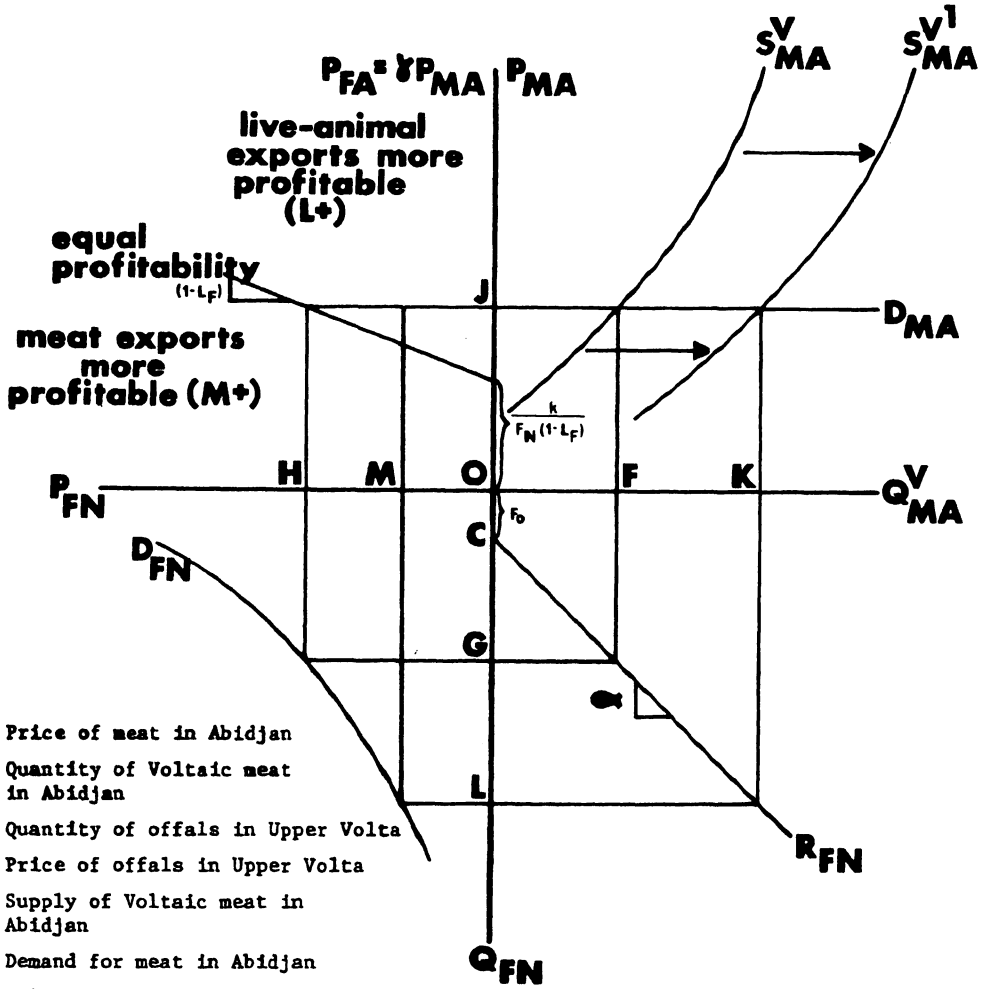
[1] See Staatz, 1979 for an explanation of why this is likely to be so, at least in the short run.

[2] Voltaic beef made up 19.1 percent of the total available in Ivory Coast in 1978, from calculations based on data in Staatz, 1980, pp. 34-50.

[3] As will be seen presently, this supply curve is somewhat of a theoretical construct, as it assumes that traders would act as though all other conditions would remain constant with a change in Abidjan meat prices. As will be shown, the price of fifth quarter parts depends on meat prices and how traders react to them. Thus, in practice it would be impossible to observe such a meat supply curve as S^{V}_{MA}.

FIGURE 1



P_{MA} = Price of meat in Abidjan

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Q_{FN} = Quantity of offals in Upper Volta

P_{FN} = Price of offals in Upper Volta

S^{V}_{MA} = Supply of Voltaic meat in Abidjan

D_{MA} = Demand for meat in Abidjan

R_{FN} = Relation between offals available in Upper Volta and Voltaic meat shipped to Abidjan

D_{FN} = Demand for offals in Upper Volta

(c) Demand for Edible Offals in the North

The demand for edible offals in Upper Volta is shown in quadrant III. It is a normally-sloped demand curve where the greater the quantity supplied, the lower will be the market-clearing price.

(d) Relative Profitability

The relative profitability of meat and live-animal exports is shown in quadrant II. There the price of edible offals in the North (P_{FN}) is related to the price of offals in Abidjan (P_{FA}). The price of offals in Abidjan has been assumed proportional to the price of meat in Abidjan ($P_{FA} = \gamma P_{MA}$), hence they may be represented by the same axis. According to scenario (2) above, it is the difference between the price of offals in the North and in Abidjan that determines whether meat or live-animal exports are more profitable. Assuming the difference in shrinkage losses and the difference in slaughter and transport costs are given and sum to a cost advantage of the amount k for meat exports,

$$DW_{LN}P_{MA}(L_L - L_M) - (C_M - C_L) = k,\ k > 0 \text{ (from equation (3))}$$

then for meat and live-animal exports to be in equilibrium, the loss in receipts from the sale of the edible offals in the North would have to equal k:

$$F_N[P_{FA}(1-L_F) - P_{FN}] = k \tag{4}$$

rewritten:

$$P_{FN} = P_{FA}(1-L_F) - \frac{k}{F_N} \tag{5}$$

Thus, the equilibrium price of offals in the North is a linear function of the price of offals in Abidjan adjusted for shrinkage losses. Equation (5) defines the relation between edible-offal prices in the North and Abidjan where meat and live-animal exports are equally profitable and may, therefore coexist. This line is labelled "equal profitability" in quadrant II.

A rise (fall) in the offal price in the North, ceteris paribus, would make the loss in receipts from their sale in the North smaller (larger) and make meat exports more (less) profitable. More (less) profitable meat exports would lead exporters to sell more (less) meat in Abidjan relative to live animals. Therefore the area below (above) the

line given by equation (5) labelled M+ (L+) is the region of greater profitability of meat (live-animal) exports relative to live-animal (meat) exports.

(e) Interrelationships of Markets

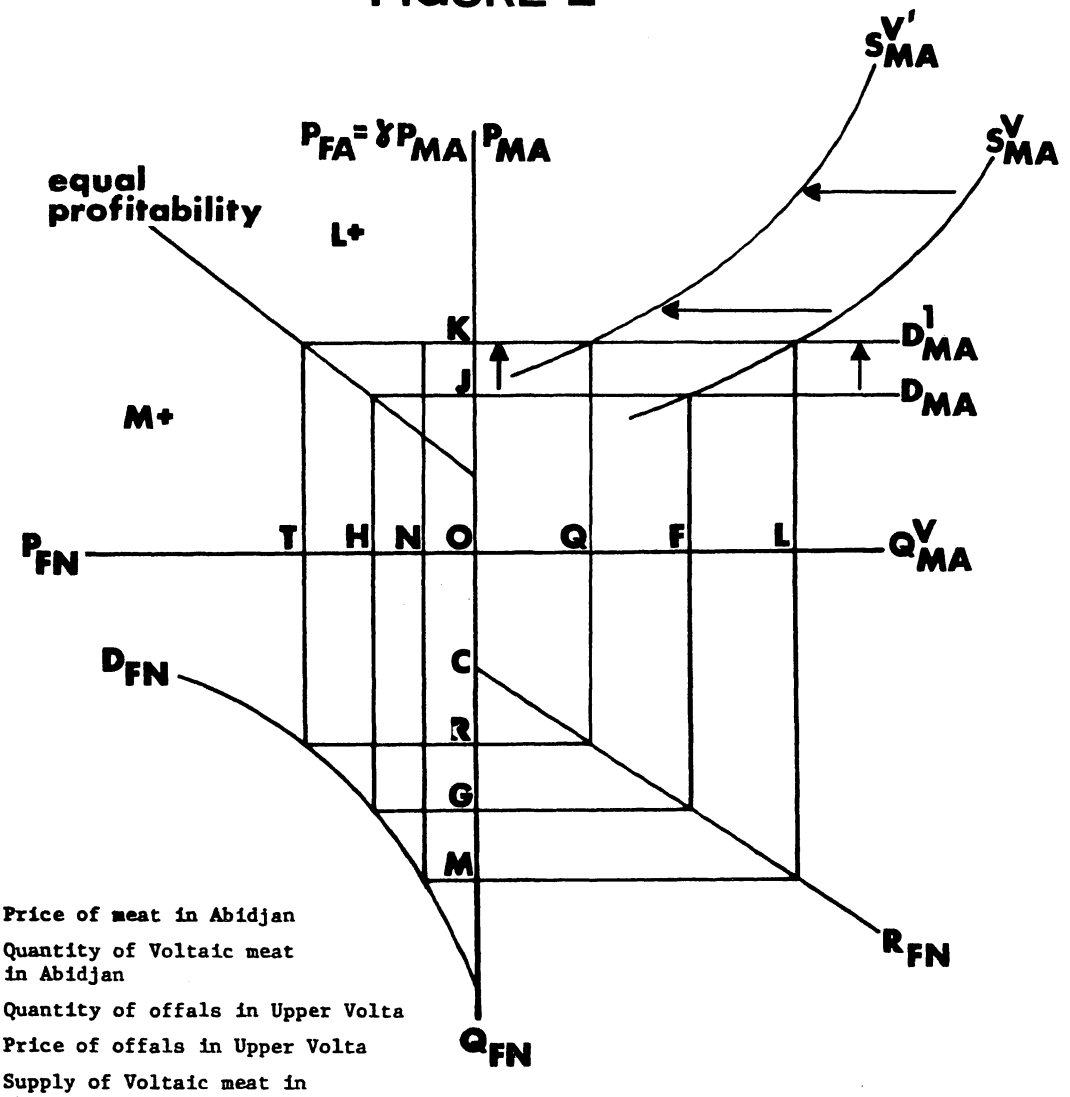
The interrelationships between the market for meat in Abidjan, the market for edible offals in the North, and relative meat-export profitability is also shown in Figure 1. The quantity of Voltaic meat exported to Abidjan is determined by the intersection of the supply and demand (at a fixed price OJ) curves in quadrant I. The quantity of meat exported OF then determines the quantity of edible offals supplied in the North by the intersection of the vertical line from point F with the meat export-offal supply relation (R_{FN}) in quadrant IV (quantity of offals supplied in the North is OG). The intersection between the fixed supply of offals in the North[1] and the demand curve for them in quadrant III, gives the equilibrium price of OH. As shown, there is an equilibrium between meat and live-animal exports as the ratio of offal prices in the North and offal prices in Abidjan (OH/γOJ) falls on the equal profitability boundary.

Effects of Exogenous Changes

Six kinds of exogenous changes in the Voltaic meat/live-animal export system will now be explored: (1) efforts to expand meat exports by financing new meat traders, (2) changes in Abidjan meat prices; (3) increased ability to process and export edible offals; (4) changes in relative transportation costs; (5) changes in the relative prices of meat and offals in Abidjan; and (6) changes in the demand for offals in the North. The exploration of these changes will allow the effects of likely future events to be anticipated and will make clear which policy

[1] It is assumed that there are no effects of Abidjan meat prices on the level of meat and offal production and consumption in the North. In practice there is some consumption response to changing export prices, but the responses are small enough to be ignored for simplicity here without affecting our conclusions. Production is probably even less price responsive, "The Peul [Voltaic] herder thus sells animals only when he must, either to salvage an element of his herd or to generate a given income for some specific purpose" (Herman, p.12), so it may safely be regarded as constant.

FIGURE 2



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D_{FN} = Demand for offals in Upper Volta

measures are appropriate to raise the meat/live-animal export ratio as well.

(a) Self-Braking Effect

The self-braking of expanding meat exports is shown in Figure 1. Assume that meat and live-animal exports are initially in equilibrium with OF meat exported to Abidjan at price OJ, OG offals sold on the Northern market at price OH, and the North-Abidjan offal price ratio OH/γOJ on the equal-profitability line.

Now assume that the government of Upper Volta, wishing to expand its foreign-exchange earnings from meat exports, gives seed money to several firms to enter the meat-export business. This action shifts the supply curve of Voltaic meat in Abidjan to the right (to $S^{V'}_{MA}$). The new quantity of meat exported, OK, means that a larger quantity of offals is supplied on the Northern market, OL; hence, a lower market-clearing price of offals in the North, OM. The ratio of North-Abidjan offal prices, now OM/γOJ, falls above the equal-profitability line, indicating that live-cattle exports are more profitable than meat exports. This will induce some meat traders to shift operations to live-animal exports, shifting the supply curve of Voltaic meat in Abidjan back towards its initial position, until there is a restoration of equilibrium between meat and live-animal exports. Thus, the government seed money will not have succeeded in increasing meat exports,[1] as the temporary increase in meat exports acted to brake itself by depressing offal prices in the North.

(b) Changes in Abidjan Prices

Again assume initial equilibrium in the system, as in Figure 1. Figure 2 shows an exogenous increase in the demand for animal protein in Abidjan (D^{1}_{MA}), with the prices of meat and offals rising from OJ and γOJ to OK and γOK. The short-run effect is to raise the quantity of Voltaic meat supplied to OL; thus, increasing the supply of offals in the North to OM; which causes the price of Northern offals to decline to ON. The ratio of Northern to Abidjan offal prices falls to ON/γOK in the short-run, making live-cattle exports more profitable than meat exports. This

[1] There will have been an increase in total meat exported regardless of mode, however, as is shown below.

causes an adjustment away from meat exports, shown by the leftward shift in the supply curve in quadrant I to $S^{V'}_{MA}$, where equilibrium is restored. When equilibrium is restored following the increase in Abidjan demand, the quantity of meat exported has fallen (!) from its initial level (OF) to OQ, the quantity of offals supplied in the North has also fallen, to OR, and their price has risen to OT.

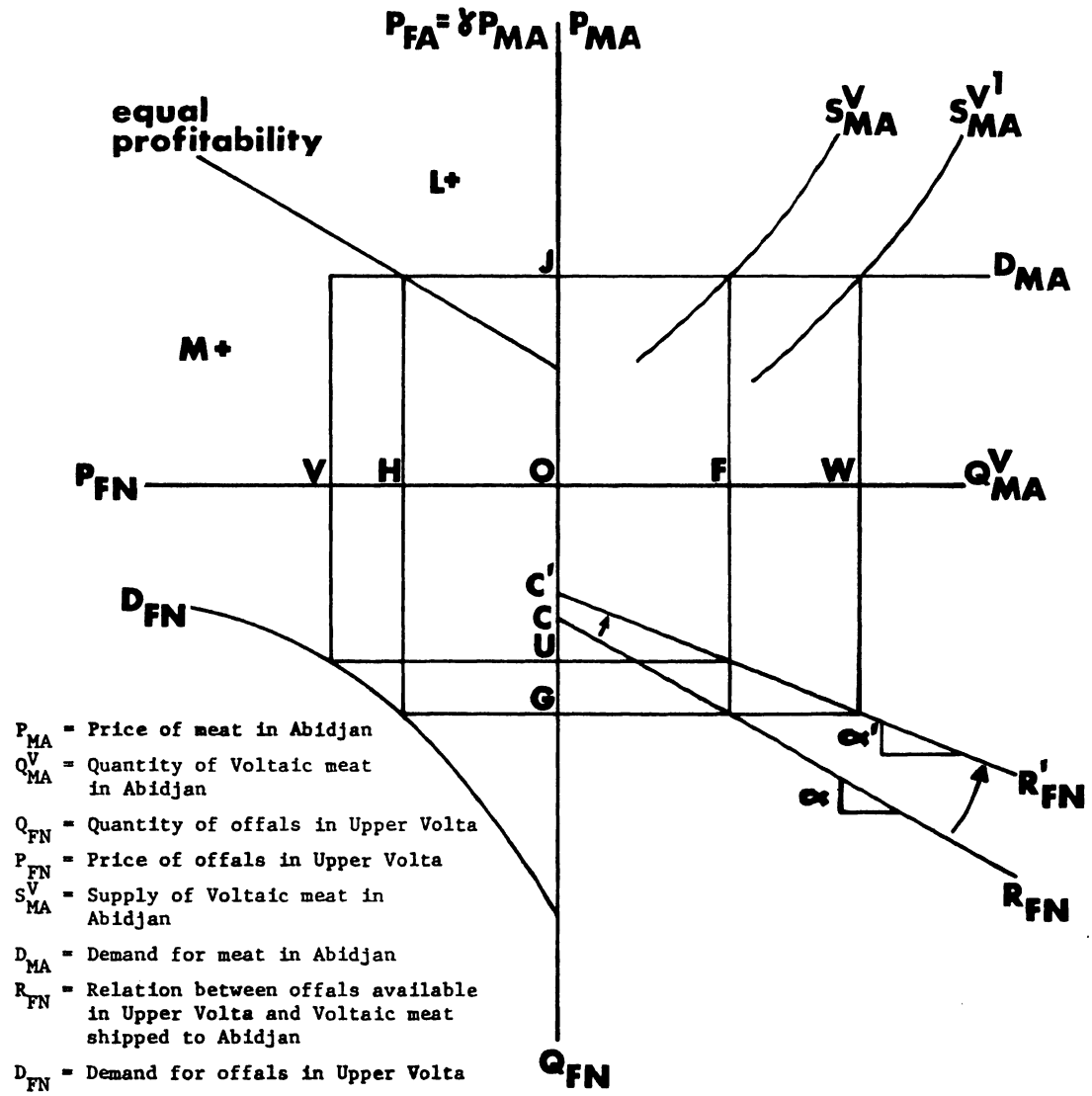
Conversely, a decline in Abidjan meat and offal prices would set in motion forces leading to increases in the quantity of meat exported and the quantity of offals supplied in the North, and a decrease in the market price of Northern offals.

(c) Processing and Exporting Offals

Figure 3 shows the effect of developing methods for processing and exporting a greater proportion of offals. This might be done by adding sausage-making facilities, a tannery, a cannery, or other processing facilities. The effect of such added processing capability would be to decrease the amount of fifth-quarter products necessarily marketed in the North when cattle are slaughtered there (both for domestic consumption and for export). This is shown by changes in the curve relating Northern offal supply to the quantity of meat exported (R_{FN}) in quadrant IV. The intercept shifts closer to zero (from OC to OC') as the quantity of offals marketed from cattle slaughtered for domestic consumption decreases. The increase in offal processing means a smaller proportion of offals must be sold in the North for each animal slaughtered for export, hence α, the slope of the curve, is reduced to $\alpha' < \alpha$.

Once again, assume an equilibrium prior to increasing processing capacity, with OF meat exported at price OJ and OG offals sold in the North at OH. The displacement of the R_{FN} curve decreases the quantity of offals supplied in the North to OU, raising the price of Northern offals to OV. The North-Abidjan ratio of offal prices rises to $OV/\gamma OJ$, on the M+ side of the equal-profitability line (where meat exports are more profitable). This leads to an expansion of the meat-export trade (to OW), increasing the supply of offals on Northern markets until their price falls back to OH where equal profitability is restored. The result of increased offal-processing capacity is an expansion, though limited, of meat exports. The larger the proportion of offals that can be processed and exported, the larger will be the resulting increase in meat exports.

FIGURE 3



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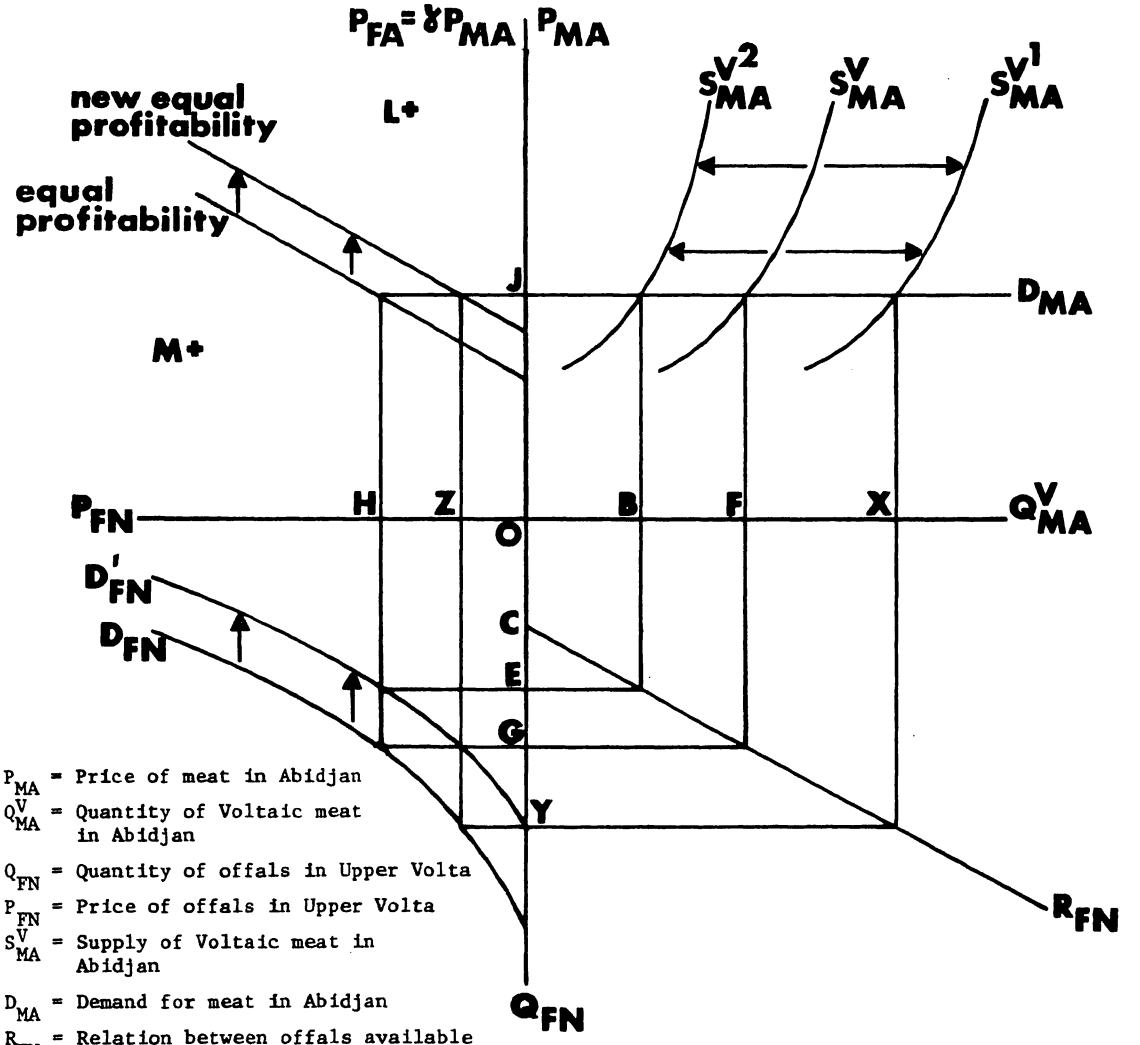
D_{FN} = Demand for offals in Upper Volta

FIGURE 4



P_{MA} = Price of meat in Abidjan

Q^{V}_{MA} = Quantity of Voltaic meat in Abidjan

Q_{FN} = Quantity of offals in Upper Volta

P_{FN} = Price of offals in Upper Volta

S^{V}_{MA} = Supply of Voltaic meat in Abidjan

D_{MA} = Demand for meat in Abidjan

R_{FN} = Relation between offals available in Upper Volta and Voltaic meat shipped to Abidjan

D_{FN} = Demand for offals in Upper Volta

(d) Changes in Transportation Costs

The effect of an improvement in the relative transportation cost of meat exports is shown in Figure 4. This relative cost advantage might come about as a result of better maintenance of refrigerated rail cars, reducing spoilage losses; or a change in RAN freight rates in favor of meat over live-animal exports. Of course, there could be similar transport-cost shifts in the opposite direction, which would reverse the following analysis. A reduction in relative meat transportation costs, makes the last element on the righthand side of equation (3) smaller, hence, a larger loss on fifth quarter sales will allow meat exporting to be profitable. Otherwise stated, the value of the cost advantage of meat exports, k, has risen, implying an upward shift in the equal-profitability line in quadrant II. The shifted curve is shown in Figure 4 as "new equal profitability."

Starting from initial equilibrium, with OF meat exported and OG offals sold in the North at price OH, the upward shift of the equal-profitability line puts the $OH/\gamma OJ$ offal-price ratio in the M+ zone. This attracts entrants into meat exporting, shown by the rightward shift of the meat-supply curve in quadrant I, to $S^{V'}_{MA}$. Entry occurs until the resulting increase in Northern offal supply lowers their price to OZ, with $OZ/\gamma OJ$, on the new equal-profitability line. Meat exports have expanded to OX, offals sold in the North to OY. A decrease in relative live-animal transport costs would have the opposite effect; a downward shift in the equal-profitability line, a decrease in meat exports and Northern offal supplies, and a rise in Northern offal prices.

(e) Changes in the Relative Prices of Meat and Offals in Abidjan

A change in the relative prices of meat and edible offals in Abidjan would mean a change in the value of the parameter γ; hence, a change in the scale of the vertical axis in quadrant II. An increase in the relative price of offals to meat would be represented by a downward shift in the equal profitability curve in quadrant II;[1] a decrease by an upward

[1] And the equal-profitability line would appear more steep, although its slope would not change.

shift. The increased relative offal price would cause a contraction of meat exports; a decreased offal price an expansion, such as shown in Figure 4.

(f) Changes in the Demand for Offals in the North

The demand for offals is relatively income inelastic, as meat is a preferred form of animal protein. The demand for offals is also inversely related to urbanization; city dwellers prefer meat more strongly than rural residents. Thus, as incomes rise and urbanization increases in the North the demand curve for offals there will likely shift toward the price axis, as shown by D'_{FN} in Figure 4. Assuming again the initial equilibrium at F, G, H, and J, with the decline in demand, the OG offals supplied can be sold at only OZ. There the North-Abidjan offal-price ratio falls on the L+ side of the equal-profitability line. This causes exit from meat exporting, shown by the shift to supply curve S^{V2}_{MA} in quadrant I. Equilibrium is restored with reduced meat exports (OB) and reduced offals sold in the North (OE) at the original offal price (OH).

Expansion to Include Total Meat-Product Exports

So far, the model has been used to show only the effects of exogenous changes on the quantity of meat exported. The model will now be expanded to show the interrelationship of meat (Q^V_{MA}) and live-animal (Q^V_{LA}) exports.

It has been shown that meat exports tend to decline with increases in Abidjan meat prices, because of the interaction of offal markets.

$$\frac{\partial Q^V_{MA}}{\partial P_{MA}} < 0$$

This is not to say, however, that there is a perverse relation between the total quantity of meat exported ($Q^V_{TA} = Q^V_{MA} + Q^V_{LA}$) and the price of meat in Abidjan. It is expected that Q^V_{TA} is positively responsive to P_{MA}:

$$\frac{\partial Q^V_{TA}}{\partial P_{MA}} > 0$$

This means that live-animal exports must be very positively responsive to Abidjan meat prices, sufficient to overwhelm the perverse Q^V_{MA} effect:

$$\text{Since} \quad Q^V_{TA} = Q^V_{MA} + Q^V_{LA}$$

$$\text{and} \quad \frac{\partial Q^V_{TA}}{\partial P_{MA}} > 0$$

$$\text{then} \quad \frac{\partial Q^V_{MA}}{\partial P_{MA}} + \frac{\partial Q^V_{LA}}{\partial P_{MA}} > 0$$

$$\frac{\partial Q^V_{LA}}{\partial P_{MA}} > - \frac{\partial Q^V_{MA}}{\partial P_{MA}} > 0$$

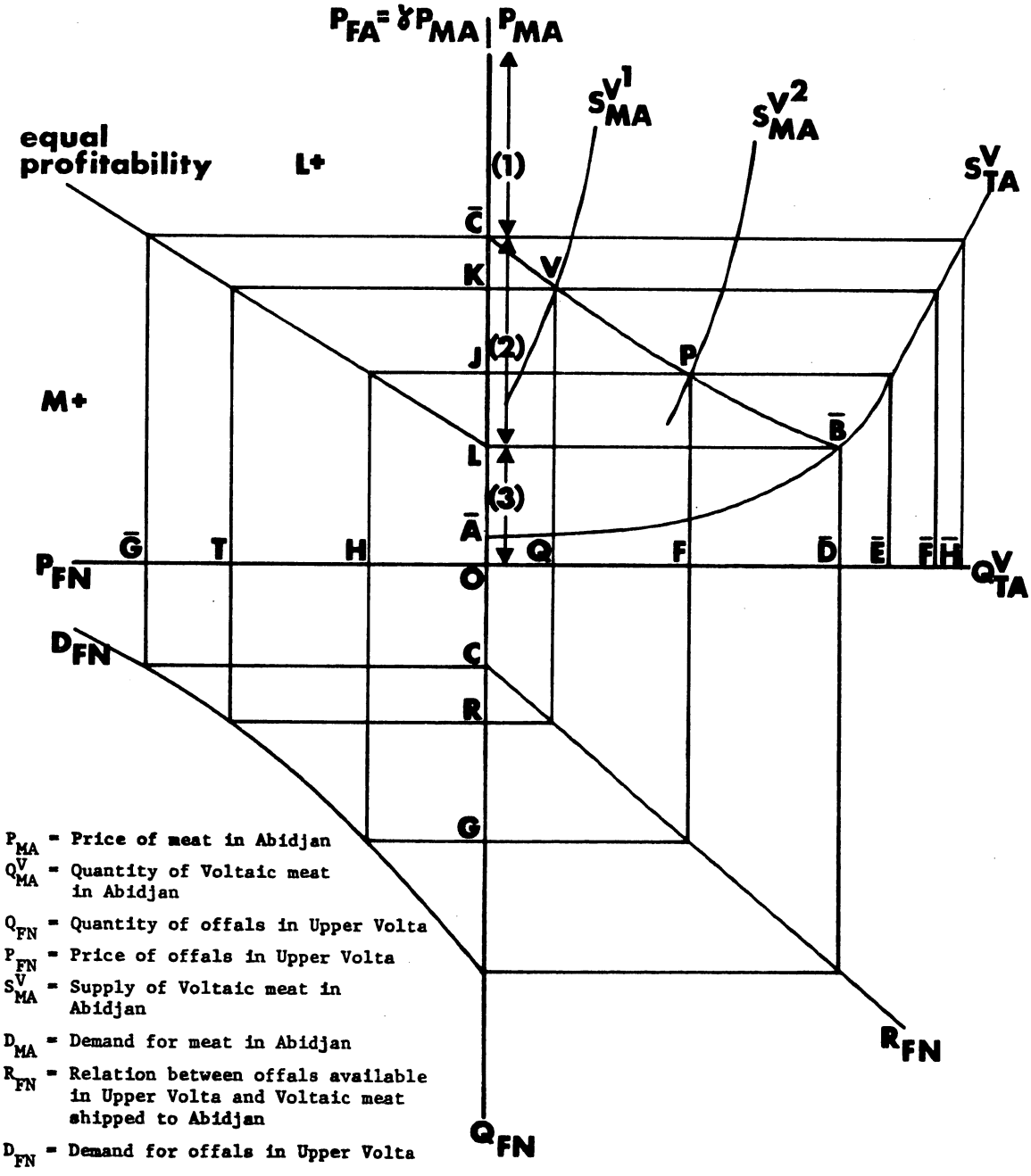
$$\text{so} \quad \frac{\partial Q^V_{LA}}{\partial P_{MA}} > 0$$

This can be shown by drawing in a normally-sloped total meat export supply curve (S^V_{TA}) in quadrant I of the graph of our system (Figure 5).

The share of total meat exported as meat or as live-animals at any price can be shown as well. First, the range of prices where meat and live-animal exports may coexist can be found. When meat exports are zero, the total supply of offals on Northern markets would come from cattle slaughtered for local consumption only ($Q_{FN} = OC$). At that level of Northern offal supply, the price of offals would be $O\bar{G}$ and could rise no higher. Equal profitability of both modes of export would occur at $O\bar{G}/\gamma O\bar{C}$. Any Abidjan meat price above $O\bar{C}$ would produce a permanent advantage for live-animal over meat exports, as no further reduction in Northern offal supply by cutting meat exports is possible, hence Northern offal prices would remain at $O\bar{G}$ and the offal-price ratio always falls in the L+ region of quadrant II. Below $O\bar{C}$, adjustments in meat exports can be made to restore equilibrium. Thus, prices above $O\bar{C}$ represent scenario (1) above, and prices below $O\bar{C}$ represent the beginning of the range of scenario (2).

The other end of the coexistence price range (end of scenario (2) and beginning of scenario (3)) is found where the cost advantage for meat over live-animal exports (k) is just equal to the price of offals on the Abidjan market, at price γOL. At any Abidjan offal price below γOL,

FIGURE 5



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k is always greater than the possible price advantage for sales of offals in Abidjan over Northern markets, since Northern prices cannot be lower than zero. The following summarizes the possible scenarios:

Scenario	Abidjan Meat Price Range
(1) Live-Animal Exports Only	$O\bar{C}$ and above
(2) Coexistence of Meat and Live-Animal Exports	OL to OC
(3) Meat Exports Only	OL and below

The quantity of Voltaic meat exported at any Abidjan price can be traced as follows. At prices below OL the quantity of meat exported is given by the total meat supply curve (S^V_{TA}). Above OL it is given by the locus of intersections between Abidjan meat prices and the corresponding equilibrium short-run meat supply curves (S^V_{MA}) found using the R_{FN}, D_{FN}, and equal profitability curves in quadrants II - IV. Two examples are shown in Figure 5: at Abidjan meat price OK, the equilibrium short-run supply curve of Voltaic meat (the one which makes meat and live-animal exports equally profitable) is S^{V1}_{MA}, with OQ meat exported. At price OJ, S^{V2}_{MA} is the equilibrium supply curve, with OF meat exported. The locus of intersections is given by the curve $\bar{C}VP\bar{B}$. Meat exports are maximized at Abidjan meat price OL and fall to zero at $O\bar{C}$ where only live-animal exports are profitable and below $O\bar{A}$ where no exports are profitable.

In the price range of scenario (2), the quantity (in meat equivalent) of live-animal exports is the difference between the total meat supply curve (S^V_{TA}) and the meat-supply locus. For example, at price OK, total meat exports are $O\bar{F}$, made up of OQ exported as meat and $Q\bar{F}$ as live-animals. At price OJ, OF meat is exported and $F\bar{E}$ live-animals. At $O\bar{C}$, the beginning of absolute dominance of live-animal exports, quantity $O\bar{H}$ of live-animals is exported, the entire supply of Voltaic exports.

Summary and Conclusions

The model developed shows how the interrelationships of northern and southern markets for meat and edible offals allow for the possibility of long-run coexistence of both meat and live-animal exports. The model is depicted graphically to show the effects of exogenous actions

on the system. The predicted impacts of the exogenous actions on meat exports, offals sold in the North, and Northern offal prices are summarized in Table 2. One of the most important policy conclusions arising from the model is that any exogenous change favoring either mode of export is likely to be self-braking. The best actions to promote meat exports available to the government of Upper Volta appear to be to increase the capacity to process and export offals and to decrease meat transportation costs.

TABLE 2: Summary of Model Results

Exogenous Change	Total Quantity of Meat Exported	Quantity of Total Meat Exported as Live Animals	Quantity of Total Meat Exported as Meat	Quantity of Offals Sold in North	Price of Offals in North
Abidjan Prices:					
1. Increase	up	up	down	down	up
2. Decrease	down	down	up	up	down
Increased Capacity to Process and Export Offals	no change	down	up	no change	no change
Transportation Costs for:					
1. Meat:					
a. Rise	down	up	down	down	up
b. Fall	up	down	up	up	down
2. Live-Animals					
a. Rise	down	down	up	up	down
b. Fall	up	up	down	down	up
Relative Abidjan Meat-Offal Price Ratio	no change	down	up	up	down
1. Rises	no change	down	up	up	down
2. Falls	no change	up	down	down	up
Effect on Offal Demand in North					
1. Rising Incomes	down	no change	down	down	no change
2. Increased Urbanization	down	no change	down	down	no change

Finally, the questions asked in the Introduction may now be answered:

(1) The two modes of export may coexist because of the equilibrating effect of the market for the non-tradable by-product of Northern cattle slaughter.

(2) There was a decline in the supply of Sahelian cattle in the 1971-1977 period because of the 1968-1972 drought, which shifted the total meat supply curve to the left. This, by itself would have caused no necessary change in the proportion of exports as meat versus live-animals. However, the concomitant rise in retail meat prices, would be expected to cause a greater decline in meat than in live-animal exports.

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