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IMPLICATIONS OF OPEN TRADE IN WEST AFRICA FOR THE BEEF SECTOR: EVIDENCE FROM GHANA, COTE D'IVOIRE, MALI, AND BURKINA FASO

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Major professor

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IMPLICATIONS OF OPEN TRADE IN WEST AFRICA FOR THE BEEF SECTOR: EVIDENCE FROM GHANA, COTE D'IVOIRE, MALI, AND BURKINA FASO

by

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ABSTRACT

This study focused on estimating the magnitude and direction of trade flows in cattle and beef in the event that more open trade is instituted in the West African Central Corridor, made up of four countries: Ghana, Cote d'Ivoire, Mali, and Burkina Faso. The specific objectives were (a) determining the direction of shifts in the production and consumption of cattle and beef under more open trade in the Central Corridor; (b) determining what effect(s) more open trade will have on beef imports into the sub-region; and (c) determining how exchange rate adjustments and alternative exchange rate regimes may cause shifts in the production and consumption of cattle and beef in each country.

The study applied a mathematical programming approach to model trade in cattle and beef in the West African Central Corridor. Quadratic programming which maximizes the net social surplus in the Samuelson sense under a competitive market framework when farmers are risk averse was used. The simulation model allowed a multi-country analysis that treated the Central Corridor as 'one huge market place' in the context of a spatial equilibrium framework.

The base model was run under three scenarios: (a) all four countries had more open trade in cattle (i.e., all existing cattle trade barriers removed); (b) all four

countries adopted the same currency (CFA Franc in this case); and (c) all four countries had more open trade and also adopted a single currency (a combination of scenarios (a) and (b) above). Subsequently, the recent devaluation of the CFA Franc and how it has affected the cattle and beef sector was also analyzed.

The model results of the more open trade scenario in the Central Corridor indicates that there will be increased cattle trade and beef consumption in the sub-region; while beef imports from outside the region would decline. Under the single currency scenario, the total volume of trade in live cattle within the Central Corridor would increase even though both exporting and importing countries might have different experiences. But in the presence of substantial trade barriers, adopting a single currency for the sub-region will not automatically lead to expansion in cattle production and beef consumption. In the case of the single currency with a more open trade scenario, the analysis showed that there shall be expansion in the cattle sector, as well as increase in the overall trade flows in cattle, and the consumption of beef in the Central Corridor.

Welfare analysis using consumer surplus and producer profits, as well as estimates of government revenue changes, indicates that there would be an overall net gain for the Central Corridor sub-region under the different trade scenarios, even though cattle exporting countries would enjoy higher gains; while some countries would suffer some welfare losses.

Dedicated to:

Madam Hannah Yaa Adoma

my beloved mother

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Problem Statement and Study Objectives

1.0. Introduction

Regional economic integration, which featured prominently in debates on economic issues in the 1970s, has again become an important policy issue for Africa in the 1990s. It is viewed as a means of achieving faster and sustained growth, as well as reducing the dependance of many African economies on their past colonial masters. Following the economic stagnation in Africa in the 1980s, and the recent global move toward forming free trade areas (*e.g.*, NAFTA, the EU, and ASEAN), many economists and policy makers have revisited efforts at African regional economic integration as a facilitator of faster economic growth in Africa (Egg *et al.* 1991).

Economic integration, a more encompassing term than economic cooperation, generally refers to arrangements among countries ranging from the creation of free-trade areas (free flow of resources, goods and services), to full economic unions (common monetary and fiscal policies). This study analyzes the implications of creating a free-trade zone for cattle among West African countries, which is one aspect of the ongoing economic integration discussion. The analysis focuses on trade arrangements that allow free movement of cattle[1] among the countries constituting the

[1]Even though most of the cattle in the sub-region are raised for beef, they are generally dual-purpose animals. This study concentrates on the beef aspect of the sub-sector.

Economic Community of West African States (ECOWAS), while each country sets its own trade policies with non-members. It also analyzes the effect of alternative exchange rate arrangements on cattle trade flows in the sub-region.

Historically, cattle have been an important item of trade among ECOWAS countries, particularly between the Sahelian (semi-arid north) and coastal (humid south) countries. Trade flows have generally been in a north-south direction, and movements across coastal countries have been uncommon, except for some beef and other cattle products in limited quantities. The study covers cattle trade in the "Central Corridor"[2] of West Africa, where the dumping of beef from the European Union has been high in recent years (Madden, 1993). Fig. 1. shows cattle trade flows as it has historically existed in the subregion, including beef imports from the European Union in recent years. The lighter arrows indicate limited trade in processed beef (e.g., smoked beef and hide) and other cattle products (e.g. leather).

1.1. Problem Statement and Justification

Inter-regional trade within the West African sub-region has been limited, averaging less than 10% of total trade, compared to about 70% for Western Europe and 40% for NAFTA (Sander, 1996). Traditionally, Ghana, Nigeria, Cote d'Ivoire, and Senegal have been relatively large trading partners with each other, at least at the official level. But in spite of the provisions made under the ECOWAS treaty, there

[2]The "Central Corridor" is a short-hand term for the four countries situated in the central part of the West African sub-region: Ghana, Cote d'Ivoire, Mali, and Burkina Faso.

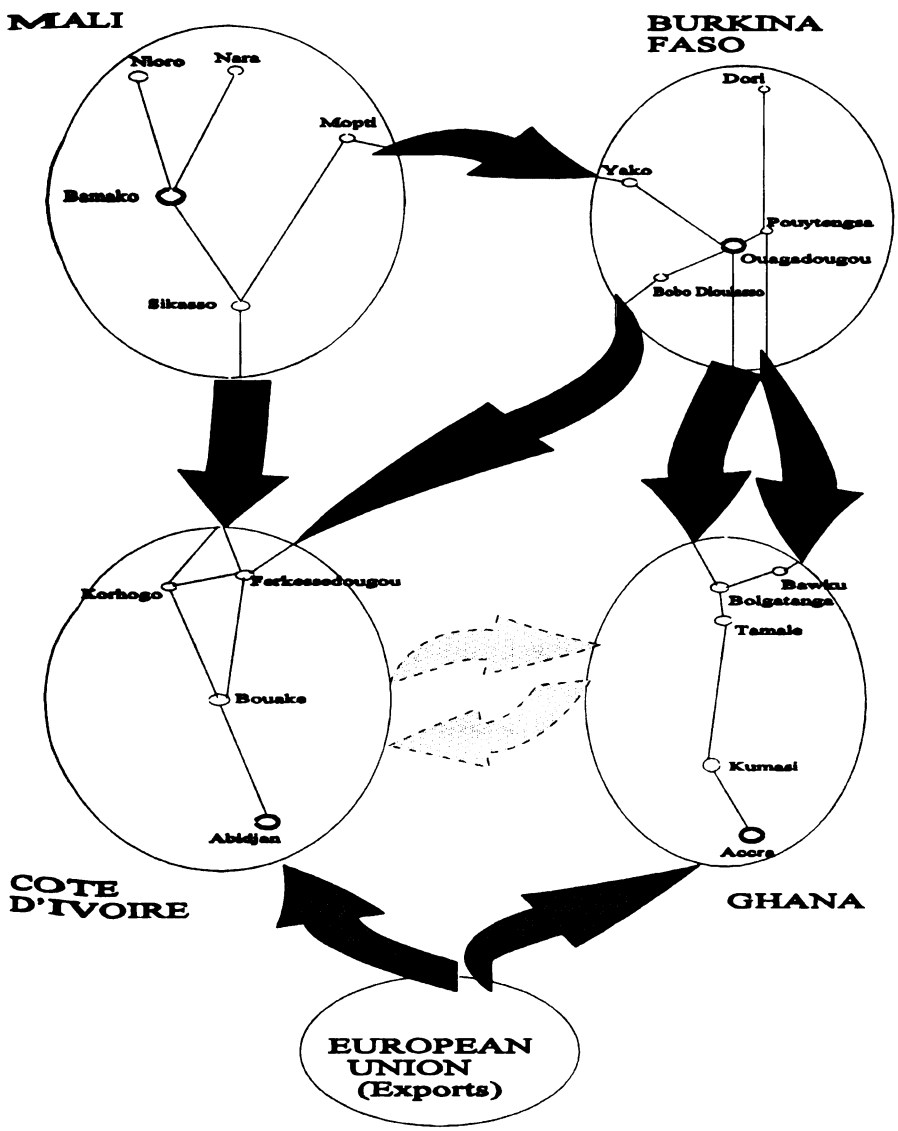

Figure 1.1. Beef and Cattle Trade Flows in the Central Corridor of West Africa.

still exists substantial tariff and non-tariff trade barriers that have prevented free movements of goods and services throughout the region (Egg *et al.*, *ibid.*).

Even though trade restrictions may have created selected benefits in some areas, they also have generated economic inefficiencies in some of the countries in the sub-region. It is not surprising therefore that a thriving parallel trade (or black/underground trade) has existed in the region over decades. Moreover, policy makers in the sub-region have always stressed economic integration in terms of the production and distribution of industrial products, interpreting it as a component of national industrialization strategies, and have paid very little attention to trade in agricultural products, which constitute the bulk of bilateral trade among West African countries (Badiane, 1991).

Some of the reasons given for the failure to expand trade among West African countries include: (1) the lack of political will on the part of governments to sacrifice inefficient domestic production in favor of cheaper imports from countries in the sub-region; (2) balance of payment problems resulting from significant differences in macroeconomic policies; (3) large differences in economic size and levels of development such as between coastal and interior states; (4) similarity of products and high transaction costs; and (4) structural and historical factors emanating from different colonial experiences and economic traditions. But at the core of all these problems is the lack of information on the specifics, such as the magnitude of expected changes that will be generated in goods and services as a result of economic

integration.

Although West Africa is the most densely populated sub-region in Africa, it consists of small separate national markets which are limited in terms of size (population) and purchasing power (low per capita income). Since there exist similarities in terms of foods consumed across countries in the region, the potential for market expansion that integration could generate, particularly in the food sector, is therefore a reasonable justification for integration. Answers to questions regarding production and consumption changes, as well as payoffs and their distribution, are thus crucial to arguments about creating a free trade zone in West Africa.

This also brings into focus the issue of alternative currency arrangements within the sub-region. For example, among the four countries that constitute the Central Corridor, Ghana is the only one that is not a member of the CFA Franc zone. Since 1983 Ghana has undertaken exchange rate reform to correct overvaluation of her currency, the Cedi, as part of a World Bank/IMF sponsored structural adjustment program. This has resulted in massive devaluations of the Cedi, which exchanged for the US Dollar at a fixed rate of C2.75/US$1 at the onset of the reform in 1983, but had declined in value by 99.2% to C345/US$1 in 1990, and by a further 80% to C1,700/US$1 by 1996. The Cedi-Dollar exchange rate in 1998 was in excess of C2,000 per US$1. These devaluations have occurred in the presence of a significant parallel foreign exchange market. On the other hand, the CFA Franc, which has been pegged to the French Franc, had since 1948 not been

devalued until January 1994, when it experienced a one-time devaluation of 50% relative to the French Franc.

The differences in the currency regimes that exist in the West African sub-region between the francophone CFA Franc, on one hand, and other non-CFA Franc countries, on the other, could substantially affect trade and trading patterns, including beef and cattle, in the sub-region.

Moreover, even though the ECOWAS treaty advocated, in general terms, more open trade across borders in the sub-region, each country has both tariff and non-tariff barriers which negatively affect trade among them. At the official level, most forms of export taxes and import tariffs on cattle and other livestock products have recently been removed or substantially reduced by all the countries in the Central Corridor. However, other forms of taxes still persist, both at the official and unofficial levels. These include market taxes, veterinary taxes, sales tax, and various forms of certification and licensing fees which together constitute substantial transaction cost. Kulibaba and Holtzman (1990), for example, report the existence of several types of payments along the marketing chain for livestock in the central corridor: tips to government officials (or what they term as payment for licit services), bribery (or payment for illicit services), extortion, and fraud. The aggregate of these costs could be very substantial, thereby impinging on the benefits that would otherwise have accrued to free trade in cattle in the sub-region. There is thus a significant gap between what is theoretically desirable at the official level and what pertains in actual

practice of more open trade in cattle in the sub-region.

The foregoing generates some interesting questions: What would be the direction of shifts in the production of cattle and consumption of beef under free trade in the region? What would be the distribution of gains and losses (*i.e.*, who would be the gainers and losers) when there is more open trade ? What would be the magnitude of these changes? How would the flow of beef imports to the sub-region change, and what would be its implication for import substitution in the region ? Would a common currency or a common exchange rate regime for the sub-region make any difference to cattle trade flows in the Central Corridor? To inform these questions, there is need to investigate what would happen to the production of cattle and consumption of beef in the sub-region if all intra-regional trade restrictions were removed, and what would be their implications for regional food imports, particularly beef, under a common currency system.

Much discussion has focused on the benefits that economic integration in the sub-region would generate for all the ECOWAS countries, but these have tended to be mainly qualitative or descriptive. Few studies have attempted to quantify the magnitudes of the consumer/producer trade-offs that freer trade resulting from economic integration would provide. Empirical analysis that fills this gap will be an important input for the on-going discussion, and contribute to the debate on economic integration and its implications for the ECOWAS sub-region. Moreover, it is important to define clearly the gains and losses resulting from economic integration

to help policy makers decide what might be best for their respective countries in the face of recent global move towards integration. Also, knowledge of the magnitudes of the gains and loses will stimulate competition among member countries and therefore efficiency in the production of food products in which specific countries have comparative advantage. This will both increase trade in the sub-region and enhance economic welfare among the ECOWAS countries.

The choice of cattle for this analysis is borne out of two related issues. First, animal production is a major economic activity in the two Sahelian countries, representing about 16% and 10% of Gross Domestic Product (GDP) in Mali and Burkina Faso, respectively. The World Bank, for example, estimates that about 30% of exports from Mali and 26% from Burkina Faso are trade in animals. At the same time, coastal countries in the region, such as Ghana and Cote d'Ivoire, are net importers of beef and cattle; and this has traditionally created a potentially viable trade in animals between the Sahelian and coastal countries.

Second, the European Union (EU) in the 1980s and early 1990s followed a policy of dumping beef in West Africa (at prices about 30% to 50% lower than beef from the West African sub-region) as a way of containing problems with European surpluses (Madden, *ibid.*). The exports of beef from the EU to West Africa increased about 700% in the 1980s, which greatly affected the traditional cattle trade in the region. GATT (1993), for example, reports that in 1992/93 about 99% of all non-African beef imports to West Africa came from the EU countries. There is need for

assessing how cattle trade in the sub-region has been affected as a result of the EU beef dumping, as well as the overvaluation of West African currencies, which also contributed to making imports of beef from Europe relatively cheap.

Traditional trade theories have emphasized gains from trade. However, in the face of secular decline in the terms of trade of the South (relative to the North) in the process of trade and growth (Sakar, 1996), recently more emphasis are being placed on South-South as well as inter-regional trade to promote growth and improvements in welfare in developing countries. For example, Appleyard *et al.* (1989) demonstrate that while industrial countries improve their terms of trade unambiguously from Free Trade Arrangements (FTA) with Less Developed Countries (LDCs), LDCs do not experience unambiguous terms of trade improvement from such arrangements; even though there is some gain by LDCs over non-members. They further conclude that trade among nations with similar levels of economic development generates benefits that are fairly distributed among such countries based on the position of their traded goods on the continuum of goods and services traded. For example, two developing countries trading in cattle (such as Burkina Faso as the exporting country and Ghana as the importer) both benefit through trade, but the distribution of benefits depends on the size and importance of cattle relative to other commodities exported by Burkina Faso, and the size and importance of cattle relative to other commodities that Ghana import.

This assertion is supported by Wooton (1986), who provides a theoretical

model to show that LDCs gain by forming a FTA with each other if the volume of their international trading increases. Hamada and Goto (1996) also extend Krugman's (1991) model on optimal tariffs and regional integration to argue that member countries forming a free-trade area become better off relative to non-members. Thus, there is growing theoretical support for integration among developing economies such as those found in the West African sub-region.

Most of the literature on integration in Sub-Saharan Africa notes the failures of previous attempts at regional economic integration, such as the case of the Economic Community of West African States (ECOWAS), whose protocol was signed in 1975; and the East African Economic Community (EAEC). Mansoor and Inotai (1991), in a review of integration in Sub-Saharan Africa, stress inherent structural problems which continue to hinder outright regional integration, recommending that regional trade liberalization should be pursued as a first step. A similar conclusion was reached by Lipumba and Kasekende (1991) when they discussed prospects of preferential trade area for Eastern and Southern Africa.

Also, Ariyo and Raheem (1991) analyze trade flows within the ECOWAS sub-region and conclude that a major obstacle is non-liberalization of trade to member countries in the sub-region, and suggest trade liberalization with harmonization of production and investment proposals as one way to address the problem. Furthermore, in a paper on unrecorded trans-border trade in Sub-Saharan Africa, Barad (1990) makes an argument that such trade greatly influences the economies of

the respective African countries through their effect on the incomes of participants as well as loss of revenue to governments, and advocates open markets that encourage official trade as an important step in the economic integration process.

It is evident from the existing literature on regional economic integration (and therefore open trade in Sub-Saharan Africa) that there exists a wide gap between recognizing what the potential benefits of integration are, and actually quantifying such benefits. In part, the reluctance of government to commit to full implementation of the numerous protocols on integration and liberalization of trade in the West African sub-region could be attributed to the uncertainties that surround these expected benefits. This study is therefore an attempt to quantify the magnitudes of such gains (or losses as the case may be) to specific countries and economic agents.

The study is limited to the four countries (Ghana, Cote d'Ivoire, Mali and Burkina Faso). Ghana and Cote d'Ivoire provide a comparison between coastal countries in the region, while inclusion of Mali and Burkina Faso allows comparison between both coastal and interior countries, and between two interior countries.

1.2. Study Objectives and Hypothesis

The main objective of this study is to estimate the magnitude and direction of trade flows in cattle and their associated welfare implications in the event that more open trade is instituted in the West African sub-region . This will inform the ongoing debate on economic integration in West Africa (a goal that has eluded the ECOWAS

countries since the mid 1970s). The specific objectives include:

1. determine the magnitude and direction of shifts in the production of cattle and consumption of beef under more open trade based on comparative advantage;
2. estimate changes in the producer and consumer surpluses for the beef sub-sector in the countries being studied;
3. determine what effect more open trade will have on beef imports into the sub-region; and
4. determine how exchange rate adjustments may cause shifts in the production and consumption of cattle.

The following working hypotheses are formulated to meet the above objectives:

1. aggregate production of cattle and consumption of beef will increase under more open trade in the sub-region.
2. consumers in importing countries are likely to experience higher welfare gains than producers in those countries under more open trade;
3. consumers in exporting countries are likely to experience lower welfare gains than producers in those countries under more open trade;
4. beef imports to West Africa will decline as open trade in the sub-region expands; and
5. exchange rate adjustments will shift regional trade in favor of the country or countries with more flexible exchange rate regimes.

The subsequent chapters of the study proceed in the following manner. Chapter Two discusses the theoretical underpinnings of the study, and subsequently develops the mathematical model applied. Chapter Three gives an overview of trade among countries in the West African sub-region, with emphasis on trade in cattle involving Ghana, Cote d'Ivoire, Mali, and Burkina Faso. The existing trading arrangements and restrictions are outlined. Chapter Four focuses on the sectoral analysis of cattle in Ghana, Cote d'Ivoire, Mali, and Burkina Faso, with emphasis on the production and distribution of cattle and beef in each country. In Chapter Five the sources of data, as well as the model estimation and its results are discussed. Chapter Six gives the summary and the policy implications of the study; as well as provide some direction to future research that will have some relevance to the results of this study.

CHAPTER II

Conceptual Framework, Theoretical Basis, and Mathematical Model

2.0. Introduction

This chapter discusses the methods used in the analysis, including the conceptual framework which lays out the theoretical underpinnings of the simulation model applied. The discussion draws on elements of international trade theory, the competitive market framework, and welfare economics to develop a model for determining the magnitudes of gains and/or losses and their distribution among economic agents under more open trade. It consists of two sections: (a) the theoretical basis of the model and the conceptual framework which explains the methods applied, and (b) the mathematical model simulated.

2.1. Conceptual Framework

The idea that gains result from trade is an outcome generally accepted by economists. Adam Smith argued that specialization and economies of size are among the advantages that accrue to trading nations, based on the concept of absolute advantage (that a nation specializes in producing the good or goods in which its cost or costs were least relative to others).

Subsequent to Adam Smith's work, David Ricardo observed that trading countries could still gain even if one of them had absolute advantage in producing all

goods. Using a two-country two-good model (commonly called the Ricardian Trade model), Ricardo demonstrated that even when one country is disadvantaged in producing both goods, total output increased and both countries raised their living standards as long as they engaged in trade, based on the concept of comparative advantage. Comparative advantage is the concept that a nation specializes and produces the good in which it requires the least resources relative to other nations, even if it does not have absolute advantage in producing that good. Thus, in the two country case, one country produces and exports the good in which it has the greatest advantage, and the other country produces and exports the good in which it has the least disadvantage.

Further development of the trade model include the work of Heckscher and Ohlin, and later Samuelson, who gave an algebric form to their work (sometimes referred to as the Heckscher-Ohlin-Samuelson synthesis). Based on assumptions of identical consumer preferences and same technology across countries, with differences only in factor endowments without factor intensity reversals, they postulated that nations specialize in producing the goods that use their relatively more abundant factors of production more intensively; with trade equalizing output prices and returns to factors across trading nations.

Several other extensions and variants of the Heckscher-Ohlin-Samuelson synthesis have been made, such as the Stolper-Samuelson theorem, which states that when a tariff is imposed on a good that is imported, benefits accrue to the factor used

most intensively in the domestic production of that good. The Rybczynski's theorem says that given that commodity and factor prices as well as technology remain unchanged, when the quantity of a factor increases, it causes an output increase in the good that uses the factor more intensively and output decrease in the other good. The work of Mundell (1957), Markusen (1983), and others, which focused more on inputs rather than outputs, all have their basis in the Heckscher-Ohlin-Samuelson synthesis.

Krugman (1981), Melvin (1985), and others have used differences in consumer preferences in a more modern approach to international trade, such as trade between countries at similar stages of development. Issues not considered under the classical framework, including increasing returns to scale and imperfect competition, have been addressed. They conclude, among others, that international trade in many products in the modern world is driven more by economies of scale, which leads to specialization in an increasingly imperfectly competitive world, than by comparative advantage.

The foregoing discussion demonstrates that based on classical welfare analysis, a case has been made for the gains that result from free or more open trade between countries. However, in practice, trade barriers that limit trade still exist between countries and across regions. The World Trade Organization (WTO) has a mandate to address these barriers. Tweeten (1992) has listed, among others, efforts to protect or promote national security, the infant industry argument, employment, balance of payments problems, and countervailing power, as some of the major arguments that

countries give as a justification for imposing trade barriers. He points out that the new welfare economics which emphasizes efficiency (with the assumption that gainers could adequately compensate losers) also supports removal of trade barriers, irrespective of how efficiency gains are distributed. The problem, though, has to do with how compensation can be made when we factor in the issues of power politics and pressure groups.

The conclusions of classical welfare analysis also provide a tool for modeling competitive markets. Because, under certain assumptions, competitive markets maximize social surplus, a programming model that maximizes social surplus can be used to simulate a competitive market.

The theoretical basis for maximizing social surplus within a competitive market framework is rooted in the fundamental theorem of welfare economics. Varian (1992 & 1993), and Quirk and Saposnik (1968) discuss the relationship between general equilibrium and competitive partial equilibrium. In general equilibrium models, all the interactions between markets and the functioning of the individual markets in the economy are considered. All prices are variable, and determined as relative prices; and in equilibrium all markets must clear (i.e. no excess demand or supply). Competitive equilibrium, also called market equilibrium or Walrasian equilibrium, is the case where demand for each good varies continuously as prices vary until equilibrium is reached, such that there is always some set of prices where supply and demand equate in every market. Thus, whereas general equilibrium

describes the total economy, competitive equilibrium could refer to the markets of individual commodities, sectors, or the entire economy.

In a *pure exchange economy* (i.e., only consumers are considered), Warlas' law states that the value of aggregate excess demand is identically zero (or zero for all prices). This implies that if there are markets for s commodities, and s-1 of the markets are in equilibrium, then the final market must also be in equilibrium. Warlas' law supports the existence of competitive equilibrium, which forms the basis of the fundamental theorems of welfare economics. The First Welfare Theorem states that a set of competitive markets in equilibrium is Pareto efficient (i.e. the idea that there is no other way to make all the agents involved better off). The Second Welfare Theorem states that with convex preferences, every Pareto efficient allocation can be achieved as a competitive equilibrium. If demand functions are continuous, and Warlas' law is satisfied, then the sufficient conditions for equilibrium to exist are also fulfilled.

Extending the pure exchange economy to include competitive and profit maximizing firms with convex production sets, we can achieve a set of prices for all commodities (inputs and outputs) in all markets such that competitive equilibrium exists (i.e. demand equals supply). In this case, the competitive markets provide a way to achieve efficiency in resource allocation, by decentralizing decisions of producers and consumers as each agent's marginal rate of transformation (MRT) and the marginal rate of substitution (MRS) are equated. The first and second welfare

theorems both hold in an economy with production and consumption under these conditions (Varian, 1993).

Maximizing the net social surplus for beef consumption in the West African central corridor builds on the argument that the competitive equilibrium that results will yield Pareto efficient allocation in the beef sub-sector. The constrained social surplus maximization is thus a tool that allows us to use mathematical programming methods to analyze the market within a competitive market framework. When the objective function is maximized, the model generates optimal values for all prices and factors of production and outputs of commodities included in the model at the point where the market is in equilibrium. These values represent the production and consumption levels of the economy modeled, and allow us to compute the consumer and producer surpluses as welfare indicators. Hence, the model provides a convenient way for conducting simulation analysis for a sector of an economy at the country or regional level when a competitive market framework is an appropriate representation as in the case of beef and cattle trade in the central corridor of West Africa.

This study has therefore attempted to model the beef and cattle sector in the Central Corridor of West Africa using a mathematical programming approach. It applies a competitive market framework as a tool to determine the magnitudes of gains from trade and how such gains are distributed among economic agents. The idea is to consider the Central Corridor of West Africa as a trading area which satisfies the competitive market assumption (e.g., homogenous product, and large

number of sellers and buyers) with respect to cattle trade. The net social welfare that is generated from demand for beef at the country or regional level is then maximized for the case where no trade barriers exist, the common regional currency scenario, etc. The analysis of this situation was accomplished using a quadratic programming model and comparing a base year analysis with results obtained from other different scenarios.

Note that maximizing the "aggregate profit" of the sector being analyzed is, in principle, taking the algebraic sum of the profit maximizing problems of the individual producers in the sector. This implies that the total production generated by each activity is determined at the level of each producer's decision on output based on the individual's profit function first order conditions. When demand and supply relations are incorporated into the model we obtain the competitive market equilibrium which helps us estimate the producer and consumer surpluses (or net social benefit). McCarl and Spreen (*ibid.*) provide a more formal discussion on how maximizing net social benefits in the aggregate is analogous to maximizing profits and utility of individuals.

Graphically, the Net Social Benefit (NSB) can be shown in a simple market demand and supply framework as in Fig. 2.1.

The Net Social Benefit, NSB, is the sum of X and Y (Fig. 2.1) which are the consumer's and producer's surpluses, respectively. C represents the total cost

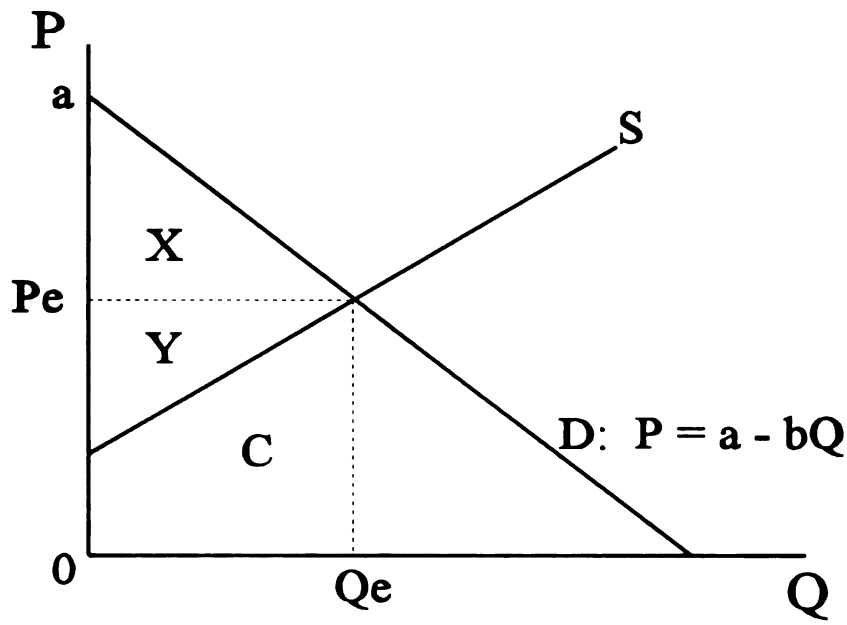

Figure 2.1 Maximizing Net Social Benefit (X + Y)

function C(Q), and P_e and Q_e are equilibrium price and quantity, respectively. The NSB associated with any commodity y can be derived by taking the integral of the total area under the demand curve from 0 to Q_e (we substitute for the price-dependant demand function), and subtracting area C.

For a linear demand curve, the procedure is as follows:

$$NSB_y = \int_0^{Q_y} P_y \, \delta Q_y - C(Q_y) \qquad (1)$$

$$NSB_y = \int_0^{Q_y} (a_y - b_y Q_y) \, \delta Q_y - C(Q_y) \qquad (2)$$

$$NSB_y = a_y Q_y - 1/2 b_y Q_y^2 - C(Q_y) \qquad (3)$$

Similarly, we can derive the NSB algebraically using Fig. 2 by computing area X plus area Y (i.e. NSB) as follows (assuming linear demand and supply functions):

$$NSB = 1/2(a - P_e)Q_e + P_eQ_e - C \qquad (4)$$

Then for one commodity, y, we get

$$NSB_y = 1/2(a_y - P_y)Q_y + P_yQ_y - C(Q_y) \qquad (5)$$

Substituting for $P_y = a_y - b_yQ_y$ and simplifying:

$$\mathbf{NSB_y = a_yQ_y - 1/2b_yQ^2_y - C(Q_y)} \qquad \mathbf{(6)}$$

As seen from equations (3) and (6), maximizing the NSB as an objective function implies maximizing a quadratic function, which justifies the use of quadratic programming for the analysis. The equilibrium values generated by the model (e.g. prices and quantities) also represent the decision variables that determine changes in production and consumption, as well as welfare.

2.2. Theoretical Basis of the Mathematical Model

The theoretical underpinnings for the application of mathematical programming models for sectoral analysis, and therefore the use of quadratic programming for modeling beef cattle trade in the West African Central Corridor, are presented in this section. Following McCarl and Spreen (1980), prices and quantities are endogenized under a neo-classical framework and marginal conditions analogous to conditions for profit maximization derived.

Mathematical Model Derivation

First, let us assume that the sector consists of a large number of economic agents each seeking to maximize some objective(s). For this analysis, we abstract from all other objectives so that both producers and consumers operate in competitive markets to maximize profits and utility, respectively. Producers produce some number of homogenous outputs and compete for the same factors of production; each using a finite set of production processes. Each producer is assumed technically efficient, and combines *i-owned* factors and *j-purchased* factors to produce a unit of each homogenous output, *Y*. Even though the actions of individual producers and consumers have no effect on market prices and quantities under the competitive framework, at the aggregate level this assumption is relaxed, making prices and quantities endogenous to the model. Then assuming inverse demand and supply functions for the output in the market, market price is given by the functional

relationship:

$$P_d = P_d(Y, H); \qquad d = 1, \ldots\ldots, D \text{ products,}$$

where P_d is market price per unit of output; Y is a $m \cdot 1$ vector of output from the sector; and H is a vector of exogenous variables. Assume also an inverse supply function for purchased inputs:

$$w_j = w_j(K, V); \qquad j = 1, \ldots\ldots, J \text{ purchased inputs,}$$

where w_j is market price per unit of purchased input; K is a $j \cdot 1$ vector of purchased factors used by the sector; and V is a vector of exogenous variables. Now we proceed to define the following terms:

n refers to the producers; n = 1, ..., N;

i refers to own inputs; i = 1,..... , I;

j refers to purchased inputs; j = 1, ... , J;

f refers to the production process, f = 1, ..., F;

g_{fn} is the level of the f*th* production process utilized by the n*th* producer;

Y_{dfn} is the yield of the d*th* output of the f*th* production process from the n*th* producer;

L_{ifn} is the use of the i*th* own input in the f*th* production process by the n*th* producer;

K_{jfn} is the use of the j*th* purchased input in the f*th* production process by the n*th* producer;

L_{in} is the endowment of the i*th* own input for the n*th* producer;

α_{ifn} is the quantity of the i*th* own input required by one unit of the f*th* production

process used by the n*th* producer;

β_{jfn} is the quantity of the j*th* purchased input required by one unit of the f*th* production process used by the n*th* producer;

θ_{dfn} is the per unit quantity (or yield) of the d*th* output from the f*th* production process used by the n*th* producer.

Based on the above definitions, we can express the sectoral supply of the d*th* commodity as:

$$Y_d = \sum_{f=1}^{F} \sum_{n=1}^{N} Y_{dfn} \qquad (7)$$

Similarly, the sectoral use of the j*th* purchased input may be expressed as:

$$K_j = \sum_{f=1}^{F} \sum_{n=1}^{N} K_{jfn} \qquad (8)$$

and that for the use of individual owned input, i, expressed as:

$$L_i = \sum_{f=1}^{F} \sum_{n=1}^{N} L_{ifn} \qquad (9)$$

If we assume constant returns to scale (CRS) for all producers, then their "aggregate" profit function can be written as:

$$\Pi_N = \sum_{n=1}^{N} [\sum_{f=1}^{F} (\sum_{d=1}^{D} P_d Y_{dfn} - \sum_{j=1}^{J} w_j K_{jfn})] \qquad (10)$$

subject to:

$$\sum_{n=1}^{N} (Y_{dfn} - \theta_{dfn}\, g_{fn}) = 0; \quad d=1....,D;\ f=1....,F;\ n=1....,N; \qquad (11)$$

$$- K_{jfn} + \beta_{jfn}\, g_{fn} = 0 \quad j=1....,J;\ f=1....,F;\ n=1....,N; \qquad (12)$$

$$- L_{ifn} + \alpha_{ifn}\, g_{fn} = 0 \quad i=1....,I;\ f=1....,F;\ n=1....,N; \qquad (13)$$

$$\sum_{j=1}^{J} \sum_{f=1}^{F} K_{jfn} * w_j \leq VK_{jn} \quad j=1....,J;\ n=1....,N; \qquad (14a)$$

$$\sum_{i=1}^{I} \sum_{f=1}^{F} L_{ifn} \leq L_{ni} \quad i=1....,I;\ n=1....,N; \qquad (14b)$$

where VK_{jn} is defined as the value of total credit available to producers.

By forming a Lagrangian, L, we can derive the necessary and sufficient **conditions** for a constrained maximization using Kuhn-Tucker conditions, analogous **to** profit maximization of an individual producer (see McCarl and Spreen, *ibid.*). This **will** yield optimal values for Y^*_{dnf}, L^*_{inf}, K^*_{jnf}, g^*_{nf}, and Lagrange multipliers, **which** are marginal prices or values. Thus, while individual producer decisions are **determined** by their first order conditions of profit maximization, including factor supply and product demand functions in the model make aggregate quantities and prices endogenous.

Now we assume well-behaved continuous linear demand and supply functions in matrix notation as follows:

$$P_d = A_d - B_d Y \quad (15)$$

$$W_j = C_j + M_j K \quad (16)$$

where A_d and C_j are scalars, and B_d and M_j are row vectors. Then we can combine the price dependent product demand and input supply functions into an objective function that maximizes the Net Social Benefit (NSB) which is the algebraic sum of producer's and consumer's surpluses.

The maximization problem may be expressed as:

$$\text{Max NSB} = \text{Max}\{Y'A - 1/2Y'BY - KC' - 1/2K'MK\} \quad (17)$$

subject to:

$$Y_d - \sum_{n=1}^{N}\sum_{f=1}^{F} Y_{dfn} = 0 \quad (19)$$

$$-K_{jfn} + \beta_{jfn}\, g_{fn} = 0 \quad (20)$$

$$-L_{ifn} + \alpha_{ifn}\, g_{fn} = 0 \quad (21)$$

$$\sum_{j=1}^{J}\sum_{f=1}^{F} K_{jfn} - K_j = 0 \quad (22)$$

$$\sum_{j=1}^{J}\sum_{f=1}^{F} K_{jfn} \le VK_j \quad (23a)$$

$$\sum_{f=1}^{F} L_{ifn} \le \alpha_{ifn}\, g_{fn} = 0 \quad (23b)$$

where the term (Y'A - 1/2Y'BY) is the sum of the areas under the output demand functions; and the term (KC' + 1/2K'MK) represent the total cost or the sum of areas under the output supply functions. Thus, the difference between these two terms is the sum of consumers' and producers' surplus over all markets, which is maximized at the point of supply and demand equilibrium.

By using Kuhn-Tucker conditions for the constrained maximization problem as before, we can verify an "aggregate" marginal cost to which each producer equates product price; and "aggregate" marginal value product to which factor prices are equated (Samuelson, 1952; Takayama and Judge, 1964; Hazell and Norton, 1986). Thus we obtain a sectoral supply curve as the aggregate marginal cost schedule, and sectoral derived demand curve for purchased inputs as the aggregate marginal value product schedule. The optimal solution of the model provides values for equilibrium prices and quantities of both outputs and inputs.

Accounting for Risk in the Trade Model

Any event with more than one outcome involves uncertainty when there is no foreknowledge of the probabilities of the occurrence of such outcomes. In the cases where the probabilities are known, the outcomes involve risk. This distinction between risk and uncertainty has broken down in recent years as analysts have realized that everything we know, including probability distributions that characterize "risk", we know in a probabilistic sense. Hence, the notion of risk is not clear-cut.

In this analysis, the term risk is used to represent the general state of ambiguity within which economic agents make decisions in the beef and cattle sub-sector.

Farmers generally confront numerous natural hazards such as drought, fire, or floods, which may destroy both crops and livestock; as well as variability in outputs, inputs, and prices that affect their incomes. Consequently, agricultural production, particularly in developing countries, has been recognized as risky due to the mostly uncontrollable nature of the environment in which production and distribution take place; and empirical studies show that farmers in general behave in a risk-averse manner (e.g. Binswanger, 1980). The challenge, however, has been how to specify "aggregate risk aversion" in a model which represents a constrained equilibrium when the decision makers (e.g. farmers) usually have a myriad of objectives.

Three main approaches for incorporating risk in programming models have been identified in the literature (Wicks, 1978; Hazell and Norton, *ibid.*). These include (a) the mean-variance (E, V) criterion, which uses the relationship between the expected value of that variable and its associated variance or standard deviation; (b) safety-first models based on what is termed focus-loss (FL) approach, where the risk-related activity is set at a predetermined level; and (c) flexibility constraint formulation (FLEX), in which a constraint on some activity is predetermined and incorporated into the model.

This study applies the more commonly used mean-variance (E, V) method to

account for the risk-averse behavior of economic agents in the cattle sub-sector of the Central Corridor of West Africa. The basic assumption here is that the coefficient for aggregate risk aversion for a region or country should be equal to the sum of the individual risk aversion coefficients (Hazell and Scandizzo, 1974). This may be expressed as:

$$\Sigma_n \phi_n y_n' \omega_n y_n \quad = \quad \Phi\, Y'\, \Omega\, Y$$

where **Y** is a vector of the aggregate of cattle numbers supplied (off-take) in each region; Ω is the aggregate $n*n$ covariance matrix of "activity" revenues with diagonal elements for all cattle producing regions; and Φ is the aggregate risk aversion parameter.

Following Hazell and Scandizzo (1977), and Hazel and Norton (*ibid.*), the model maximand of the quadratic programming formulation (equation 17) can be adjusted to account for producer risk-aversion behavior, and expressed as:

$$\text{Max NSB} = \text{Max}\{Y'A - 1/2Y'BY - KC' - 1/2K'MK - \Phi(Y'\Omega Y)^{1/2}\} \qquad (24a)$$

subject to equations (19) to (24). However, Hazell and Scandizzo (1975), and supported by Newbery (1976), have argued that when production is risky, competitive markets may no longer be socially efficient; and that the assumption that farmers make decisions based on price expectations independent of their anticipations about yields may be what largely accounts for this outcome (i.e., that competitive markets

may no longer be socially efficient). Hazell and Scandizzo (1977) then demonstrate mathematically that when producers have revenue expectations rather than price expectations, they lead to a market equilibrium in which social welfare is maximized, based on the assumption that revenue expectations are rational expectations.

The appropriate maximand for a model in which producers act on the basis of revenue rather than price expectations is:

$$\text{Max NSB} = \text{Max}\{E[Y'(A - 1/2Y'BY)] - KC' - 1/2K'MK - \Phi(Y'\Omega Y)^{1/2}\} \quad (24b)$$

where the term $E[Y'(A - 1/2Y'BY)]$ is the expected sum of the areas under the demand curves given actual supplies (Y); and $KC' + 1/2K'MK + \Phi(Y'\Omega Y)^{1/2}$ represent the total cost or the sum of areas under the output supply functions. The difference between Equations (24a) and (24b) is the expectation on Y in Eqn (24b) compared to Eqn (24a) such that our maximization problem in the latter incorporates expected sum of areas under the demand curves given actual supplies,

$$E\left[\int_0^Y (A - BY)\right] \delta Y$$

compared to the former where we sum the areas under the demand curve given expected supplies,

$$\left[\int_0^{E[Y]} (A - BY)\right] \delta Y$$

Since the market clearing prices in any one year are given by $P_y = A - BY$, the vector of unit revenues (R) is $R = PY = Y'A - Y'BY$. Assuming that producers form

their expectations about R* in such a way that at equilibrium

$$R^* = E[R] = E[Y]A - E[YBY]$$

then the expected unit revenue E[R] at equilibrium would satisfy the optimality condition that expected unit revenues must be equal to the marginal cost for each activity (see Hazell and Norton, *ibid.*).

The covariance matrix, Ω, may be constructed by the use of ordinary least squares regression analysis that applies time-series data on prices and the number of cattle supplied by region (and accounting for trend). A common approach for obtaining the risk-aversion parameter, Φ, in a sector model is to first parameterize the model for different values of Φ. The different predicted values of the model are subsequently compared to some base year actuals, so that the parameter which gives the best predictions is selected (Hazell and Norton, *ibid.*).

Measuring Welfare Changes

In terms of measuring the changes in welfare of economic agents such as consumers, the usual approach (at least in theory) is to use the value of that agent's objective function, such as the level of utility for consumers and of profit for producers. However, since consumer utility functions are ordinal measures and therefore not fully defined to give measurable indicators of welfare, alternative measures of welfare based on monetary values have been developed. These include measures based on the concepts of consumer surplus, real income, compensating

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variation, and equivalent variation. In the case of producers in a competitive market, a change in producer surplus or profits accruing to owned factors may be used as an indicator of a change in welfare (since purchased factors are paid their marginal values).

Consumer surplus (CS) may be defined as the area above the price line and below the demand curve. Using a market demand curve (called the Marshallian demand curve, which is demand for a commodity as a function of its price for a given level of income; as opposed to Hicksian demand curve which refers to demand for a commodity as a function of its price for a constant level of utility), a change in CS is a monetary value for a change in utility due to price change. CS is therefore a good measure of welfare when constant marginal utility of money is assumed. Note that the market demand curve itself is also a measure of the marginal utility of consumption. If price and income change occur together, or where there are multiple price changes, CS is not an accurate measure of welfare change since it is path dependent and therefore not unique.

Similarly, compensating variation (CV) and equivalent variation (EV), which are based on expenditure functions (minimum income required to reach a given level of utility at a given price), even though more appealing since they are not path dependent and therefore give unique measures of combined price and income changes, have one important drawback. They each rely on a specific level of utility (CV is specific to initial utility level while EV is specific to final utility level) so that

when utility changes as a result of an income-price change, their measure does not really reflect changes in welfare (Sadoulet and de Janvry, 1995). Also, real income (defined as the ratio of nominal income to a price index) is simple and a useful measure of welfare when changes are small or product substitu ion is minimal. On the other hand, measures of real income are sensitive to the type of price index used.

All the welfare indicators discussed above provide values that are close to each other, as demonstrated by Sadoulet and de Janvry (*ibid.*). For this study, therefore, the use of CS as a measure of welfare is appropriate since the proportion of consumer income spent on beef is small relative to total income in all the four countries considered, so that measurement errors in CS are likely to be small. The rationale is that beef price changes will not affect a consumer's total income significantly, and any welfare changes due to price change could be attributed to substitution effect rather than income effect.

Exchange Rate Determination

One other issue this study attempts to address is how exchange rate changes in the countries concerned will affect the flow of beef across countries and regions; and subsequently its impact on beef consumption and beef imports to the sub-region. The exchange rate literature shows that the basic index of a country's competitiveness is the real exchange rate (defined as the ratio of the foreign price index converted at the nominal exchange rate to the domestic price index), which reflects the changes in the domestic price of tradeable goods relative to the price of non-tradeable goods in

the whole economy. However, since this analysis is sectoral (rather than a general equilibrium model) and does not incorporate all sectors of the economy, incentive to import or export in the beef sector is assumed to be determined by the effective exchange rate (EER) relative to the beef sector.

The EER, defined per commodity as the exchange rate after accounting for distortions due to export taxes and import tariffs, determines the effective prices at which importers and exporters carry on financial transactions within particular sectors or for specified commodities. For example, an export tax t_{xi} reduces the price received by the exporter of a commodity i because the price of the foreign currency becomes $E(1-t_{xi})$, where **E** is the prevailing nominal exchange rate. Similarly, an importer of a commodity with an import tariff t_{mi} levied on it pays more for the commodity since the price of the relevant foreign currency becomes $E(1+t_{mi})$. For any commodity i then, the EER takes account of both import and export taxes associated with it, and it is computed as:

$$EER = E(1 + t_{mi} - t_{xi}) \qquad (25)$$

In order to derive the effective exchange rate, the major question hinges on how the nominal exchange rate, E, is determined. Particularly for a country like Ghana with floating dual exchange rates (inter-bank rate and forex rate), it is important to establish the elements that influence the determination of the nominal exchange rate.

Following Dornbusch (1976) and Himarios (1987), we combine a money

market equilibrium framework and a goods market analysis (elements of both monetarist and neo-Keynesian thinking) to derive the rate of change of the relevant nominal exchange rate for each country.

The demand for real money balances is specified as a function of real income and domestic interest rate:

$$M/P = Y^{\alpha}\exp^{(-\beta i)}$$

where **M** is nominal money supply, **P** is the general price level, **Y** is real income, **i** is domestic real interest rate, α is income elasticity of demand for money, and β is price elasticity of demand. Thus, in logarithmic form we have

$$LnM - LnP = \alpha LnY - \beta i$$

which gives a rate of change in the variables as

$$m - p = \alpha y - \beta i' \qquad (26)$$

In equilibrium the demand for real money balances is equal to the real money supply. Domestic money market equilibrium then determines the domestic interest rate (i). In this case (') indicates the rate of change in the domestic interest rate.

We assume domestic assets are substitutes of foreign assets (both denominated in domestic and foreign currencies). Then expected changes in the domestic interest rate on assets relative to the interest rate abroad will be proportional to expected rate of change in the domestic currency (assuming perfect capital mobility):

$$i = i^* + B \qquad (27)$$

where i^* is foreign interest rate and **B** is the expected rate of change in the domestic

currency. For example, a devaluation of the domestic currency will increase the interest rate on assets denominated in terms of domestic currency over interest rate abroad.

In the long run the economy converges to an equilibrium. The long-run equilibrium exchange rate, **F**, may therefore be distinguished from the current nominal rate, **E**, so that the expectation formation about the change in the domestic currency is proportional to the difference between the current and the long run exchange rates. This may be represented as

$$B = \pi(F - E)$$

where π is coefficient of adjustment. Taking logs of the above expression we get

$$LnB = Ln\pi + LnF - Ln\pi + LnE$$

so that in terms of rates of change we have

$$b = f - e \qquad (28)$$

Combining equations (26), (27), and (28) we have

$$m - p = \alpha y - \beta\{i^{*\prime} + (f - e)\} \qquad (29)$$

But the general price level, **P**, is a weighted average of the domestic prices of tradeables and non-tradeables. This may be expressed as

$$P = cP_n + (1 - c)P_T$$

where **c** and **(1 - c)** are weights equal to the expenditure shares of non-tradeable and tradeable goods, respectively. Thus, the rate of change in the general price level is given by

$$p = cp_n + (1 - c)p_T \quad (30)$$

Furthermore, the rate of change in the domestic prices of tradeables, p_T, can be derived so as to account for the per unit transaction cost, V, involved in currency exchange as follows (we abstract from transport cost and tariffs since these are already accounted for in the EER calculation):

$$P_T = (1 + V)EP_T^* \quad (31)$$

where V may be interpreted as the markup for a unit cost of smuggling equal to the exchange rate premium, and (*) indicates foreign country . Then, in terms of rates of change (by expanding and taking logs of equation 31), we have

$$p_T = 2(e + p_T^*) + v \quad (32)$$

so that the rate of change in the general price level is

$$p = cp_n + (1 - c)\{2(e + p_T^*) + v\} \quad (33)$$

Substituting (33) into (29) we get

$$m = cp_n + (1 - c)[2(e + p_T^*) + v + \alpha y - \beta\{i^{*\prime} + (f - e)\}] \quad (34)$$

In the long run, $f = 0$ and $i = i^*$ as exchange rates stabilize and interest rates equalize across borders. Re-arranging, and solving for the rate of change in the current Forex exchange rate, we get

$$e = \{c(p_n + \beta i' - 2p_T^* - v - \alpha y) + 2p_T^* + v + \alpha y - \beta i' - m\}/\{2 + \beta - \beta c - 2c\} \quad (35)$$

Equation (35) gives the rate of change in the nominal exchange rate, so that

using the current forex rate for the analysis and combining equations (25) and (34), the adjusted effective exchange rate (EER_a) operative in a country with a *flexible exchange rate* regime (such as in Ghana) may now be expressed as:

$$EER_a = (1+e)\,E\,(1 + t_{mi} - t_{xi})\,;$$

or

$$EER_a = E\,(1 + e)(1 + t_{mi} - t_{xi}) \qquad (36)$$

Under a *fixed exchange rate* regime, the nominal exchange rate, **E**, is exogenously determined. The EER applicable therefore is equivalent to equation (25) adjusted for the rate of change, **v**, in the cross-border exchange rate transaction cost:

$$EER_x = E\,(1 + v)(1 + t_{mi} - t_{xi}) \qquad (37)$$

where **v** is the rate of change of the exchange rate premium (official rate minus the parallel rate). We should note here, though, that **v** does not account for all transaction coats, such as bank charges on currency transfers; nor does it cover the risk associated with cash transactions, which is common among cattle traders in West Africa. Thus, **v** may underestimate the rate of change in the cross-border exchange rate transaction cost and could be considered the lower limit of the actual **v**.

In this study, the EER concept shall be applied to determine the effects of exchange rate changes on trade flows, production of cattle, and consumption levels of beef in the central corridor. This shall be done at both levels of purchased inputs used and demand for beef through the use of simulation analysis within the framework of the trade model.

Mathematical Programming in Sectoral Analysis

Mathematical programming models have been successfully applied to simulate the effects of new policies upon a sector of an economy (see Blitzer *et al.*, 1975). More recently, they have been used to analyze the effects of trade policy changes on specific sectors across countries (e.g., McCarl *et al.*, 1980; Worley *et al.*, 1991). Two levels of analysis are pursued in this study: (1) a quadratic programming approach, which measures the effects of more open trade relative to a base year; and (2) measures of Consumer and Producer Surpluses to examine potential changes in welfare.

In recent years, programming models have been used extensively to address many types of policy questions, including international trade, effects of governments' commodity policies, output supply response, input demand analysis, and project appraisal and evaluation. The basic approach has been to validate the model for a base period, and then use it to simulate adjustments and responses of economic agents to policy changes (McCarl and Spreen, *ibid.*).

Sectoral analysis based on mathematical programming has examined the effects of various policies on foreign trade in both developed and developing countries. For example, Cappi *et al.* (1978) discuss trade volume restrictions within agricultural production and trade in the context of economic integration in Central America; while Duloy and Norton (1979) explore comparative advantage implications

for Mexican agriculture. Similarly, Meister *et al.* (1978) study changes in agricultural export levels using a quadratic programming model; and Rodriguez and Fajardo (1979) analyze sectoral response to changes in the prices of agricultural exports and imports. More recently, Worley *et al.* (1991) have applied mathematical programming to examine the implications of Canada - U.S. free trade agreement for red meat and grain in both countries. The available volume of literature thus indicates that in simulating the potential sectoral impacts of new economic policies, mathematical programming models have proved very useful as evidenced in the review by Blitzer *et al.* (1975).

This study applies a quadratic programming formulation to the beef cattle sub-sector in West Africa within a competitive framework. The aggregate model consists of small competitive units whose collective activities are assumed to influence prices and quantities, thereby making them endogenously determined. Hence, at the individual farm or firm level, the standard formulation implies that producers maximize profits subject to resource constraints. Even though there may be other objectives, we abstract from them so as to keep the analysis simple.

However, in the aggregate, by substituting factor-supply and product-demand price-dependant functions, we transform the objective function from individual profit and utility maximization problems into aggregate producer's and consumer's surplus measures. That is, by using market demand and market supply price-dependant functions we incorporate the underlying individual maximization problems into a

single market model which can be analyzed. These surpluses in effect represent the "net social surplus" resulting from the respective economic activities. No formal supply and demand functions are necessary since these are endogenously determined within the model, based on output demand, factor supply, and production possibilities.

In the present study, local beef, imported beef, and cattle are considered, so that the quadratic programming model is essentially a simulation model of the cattle industry within a competitive framework, allowing changes in the objective function (*e.g.*, changes in government policies or some external shock) with endogenous adjustment by economic agents. The net social benefit, which is the net social payoff, is defined here then in the Samuelson tradition as the sum of the separate payoffs from each activity considered less the total costs of all the activities.

A base year solution is obtained using the base year data, which is 1993 in this case (1993 is chosen to allow comparison between pre-devaluation and post-devaluation experiences of the Francophone countries). The model is considered to have converged if (a) the results from the model accurately replicate the respective country/region's production, consumption, and trade levels for the base year; (b) the prices and quantities demanded for beef in the base year were replicated; (c) numbers of cattle produced in the base year were reproduced for each country/region; and (d) the base period solution was sensitive to beef demand elasticities (McCarl and Spreen, *ibid.*). Once the model is validated, the expected policy changes are then

incorporated. The optimal solution provides estimates of consumer and producer surpluses, prices, quantities of beef produced, consumed, and traded; as well as herd of cattle produced and traded; which are then compared with the base period.

2.3. Mathematical Model

The quadratic programming applied in this analysis maximizes a non-linear objective function (a polynomial of the second degree) subject to a set of linear constraints, with all the variables defined for non-negative values. This is a special case of the general non-linear programming models with well-developed solution methods that overcome the existence of multiple local maxima and minima which are often associated with non-linear models. By using a quadratic objective function, the model also avoids the assumption of perfect elasticity of supply and demand for commodities which is inherent in the linear objective functions when linear programming methodology is applied to economic problems.

A major advantage of applying mathematical programming to analyze trade flows is that it permits both the analysis of a single commodity in a multi-country/region context, and the incorporation of multiple commodities and multiple regions/countries in a single model, while at the same time preserving the theoretical elements inherent in real trade models. For this quadratic programming model, in which net social benefits are maximized within a competitive market framework, the decision variables include regional/country levels of cattle production, beef

consumption, shipments, and imports which are determined within the model. Each region/country defined has a linear demand function for beef incorporated into the model, while the total number of hectares of available pastoral land per region/country, the maximum number of cattle a hectare of pastoral land can support, and other accounting rows constitute the constraints.

The maximization problem is specified as:

$$Max\ NSB = \sum_j \int_0^{Q_j^D} P_j^D\ \delta\ Q_j^D - \sum_s Q_s^s * C_s^F * C_s^P - \Phi(L'\Omega L)^{1/2}$$

$$- \sum_s \sum_j \sum_t^4 X_{sjt} * D_{sjt} * T_t$$

$$- \sum_j \sum_s X_{sj} * MC_s * MC_j * C_s^F \qquad (38)$$

Subject to the following constraints:

$$\sum_s X_{sj} * C_s^F = Q_j^D; \quad j=1,\ldots\ldots\ldots, J \qquad (39a)$$

$$\sum_j X_{sj} = Q_j^D; \quad j=1,\ldots\ldots\ldots, J \qquad (39b)$$

$$\sum_s \sum_t X_{sjt} = \sum_s X_{sj}; \quad j=1,\ldots\ldots\ldots, J \qquad (40a)$$

$$\sum_j \sum_t X_{sjt} = \sum_j X_{sj}; \quad s=1,\ldots\ldots\ldots, S \qquad (40b)$$

$$R_s^A * Q_s^S \leq A_s; \quad s=1,\ldots\ldots\ldots, S \qquad (41a)$$

$$R_s^L * Q_s^S \leq L_s; \quad s=1,\ldots\ldots\ldots, S \qquad (41b)$$

$$R_s^K * Q_s^S \leq K_s; \quad s=1,\ldots\ldots\ldots, S \qquad (41c)$$

$$P_j^D, Q_j^D, P_s^S, Q_s^S, X_{sjt} \geq 0$$

The variables in the model are interpreted as follows:

NSB	=	aggregate consumer and producer surplus measures for beef in a region or country
j	=	demand/consuming region/country
s	=	supply/producing region/country
t	=	mode of transport: t_1 = truck; t_2 = trek, t_3 = train; t_4 = plane
Q_j^D	=	equilibrium quantity of beef demanded in country/region **j**
P_j^D	=	represents the price-dependent demand function for beef in region/country **j**; (where $P_j^D = a_j - b_j Q_j^D$)
Q_s^S	=	head of cattle supplied from producing country/region **s** if **s** = African region/country; or
	=	quantity of beef supplied from abroad if **s** = world market.
X_{sjt}	=	cattle shipments from supply region/country **s** to demand region/country **j** by mode of transport **t** if **s** = African region/country; or

	=	quantity of beef shipments from abroad if **s** = world market.
D_{sjt}	=	distance in kilometers from supply region/country **s** to demand region/country **j** by mode of transport **t**, where **t = 1, 2, 3, 4**
C_s^F	=	conversion factor of per head cattle to ton beef
C_s^P	=	cost of production per ton beef from supply region/country **s**
T_t	=	unit cost per kilometer for mode of transport **t**, where **t = 1, 2, 3, 4**
MC_j	=	marketing cost per ton beef (sum of transformation cost and distribution cost) in demand/consuming region/country **j**
MC_s	=	marketing cost per head of cattle in supply/producing country **s**
R_s^A	=	land (hectares) requirement for cattle production in supply/producing country **s**
R_s^L	=	labor (man days) requirement for cattle production in supply/producing country **s**
R_s^K	=	capital requirement for cattle production in supply/producing country **s**
A_s	=	land (hectares) endowment for cattle production in supply/producing country **s**
R_s^A	=	labor (man days) endowment for cattle production in supply/producing country **s**
R_s^A	=	capital endowment for cattle production in supply/producing country **s**
$\Phi(L'\Omega L)^{1/2}$	=	expression that accounts for risk-averse behavior of producers (see equation (24b)

The objective function (Equation (38)) measures the sum of the total area under the demand curve for beef for each country/region considered, less the costs representing the determinants of the aggregate supply function for each activity:

Objective function = Consumer Utility - Production Cost - Transportation Cost - Transformation/Marketing Cost;

subject to:

cattle off-take numbers at supply centers, land, labor, and capital requirements for production, and factor endowments.

At the optimal solution, we can estimate the net social benefit change relative to the base period as a change in welfare measure. As described below, the welfare measures accruing to economic agents in each country/region are estimated using parameters generated within the objective function for each optimal solution.

Equations (39) to (41) represent the constraints which give form to the model. For example, Equations (39a) and (39b) state that the sum of the total number of cattle produced and transformed into beef in all countries/regions plus all beef imports should equal the total quantity of beef demanded in all countries/regions. Similarly, Equations (40a) and (40b) ensure that shipments of cattle and beef by all modes of transport are equalized between production and demand or consuming centers. Equations (41a), (41b), and (41c) represent land, labor, and capital constraints, respectively, in all producing countries/regions.

Since price equates marginal cost in the set of competitive markets in the trade model, for these markets the implicit aggregate supply functions define costs of production that include both the explicit costs of production and the opportunity cost of owned resources. As multiple regions/countries compete to produce the same commodity, less favorable areas with higher production costs are brought into production as output expands. The result is an upward sloping stepped supply function which is implicit in a sector model with multiple production centers (see Hazel and Norton, *ibid.*).

The optimal solution of the model gives estimates of beef cattle numbers per

country/region; and also provides information on the transportation network among supply and demand centers. The analysis is based on a long run-scenario, allowing time for changes in government policies to take effect.

2.4. Measuring Consumer and Producer Surpluses

The quadratic programming model provides a measure of aggregate consumer surplus (the model sums up all the consumer surplus measures from demand for beef from both domestic and regional sources, as well as imports from the European Union). Hence, an explicit measure of the consumer surplus (as a measure of consumer welfare) for each demand country/region is warranted. This is accomplished using the formula below, which is derived from equation (6), with price and quantity parameters endogenously determined within the quadratic programming model (the model generates beef prices and quantity parameters within the objective function for each optimal solution).

$$ACS_j = \Sigma_i (a_i - 1/2 b_i Q_i^*) Q_i^* - P_i^* Q_i^* \qquad (42)$$

where ACS_j is the aggregate consumer surplus for country/region **j** ; P^* and Q^* are optimal prices and quantities, respectively, for beef from each source **i** demanded in the respective consuming country/region; and **a** and **b** are the intercept and slope parameters, respectively, for each demand function.

Similarly, since we assume a long-run phenomenon in which case producers can adjust all inputs, supply from each producing country/region is limited by the total land available and other endowments. The usual approach in measuring the producer surplus in each country/region is to estimate the shadow price of available land (or the return to the owned factor which is land in this case). This is endogenously determined by the model; and changes in the producer surplus relative to the base year model can be quantified as a measure of changes in producer welfare. In the case of the Central Corridor, estimates of producer profits were used as indicators of producer gains since pastoral lands are mostly communally owned and have no functioning markets, or at best existing land markets are only rudimentary.

In addition, estimates of the changes in government revenue were made to give some indication of what effect changes in the patterns of cattle trade in the Central Corridor could have on government budgets for the different countries. These estimates were computed using the cattle export or import figures and the relevant taxes, as well as quantities of beef imports and the respective tariffs of each importing country. Similarly, estimates of other transfers, such as tips and bribes cattle traders pay along the trade routes, were computed.

CHAPTER III

Cattle Trade and Trade Restrictions in the Central Corridor

3.0 Introduction

In this chapter a short overview of the patterns of trade in West Africa within the sub-region and with the rest of the world, including beef and cattle trade, is presented. A more detailed account of the evolution of beef and cattle trade in the Central Corridor is then pursued, with a focus on the trade policy dimensions of each country; particularly during the period of structural adjustment initiatives beginning in the early 1980s. Both tariff and non-tariff restrictions that have affected cattle trade in the central corridor are also discussed.

3.1 Overview of External Trade of West African Countries

Recorded intra-regional trade within ECOWAS (comprising all the 16 countries in the West African sub-region) has historically been low relative to their trade with the European Union (EU) and the rest of the world (ROW). It is common knowledge, however, that a significant volume of intra-regional trade goes on across all the borders in the sub-region which are unrecorded.

Kornfeld (1990) finds that intra-ECOWAS exports represented about 4% of the total exports from the sub-region in 1975, and it declined further to 3% in 1980 before recovering slightly to 3.5% in 1985. Hewitt and Koning (1996) attribute the

dependance of African countries on the EU for most of their export revenue (estimated at 75% between 1990 and 1992) partly to their former colonial ties to member states of the EU that has allowed them to enjoy preferential access into the EU market since the European Union was created in 1957 (then called the European Economic Community). It was also partly due to successive Lome Conventions starting 1975 that gave special privileges to a group of countries (now made up of 70 African, Carribean, and Pacific countries, called ACP states).

A fundamental problem that has adversely affected most African governments in their desire for more recognition and involvement in the international economic system is the smallness of their economies and their low levels of trade. Moreover, most economies in Africa have persistently been in bad shape, making their participation in international trade and commerce only peripheral. For example, even though some twenty-seven mainly African countries (including all ECOWAS countries) derived 75% of their total export revenues from EU countries between 1990 and 1992, the total exports from Africa (excluding South Africa) represented only 4 % and 3 % of EU imports in 1990 and 1992, respectively (Hewitt and Koning, *ibid.*).

Also, growth in trade (the average annual percentage changes in the value of exports and import) for the period 1980 - 1990 increased 8% for Western Europe to Western Europe, 8% for North America to North America, 7% between Western Europe and North America, and 11% between Western Europe and Asia. On the

other hand, trade among African countries grew by only 3% during the same period, and declined by -0.5% and -6% between Africa and Western Europe and between Africa and North America, respectively (Sander, 1996). The impact of African trade on the world economy thus continue to be negligible, making regionalism (as in the case of the European Union or the North America Free Trade Agreement, NAFTA) and economic cooperation increasingly relevant in the emancipation efforts of Sub-Saharan Africa.

Balassa (1976) distinguishes between economic cooperation and integration in the context of regionalism world wide. He argues that economic cooperation is of limited scope and concerns concerted efforts by participating countries to lessen or eliminate discrimination in certain areas of common interest. On the other hand, integration is a process that has a goal of abolishing all forms of discrimination among participating countries in terms of local and foreign goods, services, and factors of production.

There are at least four stages of the integration process which constitute a kind of non-binding sequence. The first is a *free trade area* involving removal of barriers to trade in goods and services among participating countries while each country maintains its national tariffs in respect of non-member countries. Second, we have the *customs union* whereby the national tariffs of member countries are harmonized into a common tariff against non-member countries. Third, a *common market* is created by liberalizing the circulation of factors of production within the customs union.

Finally, a fourth stage of *economic union* is reached when the remaining economic policies within the common market are harmonized. This stage then leads naturally to formalizing total economic integration under a supranational authority.

In the context of the West African sub-region, an interesting observation is that the CFA Franc Zone countries have inverted some of the order as outlined by Balassa. This is mainly because these countries reached independence with a monetary union already in place, whereas in most cases (e.g., Europe) the monetary union is reached only after many other steps in economic integration.

In its quest for economic integration, ECOWAS has sought to pursue more the issues which characterize the first stage of the integration process, namely, the creation of a free trade area in West Africa as a first step. Unfortunately, the available evidence suggests that not much progress has been made at both the global and intra-regional trade levels in more than two decades since 1975.

In terms of ECOWAS trade with the rest of the world, Table 3.1 and Figure 3.1 both indicate that the overall growth rate of imports and exports by ECOWAS countries between 1985 and 1994 has been erratic. Except for 1990 and 1992, when both exports and imports showed simultaneous positive growths, they were either negative or mixed in all other years between 1985 and 1994; suggesting that more needs to be done among countries in the sub-region to promote external trade.

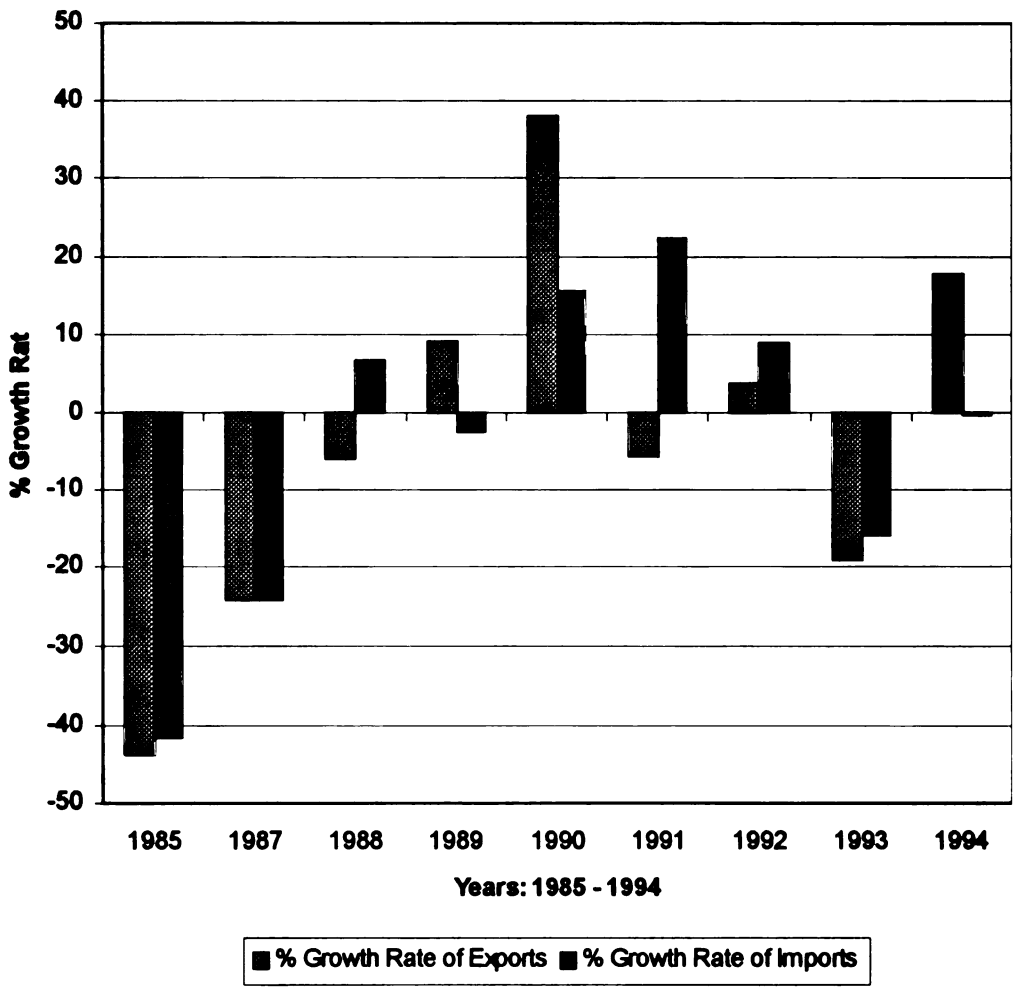
Both exports and imports, for example, declined by more than 40% in each case between 1980 and 1985, amounting to almost 4 billion US dollars in loss revenue

Table 3.1. ECOWAS External Trade (1980 - 1994): Value in Million US Dollars

Year	Exports	% Gr Rt	Imports	% Gr Rt	Tr Balance
1980	33556		25968		7588
1985	18883	-44	15172	-42	3711
1987	14329	-24	11483	-24	2846
1988	13493	-6	12270	7	1223
1989	14724	9	11971	-2	2753
1990	20347	38	13833	16	6514
1991	19181	-6	16920	22	2261
1992	19925	4	18440	9	1485
1993	16141	-19	15491	-16	650
1994	19006	18	15443	-0.3	3563

Source: International Trade Statistics Yearbook. 1995.Vol II. United Nations.

Figure 3.1. ECOWAS: Annual Growth Rates of Exports and Imports



Source: Based on figures in Table 3.1

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to the subregion. By 1994 the trade balance for the subregion was less than half the balance which accrued in 1980. It is instructive to note also that the total trade figures for ECOWAS depend heavily on how Nigeria performs, due to the relative size of its economy and also because Nigeria is a major exporter of petroleum.

Exports from individual ECOWAS countries and their destinations for 1984, 1988, and 1993 are presented in Table 3.2. In general, more than 50% of each country's exports have gone primarily to the European Union (EU) countries in all the years under review, except Cape Verde (46%), Ghana (47%), and Mali (49%) in 1984; and Cape Verde (44%) and Nigeria (44%) in 1988.

ECOWAS countries exports to Sub-Saharan Africa (SSA), which also includes the ECOWAS countries themselves, averaged only about 2% to 4% of their total exports in both 1984 and 1988 except in the case of a few countries such as Cape Verde and Togo. One can thus conclude that during the 1980s and early 1990s, ECOWAS official export trade has been skewed towards the EU and the rest of the world with only a minimal component of intra-regional trade taking place in the sub-region.

An important caveat, though, is that a substantial level of unrecorded trade has persisted across the borders of these countries for decades. For example, Burfisher and Missiaen (1990) find that intra-regional trade among West African countries grew faster than its trade with the rest of the world during the period 1970 to 1981.

Regional exports that occurred within the SSA sub-continent between 1984

Table 3.2. Direction of Trade Matrix – % of Total Exports, 1984 - 1993

	1984				1988				1993			
Exporters	SSA	EU	NAmerica	ROW	SSA	EU	NAmerica	ROW	SSA	EU	NAmerica	ROW
Benin	1	94	0.3	5	4	72	16	8	-	-	-	-
Burk Faso	2	65	0.2	32	4	81	2	14	-	-	-	-
CapeVerde	27	46	0	23	0	44	0	55	-	-	-	-
Cote d'Ivoire	4	63	21	13	2	78	13	7	-	-	-	-
Gambia	0	51	2	47	0.2	63	1	36	-	-	-	-
Ghana	2	47	12	39	0	54	26	20	-	-	-	-
Guinea	4	59	30	7	5	64	29	2	-	-	-	-
GuBissau	1	84	8	8	2	87	4	9	-	-	-	-
Liberia	3	71	20	7	0	69	12	19	-	-	-	-
Mali	4	49	1	46	1	56	4	39	-	-	-	-
Mauritania	18	55	0.3	26	2	54	4	40	-	-	-	-
Niger	1	97	0.3	2	4	95	1	0	-	-	-	-
Nigeria	1	61	21	17	0	44	47	8	-	-	-	-
Senegal	11	75	1	12	5	80	2	14	22	40	3	34
SierraLeone	2	56	9	33	0	70	26	4	-	-	-	-
Togo	12	56	1	32	10	52	13	26	-	-	-	-
SSA	3	43	19	36	3	53	23	22	11	24	12	53
EU	3	54	11	32	2	59	9	29	2	57	8	33
NAmerica	2	18	37	44	1	19	36	45	1	17	36	46
ROW	2	24	26	49	1	25	23	50	1	23	24	52

Source:

African Development Indicators 1997. The World Bank.

Note: SSA = Sub-Saharan Africa; EU = European Union; ROW = Rest of the world.

- Not Available.

and 1993 were also rather low (less than 3% in 1984 and 1988 and about 10% in 1993). In contrast, regional exports within the EU were more than 50% of the total EU exports for each of the years under review. However, SSA exports as a whole seem to be shifting from the EU and North America towards the rest of the world where over 50% of total exports from SSA went in 1993 (compared to 36% and 22% in 1984 and 1988, respectfully).

A somewhat similar picture painted by the export sector emerges when ECOWAS imports are examined (Table 3.3) for the same period (1984, 1988, and 1993). Except a few ECOWAS countries that had more than 10% of their imports from SSA in 1984 (Burkina Faso, 39%; Sierra Leone, 34%; Cote d'Ivoire, 20%; and Benin 11%), the average imports of individual countries were only 2% to 3% of their respective total imports for the year. For example, imports from SSA as a whole in 1984 by Nigeria and Ghana which are major players in West African trade represented only 0.6% and 1% of their total imports, respectively; and total imports into SSA that came from other SSA countries amounted to only 4% of the total import volume into SSA for that year. On the other hand, most imports into ECOWAS countries in 1984 came from the EU, averaging some 50% of the total imports into each respective country.

By 1988, ECOWAS imports from SSA had declined sharply for all countries, and the average was only 1% to 2% of each individual country imports (except Senegal, 12%). The decline of imports from the SSA sub-continent into ECOWAS

Table 3.3. Direction of Trade Matrix – % of Total Imports, 1984 - 1993

	Importers >																			
	Benin	Buk Faso	CapeVerd	CDvoire	Gambia	Ghana	Guinea	GBissau	Liberia	Mali	Ma'tania	Niger	Nigeria	Senegal	SieLeo	Togo	SSA	EEC	NAme	ROW
Exporters																				
1984																				
SSA	11	39	0	20	3	1	1	0	2	1	0	1	1	1	34	0	4	4	2	3
EEC	47	43	87	57	52	56	65	47	26	77	74	83	57	58	43	70	52	57	17	28
NAmerica	4	9		6	17	16	13	46	4	7	10	1	11	14	11	5	13	9	29	18
ROW	38	8	13	17	29	27	22	7	69	15	16	15	31	28	12	24	31	30	52	52
1988																				
SSA	2	2	1	0	1	0	0	0	0	0	0	1	1	12	0	0	2	2	2	1
EEC	50	79	68	74	58	59	71	82	24	80	67	74	58	63	61	61	57	62	19	29
NAmerica	5	6	3	6	10	18	10	3	3	7	4	5	9	8	12	5	10	8	29	18
ROW	43	13	28	21	32	23	19	15	73	12	29	21	32	17	26	35	31	28	50	52
1993																				
SSA	2	2	1	3	5	1	4	2	0	10	3	0	0	2	2	2	7	1	1	1
EEC	55	71	77	71	49	53	69	31	16	65	67	75	52	68	56	37	48	63	16	29
NAmerica	4	8	3	7	4	17	12	1	0	11	8	7	15	9	12	4	10	8	31	18
ROW	39	19	20	20	43	29	19	65	84	14	22	18	33	22	31	57	35	28	52	52

Source:

African Development Indicators 1997. The World Bank.

Note: SSA = Sub-Saharan Africa; EEC = European Economic Community; ROW = Rest of the world.

countries persisted in 1993 as well, implying that in the overall, intra-regional trade among ECOWAS countries as well as in SSA took a downward turn in the 1980s and early 1990s.

Balassa (1979) and Lewis (1980) both argue that export growth is a major factor in the growth of developing economies, and that trade among less developed countries could have greater potential for supporting broad economic growth than does world trade in general. Krugman (1991) further asserts that transportation and communication costs induce countries to naturally trade more with their neighbors, so that freeing intra-regional trade among such neighbors has less welfare cost than otherwise suggested. The decline therefore in SSA interregional trade, and trade among ECOWAS members in particular during the 1980s and early 1990s, could have negative impact on growth and development in the region, and should engage the attention of both researchers and policy makers.

Arguably, livestock is the most important agricultural commodity in intra-regional trade in West Africa, mainly consisting of live animals in cattle, sheep, goats, horses, donkeys, and camels. While Sahelian countries in the region (Mali, Burkina Faso, Mauritania, and Niger) are net livestock exporters, their coastal counterparts (e.g. Cote d'Ivoire, Ghana, Nigeria, etc) are net livestock importers. The livestock situation has created a natural complementarity in production and consumption between the Sahelian and coastal countries in the sub-region; and the trade patterns are also influenced by drought and changing economic and political conditions, as

well as the importance of livestock trade to national economies (Burfisher and Missiaen, *ibid.*). Underlying the official trade is a substantial unofficial and therefore unrecorded component. Much of the north-south trade occurs because of the prevalence of livestock diseases in the humid coastal countries (particularly trypanosomiasis), which raises the opportunity cost of livestock production in the coastal countries compared to the Sahelian countries.

Trade in cattle dominates livestock trade in West Africa, and constitutes the most important item of agricultural trade in the Central Corridor. Estimates based on FAO data (Table 4a) indicate that in the early to mid-1990s, cattle exports constituted about 17% of total merchandise exports, and 24% of agricultural exports in Mali.

In Burkina Faso, cattle exports accounted for 9% and 12% of total merchandise exports and agricultural exports, respectively. The importance of cattle trade to the economies of these Sahelian countries is therefore obvious. Cote d'Ivoire and Ghana are typically net importers of cattle in the Central Corridor, with trade in cattle representing some 13% of Cote d'Ivoire's agricultural imports in the early to mid 1990s (Table 4b). One should note that Sahelian cattle are not exported to Ghana and Cote d'Ivoire only but to all the West African coast from Senegal to Nigeria; neither are Mali and Burkina Faso the only cattle exporters – Niger and Mauritania also export to the coastal countries.

Table 3.4a. Importance of Cattle as an Export Commodity in the Central Corridor

	Ave. Annual Total Exports 1993-95 US$'000	Ave. Annual Agric Exports 1993-95 US$'000	Ave. Annual Cattle Exports 1993-95 US$'000	% Cattle Exports to Total Exports	% Cattle Exports to Agric. Exports
Mali	352,867	249,367	60,667	17	24
Burkina Faso	143,333	104,633	13,300	9	13
Ghana	1,255,066	350,967	0	0	0
Cote d'Ivoire	3,074,333	1,816,233	0	0	0

Source: Food and Agriculture Organization (FAO) Trade Yearbook, 1995.

Table 3.4b. Importance of Cattle as an Import Commodity in the Central Corridor

	Ave. Annual Total Imports 1993-95 US$'000	Ave. Annual Agric Imports 1993-95 US$'000	Ave. Annual Cattle Imports 1993-95 US$'000	% Cattle Imports to Total Imports	% Cattle Imports to Agric. Imports
Mali	564,933	100,933	32	0	0
Burkina Faso	509,333	95,467	0	0	0
Ghana	1,665,233	203,500	na	na	na
Cote d'Ivoire	2,310,333	379,700	50,000	2	13

Source: Food and Agriculture Organization (FAO) Trade Yearbook, 1995.

3.2. Cattle Trade and Beef Consumption in the Central Corridor

The sixteen countries that constitute the ECOWAS subregion stretching from Mauritania in the west to Nigeria in the east, present a complex mix of socio-economic and political experiences. The geographical construct has a string of landlocked countries (mainly Sahelian) on one hand, and a number of coastal countries on the other; while their colonial experiences have resulted in a francophone-anglophone sub-groupings. While about a third of Africa's over 700 million inhabitants (based on 1995 estimates) are located in the West Africa subregion, there are large diversities in country sizes by population and resource endowments. For example, Nigeria's population of over 110 million is more than the population of all the other fifteen countries combined (about 96 million). Figure 3.2 shows a map of West Africa highlighting the Central Corridor of Mali, Burkina Faso, Ghana, and Cote d'Ivoire.

The Central Corridor countries also show marked similarities and differences based on their location and level of economic development. Mali and Burkina Faso, which fall within the Sahelian zone, have lower per capita incomes (250 and 230 US dollars for Mali and Burkina Faso, respectively) compared to the coastal countries of Ghana (per capita income of 390 US dollars) and Cote d'Ivoire (per capita income of 660 US dollars) based on 1995 estimates (Table 3.5). There is also a higher concentration of people in the coastal countries, which have historically provided larger markets for cattle from the less populated Sahelian countries.

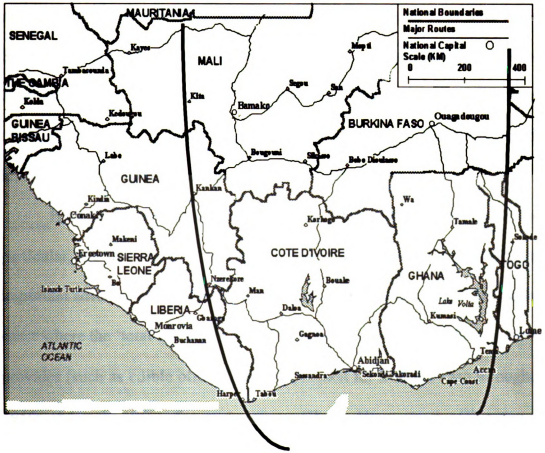

Fig. 3.2. The Central Corridor within the West Africa Sub-region.

FAO (1995) estimates that while more than 80% of the population in the interior countries are engaged in agriculture (Mali is 84.1%, and Burkina Faso is 92.4%), the population involved in agriculture is much less for the coastal countries (Ghana is 56%, and Cote d'Ivoire is 57.1%). Higher per capita incomes and more urbanization in the coastal countries have generally helped to expand market for Sahelian cattle and increased demand for beef. Consumer prices, however, have been more stable since 1980 in all the three countries which belong to the CFA Franc zone (Mali, Burkina Faso, and Cote d'Ivoire) compared to Ghana, which has experienced high levels of inflation during the same period (Table 3.5).

Historically, the livestock trade within West Africa, and cattle trade in particular, had flourished while almost 'isolated' from world market conditions. An important advantage of Sahelian producers has been the export of live animals to the coast where the 'total' animal is preferred because of other uses beside the meat it provides (such as edible offal). The major market for Burkina Faso throughout the 1950s and early 1960s, for example, was Ghana. However, the Ghanaian market seemed to have dried up by the middle of the 1970s, as the Ghanaian economy suffered severe setbacks, and also drought conditions diminished Sahelian cattle exports to the coastal countries. From the late 1960s Cote d'Ivoire became the largest market for Sahelian cattle (aided strongly by the railway line opened between Ouagadougou and Abidjan in the mid-1950s), as shown in figures 3.3a and 3.3b; even though other markets also expanded in the subregion (e.g., Southern Nigeria as a

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Table 3.5. Some Basic Macroeconomic Indicators for the Central Corridor.

	*Population 1995		Real GDP Growth Rate (%)		**GNP per Capita 1995		Consumer Prices (Annual %Change)	
	Mil.	Gr.Rt(%)	1980-89	1990-97	US$	%Gr.Rt	1980-89	1990-97
Mali	10	2.6	1.8	3.1	250	0.2	3.8	5.0
Burkina Faso	10	2.2	3.4	3.4	230	1.5	4.9	5.1
Ghana	17	2.4	1.8	4.3	390	-1.2	44.3	31.1
Cote d'Ivoire	14	3.0	1.6	2.5	660	-1.9	5.8	7.1

* population growth rate is the estimate for 1995 t0 2010.
** real GNP per capita growth rate is for 1970 to 1995.

Source: International Monetary Fund, May 1998. *World Economic Outlook*; and The World Bank, 1997. *World Development Indicators*.

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Figures for cattle exports from Mali and Burkina Faso, and also for cattle imports to Cote d'Ivoire and Ghana may be understated since there exists unofficial and therefore unrecorded trade across the national borders in the subregion. Nevertheless, the official reporting presents a clear pattern of trade flows in cattle in the Central Corridor. Whereas only the cattle-surplus interior countries of Mali and Burkina Faso have been exporting cattle (Figure 3a), the coastal countries, on the other hand, are the major importers of cattle, at least until the 1980s and 1990s.

Figure 3.3b shows cattle imports also for Mali and Burkina Faso, which is mainly attributed to cattle coming from Niger and Mauritania that are then trans-shipped to the coastal markets. Since the 1970s, there actually has existed some provision for Malian and Nigerien cattle to transit through Burkina Faso to the coastal markets after payment of transit taxes of about 500 CFAF (Herman 1983). This transit-tax has since been abolished. We should note also that trans-shipment occurring between Mali and Burkina Faso, particularly along the eastern border of Burkina Faso, has been largely due to market proximity (including markets in Ghana) and transportation advantages offered by the Ouagadougou-Abidjan railway line. Unfortunately, official records on exports do not always distinguish between trans-shipments and cattle that originate from the exporting countries.

Malian cattle exports declined in both drought years of 1968-1974 and

Figure 3.3a. Central Corridor Cattle Exports ('000 Heads)

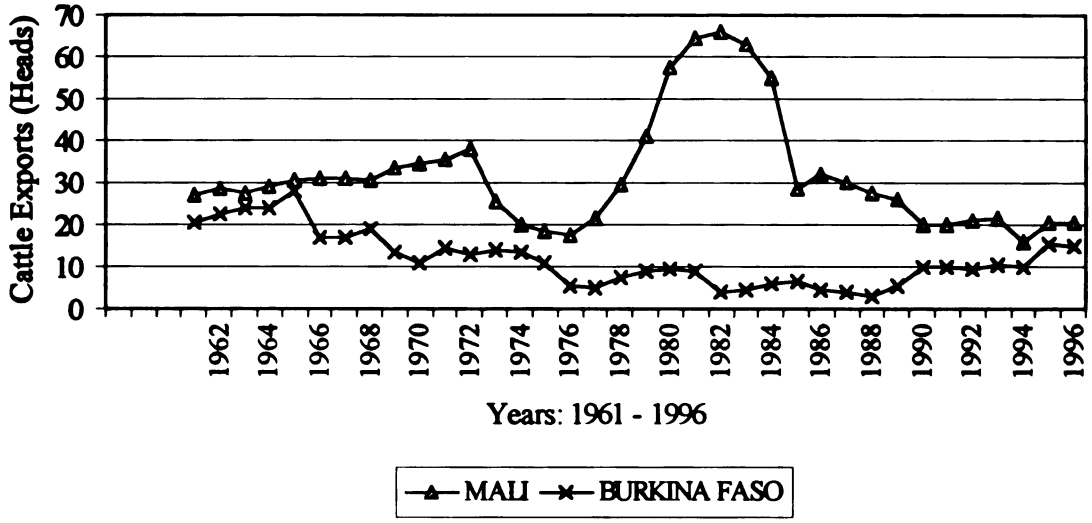
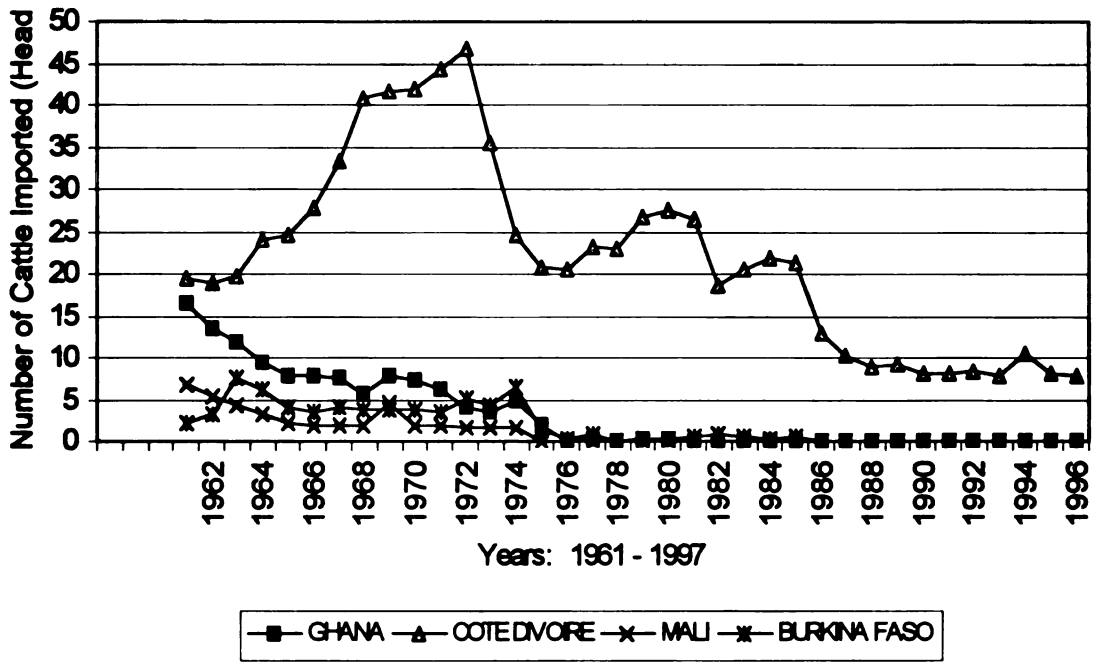


Figure 3.3b. Central Corridor Imports of Cattle ('000 Heads)



Source: FAO Agrostat Database

1983-1985; but whereas it recovered in the 1970s after the drought, the numbers failed to build up in the 1980s. The export expansion in the 1970s may be explained by declining purchasing power in Mali resulting from the drought, and a corresponding high demand and therefore high prices in coastal markets fueled in part by the Nigerian oil boom. In addition, there was a massive de-stocking by Sahelian cattle herders due to drought and reduced grazing capacity, as well as a decline in terms of trade for cattle.

During the early 1980s, low demand in coastal markets as the Nigerian oil boom evaporated and Ghana also experienced economic decline due to external shocks, as well as overvaluation of the CFA franc hindered the recovery of cattle exports. The situation had been exacerbated earlier (from about mid-1975) by Argentina which, looking for alternative markets for beef after it lost its preferential access to the UK when the UK joined the EU, began heavy exports of beef to the West African coast. Prospects for increasing cattle trade in the subregion subsequently has further been dampened by the dumping of beef from the European Union (EU) in the mid to late 1980s and early 1990s.

In the case of Burkina Faso, cattle exports after the 1968-1974 drought never recovered but declined consistently (except for a few years in the mid- and late-1970s) until the early 1990s, when they began to gradually build up again. As its major market in Ghana dried out by the mid 1970s, most of the exports of cattle from Burkina Faso (already depleted by the drought years) went to Cote d'Ivoire, where

the market was also on the decline. Figure 3.3b shows Ivorian imports of cattle peaking in the early 1970s and declining thereafter; and also Ghana's official imports of cattle drying up by the close of the 1970s (even though cattle imports to Ghana are believed to have continued in the 1980s and 1990s through unofficial channels).

By the mid to late-1980s, it had become obvious that cattle from the Sahelian countries faced stiff competition in their traditional export markets of Ghana and Cote d'Ivoire from subsidized beef from the European Union in particular; to the extent that the coastal countries had substituted substantial portions of their Sahelian cattle imports with cheaper European beef imports. The 50% devaluation of the CFA Franc relative to the French Franc in January 1994 therefore had as one of its objectives the improvement of the terms of trade in favor of Sahelian cattle so as to recapture these coastal markets.

Post devaluation studies of the beef sub-sector indicate that Sahelian countries have recaptured most of the coastal markets, particularly Ghana and Cote d'Ivoire (Yade et al., 1998). The share of cattle exports from Mali and Burkina Faso to the coastal countries increased about twice the numbers that were exported before the devaluation. However, even though post-devaluation cattle trade improved in the sub-region, higher prices of meat resulting from the devaluation seemed to have caused beef consumption to substantially decline among low-income households, especially in the cattle exporting countries (Reardon, et al., 1998).

Revenues from cattle exports have historically been very important to Mali and

Burkina Faso. As presented in Figure 3.4a, the inflow of dollars to Mali and Burkina Faso has followed the pattern of changes in live animal exports from both countries; with the revenue accruing to Mali more erratic than that for Burkina Faso, which has been relatively low but stable. Similarly, the cattle import bill for Cote d'Ivoire increased rapidly from the mid-1970s, but declined sharply at the beginning of the 1980s when imports fell as demand declined in the coastal markets (Figure 3.4b). In the case of Ghana, the decline in her cattle imports which started in the 1960s never recovered, so that by the beginning of the 1980s her cattle imports bill had dwindled to only a trickle. Also, subsequent to the CFA Franc devaluation in 1994, the dollar value of imports to these coastal countries declined on per head basis even though the physical volume of imports increased.

Both Ghana and Cote d'Ivoire substituted their dwindling cattle imports from the Sahel with beef imports from other parts of the world (meat prices on the world market were low during most of the 1970s); initially mostly from South America, and later from the EU at subsidized prices. Buoyant cocoa prices during the 1970s enabled Cote d'Ivoire to expand meat imports which continued into the early 1990; while low EU beef prices in Ghana facilitated the increases in her beef imports in the early 1990s (see Figure 3.5).

The per capita consumption of beef in the Central Corridor seemed to have peaked in the early 1970s when it reached almost 6 kg/person/year (Figure 3.6).

Figure 3.4a. Central Corridor: Value of Cattle Exports (million US$)

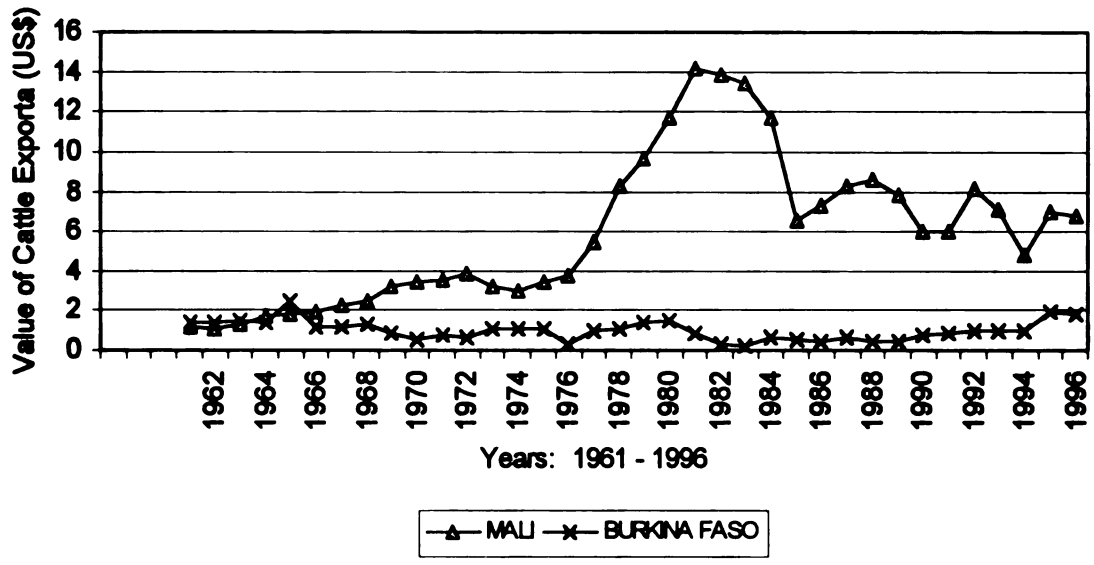
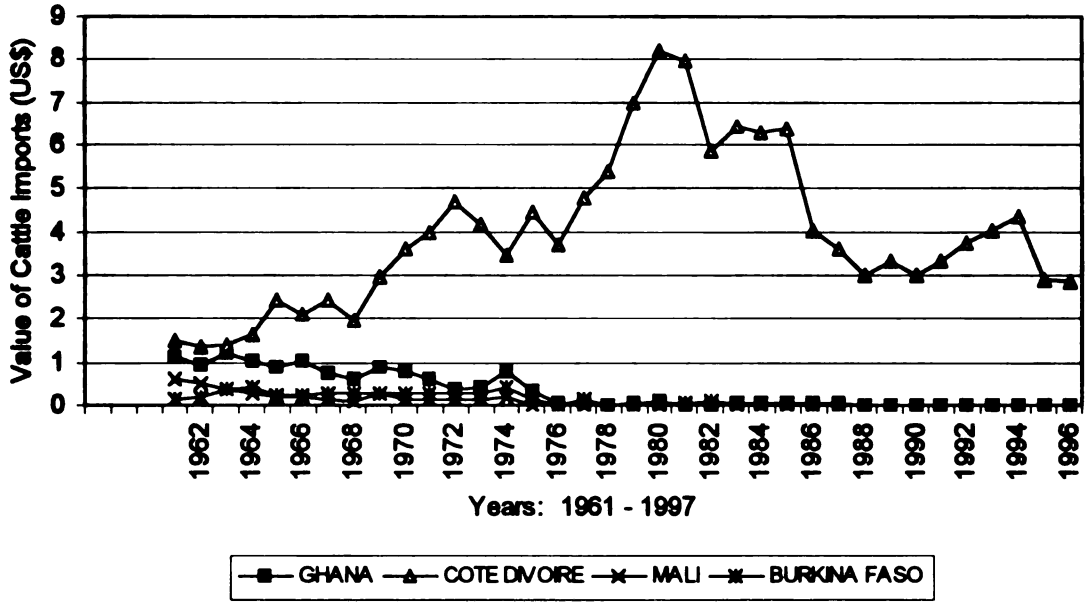


Figure 3.4b. Central Corridor: Value of Cattle Imports (million US$)



Source: FAO Agrostat Database.

Thereafter it stabilized around 4 kg/person/year throughout the 1970s and 1980s until about 1994, when it fell below the 4 kg/person/year average. This seems to suggest that there exists a great potential for the market for beef in the sub-region, assuming that per capita incomes within the sub-region increase significantly.

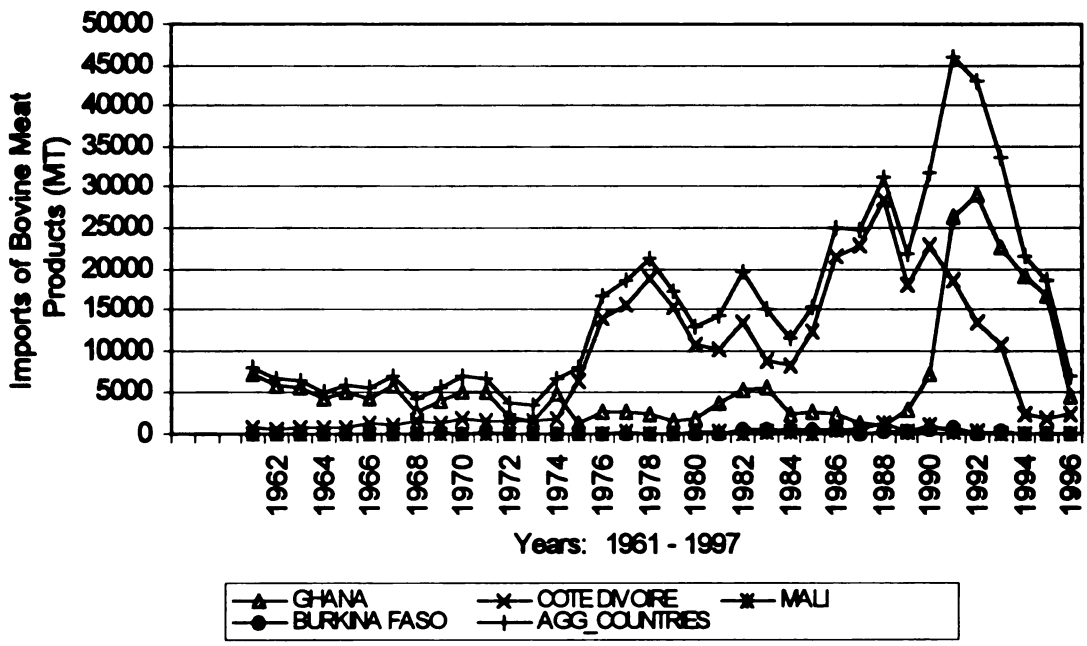
The expected increases in per capita incomes in the region will depend to a large extent on the strength of the recoveries experienced by the economies of the coastal countries, particularly Ghana and Cote d'Ivoire, whose per capita incomes and therefore purchasing power have been on the decline since the1970s (Table 3.5).

Considering the per capita beef consumption of individual countries, the official figures categorize the four countries into high (Mali and Cote d'Ivoire) and low (Ghana and Burkina Faso) beef consuming countries (see Figure 3.6). The per capita beef consumption in Mali has been the highest in the sub-region, peaking at about 8.8 kg/person/year in the late 1960s and declining thereafter to about the level of the sub-regional average (5.8 kg/person/year) before recovering gradually throughout the 1980s into the 1990s. Per capita beef consumption in Cote d'Ivoire has been more erratic over the years, increasing rapidly from below the sub-regional average in the early 1960s to peak at about 8 kg/person/year in the early 1970s, and then remaining above the sub-regional average until the early 1990s when it fell to just about 3 kg/person/year.

As noted earlier, the devaluation of the CFA Franc seemed to have adversely affected the low-income populations in both the Sahelian cattle exporting

and coastal cattle importing countries. Beef consumption in the sub-region fell to about half their pre-devaluation levels, particularly among poor households who could not afford the higher beef prices following the devaluation, even though high-income households maintained their beef consumption levels. Most households moved away from beef towards processed fish (e.g. smoked and dried fish) which was relatively cheaper (*ibid.*).

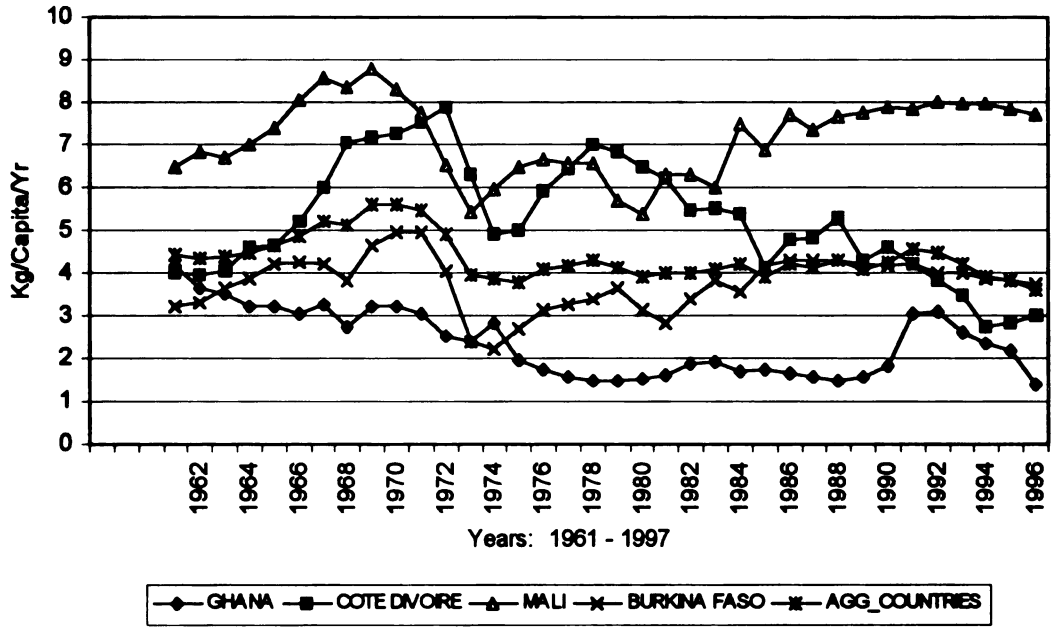
Figure 3.5. Imports of Bovine Meat and Products for the Central Corridor (MT)



Source: FAO Agrostat Database.

In both Burkina Faso and Ghana per capita beef consumption has been below the sub-regional average. Consumption in Burkina increased from about 3.2 kg/person/year in the early 1960s to a peak of 5 kg/person/year in about 1969-70, then declined to about 2.5 kg/person/year in the early 1970s before rising gradually during the 1970s and 1980s to the level of the sub-regional average.

Figure 3.6. Bovine meat Consumption per Capita in the Central Corridor



Source: FAO Agrostst Database

Ghana, however, shows a consistent decline in per capita beef consumption from a peak of about 4.2 kg/person/year in 1961 to a low 1.5 kg/person/year in the late 1970s and 1980s. Beef consumption per capita recovered somewhat in the early 1990s to about 3.1 kg/person/year but has since declined again. The prospects and potential for beef market expansion in the coastal markets of the West African Corridor therefore remain high, particularly in the face of a fast increasing population of the sub-region.

It is instructive to note, though, that the main animal protein substitute for beef, particularly in the coastal countries, is fish. The relative price of beef and fish will therefore be a major factor in determining the future demand for beef in the countries of the Central Corridor.

3.3 Tariff and Non-tariff Barriers to Cattle Trade in the Central Corridor

Historically, all four countries in the Central Corridor have pursued policies that offered protection for domestic livestock, including cattle, with the objective of improving domestic productivity and overall stock numbers, among others. However, most of these tariff and non-tariff barriers have been removed in recent years by all the countries in the subregion in response to recent protocols and memoranda of understanding among them. Part of this is also due to renewed interest among governments in the sub-region to promote intra-regional trade in cattle as a way of promoting regional cooperation; and as a fall-out from general trade liberalization

efforts in these countries.

Besides tariff (or a direct tax on imports) which most countries the world over have used as an instrument of protection (and whose use has declined considerably in recent years under multilateral trade liberalization), there exist other instruments or devices which countries apply to limit trade in some commodities. These devices include import quotas, voluntary export restraints (VERs), international commodity agreements, cartels, export subsidies, border tax adjustments, and administrative as well as technical regulations.

Whereas the use and application of some of these instruments are very visible (e.g., quotas), others are very pervasive forms of protection (e.g., administrative and technical regulations). Countries in the Central Corridor have used both tariffs and non-tariff instruments to affect cattle trade in the sub-region until recently. Under the current global and regional trade environment, border tax adjustments (i.e., indirect taxes shifted to consumers in the final price of goods and services) together with administrative and technical regulations are the most important barriers to intra-regional trade in cattle in the sub-region. Also important are road barriers and other unofficial taxes levied on cattle traders along all the routes from the Sahelian countries to the coastal countries.

Trade Barriers in Cattle Exporting Countries: Mali and Burkina Faso

Mali and Burkina Faso, being cattle exporting countries in the Central Corridor, have historically derived substantial portions of their trade revenues from both cattle exports and taxes levied on these exports. They have therefore used a combination of direct export taxes and various forms of regulatory requirements at the official level to raise revenue from trade in cattle with their neighbors.

Since the late 1960s when the cattle market declined sharply in Ghana, Cote d'Ivoire has been the most important market for cattle from both Mali and Burkina Faso. Very few cattle flow into the Ivorian and Ghanaian markets from neighboring countries except from Mali and Burkina Faso. In general, even though Mali and Burkina Faso have both eliminated direct export taxes on livestock, other taxes and fees still remain, which constitute substantial barriers to 'free trade' in cattle in the sub-region. These include market taxes, business taxes, licensing fees on animal health requirements, and unofficial fees (or tips and bribes).

Both Malian and Burkinabe cattle exporters pay what the authorities refer to as *market presentation tax* (or sales tax as referred to by some local authorities). In 1993, which is the base year for this study, the market presentation tax ranged between 100 CFA Francs and 200 CFA Francs per head for cattle depending on the location (or 150 CFA Francs on the average) in both countries (Metzel, *et al*, 1994). Also in Burkina Faso, cattle traders must pay for the right to export their herd, and this is computed as 5.6% of the value of the herd (or 3,025 CFA Francs per head of

cattle). Even though these taxes by themselves (including those discussed later) may not be large enough to be considered a significant barrier to trade, when aggregated they constitute about 12% to 14% of the average cattle prices in the coastal markets.

Then there is the *business tax* which is nothing more than a type of income tax exporters pay because there is no format for assessing the net income of these traders for tax purposes. In Mali, the business tax is in the form of a licence called *patente* which may be valid for three months to a year, or in some cases purchased to cover a specified number of animals. In practice, the *patente* is transferable, so that large traders are able to sub-contract their *patentes* to small-scale operators who are unable to purchase the *patente* up front (the annual cost of patente could run into several hundred thousand CFA francs). Sub-contracting a patente per head of cattle in Mali in 1993 amounted to 1,500 CFA Francs. The business tax takes a slightly different form in Burkina Faso, where it is called business turnover tax (*taxe sur le chiffre d'affaires*). The 1993 business turnover tax in Burkina Faso (e.g., Pouytenga market) was 2,000 CFA Francs per head of cattle.

Health certification for live animal shipments across borders is an important government responsibility as a way of preventing the spread of infectious livestock diseases. The governments of Mali and Burkina Faso therefore require cattle exporters to obtain health passes from appropriate authorities for the animals they sell both in the domestic market and abroad. Besides, traders are required to ensure vaccination of their animals against such diseases as rinderpest, peri-pneumonia,

anthrax, foot and mouth disease, pasteurelloses, and trypanosomiasis.

Whereas most of these vaccinations are subsidized and therefore cost little to the trader (e.g., in Mali in 1993, the cost per head of cattle for rinderpest and peri-pneumonia vaccination was 34 CFA Francs; and for trypanosomiasis it was 20 CFA Francs), the transaction cost could be very substantial. For example, cattle traders in Burkina Faso are required to obtain a documentation on their cattle (and other livestock) referred to as "livestock passport" which contains detailed information on herd composition, veterinary services obtained and the posts to visit along the way, as well as the traders itinerary. Even though the "livestock passport" is obtained at no official cost to the trader, the issuing Livestock Service agent requires a verification for (a) formal permission to export livestock (the *authorization d'exportation du betail*), (b) proof of the nationality of the animals (*certificat d'origine*), (c) payment of business taxes, or the *patente*, and (d) payment of health tax (taxe de visite sanitaire). The process of acquiring the "livestock passport" can therefore involve substantial transaction cost.

Trade Barriers in Cattle Importing Countries: Cote d'Ivoire and Ghana

Taxes on livestock in the beef cattle importing countries of Cote d'Ivoire and Ghana mirror those of the Sahelian cattle exporting countries discussed above. Traders in these coastal countries also pay market taxes, business taxes, licensing fees on animal health requirements, and unofficial fees (or tips and bribes). Market taxes

in Abidjan stock markets, for example, included 150 CFA Francs per head market presentation tax, 1,000 CFA Francs per head municipal tax, and 1,100 CFA Francs per head stockyard tax in 1993. Cattle importers in Ghana also paid a market presentation tax of C100 per head, sales tax of C100 per head, and stockyard tax of C1,200 per head for the same period.

Business tax in Cote d'Ivoire is similar to what pertains in Mali, where traders pay the transferable *patente* valid for three months to a year; and in Ghana it is referred to as "income tax on capital" on long-distance livestock trade, computed as 3.6% of the value of the entire herd. Again in 1993, the *patente* was 95 CFA Francs per head in Cote d'Ivoire, while in Ghana the "income tax on capital" was C3,800 per head (or 2,400 CFA Francs at the Forex Bureau exchange rate).

In terms of animal health requirements, Cote d'Ivoire conducts veterinary inspections of imported animals and verifies vaccination certification or gives vaccinations where necessary at minimal fees. Ghana, on the other hand, has since 1985 imposed stringent quarantine requirements on imported cattle (though this has somewhat eased in recent years) following an outbreak of foot and mouth disease which the Ghanaian authorities attributed to diseased Sahelian cattle imported into the country.

Importers of cattle have to apply to the Animal Health Department of the Ministry of Food and Agriculture, Ghana, for permission to import, and are required to send their animals to the department's quarantine posts at the countries borders for

inspection, which could take several days. The transaction cost involved in terms of time and expense is obviously a deterrent, which might explain why official records show very few or no cattle imports to Ghana in the late 1980s and early 1990s.

Unofficial Fees Levied on Cattle Traders

Livestock traders in general in the Central Corridor are frequently subjected to informal 'taxes' (or tips and bribes) on both sides of the international borders by government officials and law-enforcement agencies (custom officials, army, and police), which substantially raise the consumer price of beef and other meat products. Such unofficial fees levied on cattle traders are particularly prevalent at the numerous custom posts at the borders and police check points along the cattle trade routes, mainly because traders are more vulnerable since delays on the road for non-payment could result in death of animals and substantial losses. In addition, cattle traders often have to pay tips to officials at government agencies to facilitate prompt issuance of permits and other documents necessary for export of cattle.

Estimates of bribes paid by traders between a market in the interior of Mali (e.g., Fatoma, near Mopti) and say Abidjan in Cote d'Ivoire, and between Pouytenga in Burkina Faso and Abidjan average between 3,000 CFA Francs to 4,000 CFA Francs per head, distributed evenly among the officials in the countries concerned (Metzel et al, ibid.; Holtzman and Kulibaba, 1992). The corresponding figure for Ghana for a trip between Pouytenga and Accra in 1993 was estimated at C105,600

per truck or about C3,200 per head (or 1,441 CFA Francs per head). Table 3.6 provides estimates of non-tariff barriers to cattle trade in the Central Corridor.

Table 3.6. Direct and Indirect Taxes on Cattle Trade in the Central Corridor (FCFA/Head – 1993 Estimates)

	Exp./Imp. Permit	Market Taxes	Business Taxes	Veterinary Fees	Unofficial Fees
Mali	3000	150	1500	234	3500
Burkina Faso	3025	150	2000	200	3500
Ghana*	na	1500	2400	270	1441
Cote d'Ivoire	na	2250	95	500	3500

*Ghana Cedis have been converted into FCFA at the 1993 Nominal Exchange Rate of FCFA1 per C2.22.

Source: Computed from data provided in Metzel et al.(*ibid.*), Vol III, 1994.

On the average, the total amount paid in taxes and/or bribes per head of cattle in each of the countries of the Central Corridor (based on 1993 prices) were 8,384 CFA Francs in Mali, 8,875 CFA Francs in Burkina Faso, 5,611 CFA Francs in Ghana, and 6,345 CFA Francs in Cote d'Ivoire. Considering that cattle prices averaged 110,585 CFA Francs per head in Cote d'Ivoire and 103,416 CFA Francs per head in Ghana in 1993, these taxes and/or bribes constituted about 14% of the price of cattle sold in Cote d'Ivoire and 13% of those sold in Ghana.

CHAPTER IV

Beef Cattle Production and Marketing in the Central Corridor

4.0. Introduction

Agro-climatic conditions in the Sahel make it a natural choice for livestock production and development, compared to the more humid and mostly tse-tse infested coastal regions of the Central Corridor. Besides cotton, which is a major cash crop in the Sahel region, livestock production, including cattle, sheep and goats, camels, donkeys, poultry, etc, predominate agricultural activities in the Sahel. On the other hand, crop production (mainly tree crops such as cocoa and coffee) is the mainstay of agriculture in the coastal countries. This natural distribution of the livestock-crop mix in the sub-region underscores why the Sahelian countries are a cattle exporting region and the coastal countries are deficient in cattle, making cattle historically the most important item of intra-regional trade in the sub-region.

The objective of this chapter is to present an overview of cattle production and marketing in the four countries that constitute the Central Corridor – Mali, Burkina Faso, Ghana, and Cote d'Ivoire. We begin with a brief overview of the basic macroeconomic trends in these countries.

4.1 Trends in some Key Economic Variables in the Central Corridor.

The land-locked Sahelian countries of Mali and Burkina Faso are ranked among the poorest in the world – Burkina Faso was 169th out of 174 countries, and barely ahead of Mali – according to the rankings in the UNDP's 1995 Human Development Index. As indicated earlier, the estimated per capita GNP for the two countries in 1995 were US$230 and US$250 for Burkina Faso and Mali, respectively. The most important agricultural export products in both countries are cotton and livestock (including livestock products) both of which account for more than 60% of export revenue in each country (World Bank, 1996).

By contrast, the coastal countries in the central corridor are ranked higher in terms of economic development. Cote d'Ivoire is considered a lower middle-income country with a per capita GNP of US$660 in 1995 (this figure was in excess of US$1,000 in the early 1980s). Ghana, until economic decline in the 1970s, was considered to have a much higher standard of living than most countries in West Africa; and had a per capita GNP of US$390 in 1995. Both Cote d'Ivoire and Ghana are among the world's leading exporters of cocoa, coffee, and timber; and agricultural exports account for well over 40% of export revenue for each country.

All four countries have embarked on structural adjustment programs with the support of both the International Monetary Fund (IMF) and the World Bank during the 1980s and 1990s. Mali has embarked on economic and sectoral reforms under a structural adjustment program since 1988 with the objective of improving

competitiveness of the economy and creating conditions for long term economic growth. Following the devaluation of the CFA franc by 50% against the French franc, Mali implemented a second reform program covering the period 1994 to 1996 which focused more on trade reforms (e.g., general changes in tariffs and improvements in producer incentives). These reforms have paid off in terms of improved macroeconomic performance.

Similarly, Burkina Faso has embarked on a more sustained reform program since 1991, with substantial trade reforms beginning in 1993. The elimination of the requirement for export authorization for all products except cereals, removal of price controls on locally produced goods (except rice), cancellation of regulation of profit margins for imported goods, and termination of the functions of the Agricultural Product Price Stabilization Fund in price stabilization policy, all worked to improve efficiency and competitiveness in the Burkinabe economy (World Bank, 1996).

In the case of Cote d'Ivoire, adjustment policies before 1987 were only partially successful in reducing the main internal and external imbalances due to instability in international commodity prices (e.g., for cocoa and coffee) and fluctuations in the value of the CFA franc against the dollar, which depreciated and then appreciated again. But in 1990 the government undertook a medium-term reform program with the support of the Bank and IMF, whose success was in doubt until the 50% depreciation of the CFA franc against the French franc. A recession which had deepened in 1993 was quickly reversed, and domestic inflation, which reached 26%

in 1994 declined to some 11% in 1995, while government deficit declined substantially.

Subsequent to the devaluation, the Ivorian government embarked on sectoral reforms in trade, agriculture, and transport in 1994 and 1995 which enhanced efficiency and competition in the economy as well as create new investment opportunities. Market and trade liberalization were implemented for most commodities including rice and livestock, and major reforms undertaken in the cocoa and coffee sectors. Fiscal reform, tariff reform and elimination of non-tariff barriers, and price liberalization were among measures implemented by the Ivorian government to stimulate international competitiveness and private sector development (World Bank, *ibid.*).

Since 1983 Ghana has undertaken far-reaching reforms under an economic reform/structural adjustment program which was supported by both the Bank and the IMF. After a decade of sustained adjustment, fiscal imbalances re-emerged in the early 1990s during the run-up to the country's elections, raising new concerns about macroeconomic stability. Subsequently, Ghana began another three-year structural adjustment program in 1995 with IMF support, but initially missed several targets (e.g., money supply growth could not be adequately restrained, and inflation in 1995 averaged about 60%).

Private sector reforms and an ambitious divestiture program to scale down government's direct role in the economy while promoting private sector participation

have potential to improve general economic efficiency. A major initiative of the Ghana government since the mid-1990s has been a more outward economic orientation with emphasis on regional cooperation, export growth, and removal of trade barriers as a way to improve economic growth. Tables 4.1a and 4.1b present trends in some economic variables of countries in the Central Corridor.

Figures presented in Table 4.1a indicate that agriculture is a major contributor to the Gross Domestic Product (GDP) in both Mali and Burkina Faso. However, while the share of agriculture in Malian GDP has declined from more than 60% in 1975 to a little over 40% in the 1980s and 1990s, agriculture has accounted for about a third of the GDP of Burkina Faso through the 1970s to the 1990s. Gold has in recent years become an important commodity for Mali, and contributed substantially to export revenue. Also, agricultural growth has been remarkable for Mali, increasing from 1.1% in 1975 to 8.5% in 1995; whereas agriculture grew only modestly in Burkina Faso from 1.2% in 1975 to 4.1% in 1995, with a negative growth of -0.2% in 1994.

In both countries, livestock and livestock products follow after cotton as the major agricultural exports and most important sources of export revenue, emphasizing the importance of livestock to these economies. For example, livestock exports, which accounted for only a quarter of Burkina Faso's food import bill in 1985, increased to cover about three-quarters of her food import bill in the 1990s; and in Mali revenues from livestock exports were usually enough to underwrite all food import bills on

Table 4.1a. Trends in some key Economic Variables in Mali and Burkina Faso

MALI	**1975**	**1985**	**1994**	**1995**	**1996**	**1997**
GDP (billion US$)	0.8	1.1	1.9	2.5	2.7	2.5
Tot. Exports(mil US$)	-	176	333	470	434	562
Cotton Exp. (mil US$)	-	78	150	261	264	276
*Livestock Exp.(mil US$)	-	-	82	85		
Food Imp. (mil US$)	-	141	79	91	113	109
Terms of Trade(1987=100)	-	107	84	90	-	-
Agric. as % of GDP	61.0	47.3	40.2	44.0	48.1	49.2
Agric: % annual growth rate	1.1	5.1	7.5	8.1	1.2	2.8
Burkina Faso	**1975**	**1985**	**1994**	**1995**	**1996**	**1997**
GDP (billion US$)	0.8	1.4	1.9	2.4	2.5	2.4
Tot. Exports(mil US$)	-	136	226	287	231	251
Cotton Exp. (mil US$)	-	30	59	94	97	128
*Livestock Exp.(mil US$)	-	14	57	64	65	57
Food Imp. (mil US$)	-	59	68	86	88	70
Terms of Trade(1985=100)	-	100	133	145	-	-
Agric. as % of GDP	34.3	37.9	33.0	32.9	34.8	32.1
**Agric: % annual growth rate	1.2	3.5	-0.2	4.1	7.4	0.7

*Livestock includes live animals and other livestock products (e.g., hides). Figures for Mali are from FAO Trade Yearbook 1995.

**Growth rate for 1975 refers to 1975-84; and that for 1985 refers to 1985-94.

Source: World Bank. *Trends in Developing Countries.* 1996; *World Development Indicators*, 1998.

Table 4.1b. Trends in some key Economic Variables in Ghana and Cote d'Ivoire.

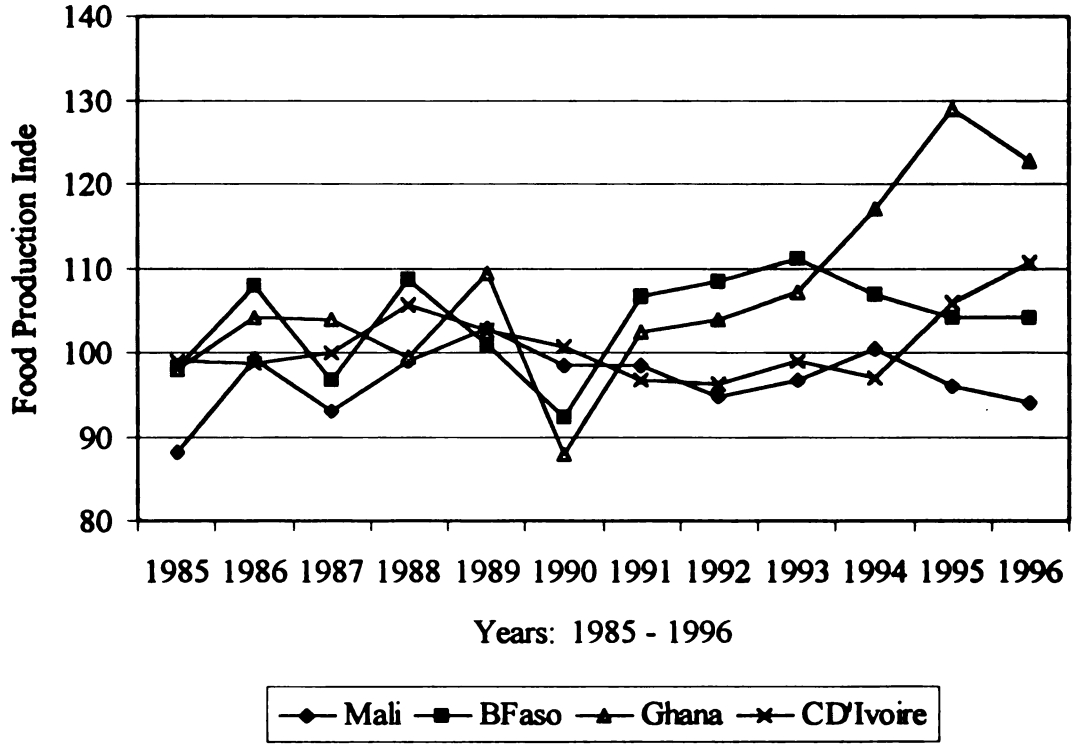
Ghana	**1975**	**1985**	**1994**	**1995**	**1996**	**1997**
GDP (billion US$)	2.8	6.3	5.4	6.3	6.3	6.8
Tot. Exports(mil US$)	-	633	1,236	1,431	1,571	1,511
Cocoa Exp. (mil US$)	-	412	320	390	552	464
*Livestock Exp.(mil US$)	na	na	na	na	na	na
Food Imp. (mil US$)	-	40	45	56	64	64
Terms of Trade(1987=100)	-	90	74	79	-	-
Agric. as % of GDP	47.7	44.9	46.4	46.3	44.4	47.4
Agric: % annual growth rate	1.2	1.9	2.6	4.20	4.0	2.2
Cote d'Ivoire	**1975**	**1985**	**1994**	**1995**	**1996**	**1997**
GDP (billion US$)	3.9	7.0	7.4	9.8	10.7	10.3
Tot. Exports(mil US$)	1,239	2,761	2,867	3,890	4,245	4,015
Cocoa Exp. (mil US$)	-	887	951	1,320	1,408	1,203
*Livestock Exp.(mil US$)	na	na	na	na	na	na
Food Imp. (mil US$)	-	273	317	514	563	604
Terms of Trade(1987=100)	102	125	71	78	-	-
Agric. as % of GDP	34.4	29.8	36.0	35.0	27.6	27.3
**Agric: % annual growth rate	2.2	1.9	2.1	5.5	1.4	4.7

*Livestock includes live animals and other livestock products (e.g., hides).
**Growth rate for 1975 refers to 1975-84; and that for 1985 refers to 1985-94.
na implies none or negligible.

Source: World Bank. *Trends in Developing Countries.* 1996; *and World Development Indicators*, 1998.

annual basis. But whereas the external terms of trade have been favorable to Burkina Faso by about 45% increase between 1985 and 1995, it has deteriorated in the case of Mali, where it declined substantially during the same period. The decline in the terms of trade for Mali may be attributed to the shifting export pattern in Mali in favor of non-traditional commodities such as gold, whose price on the world market has been on the decline in recent years. All the same, GDP has shown modest growth in both countries at about the same level in the 20-year period between 1975 and 1995.

Figure 4.1a. Food Production Index per Capita (1989-91 = 100)



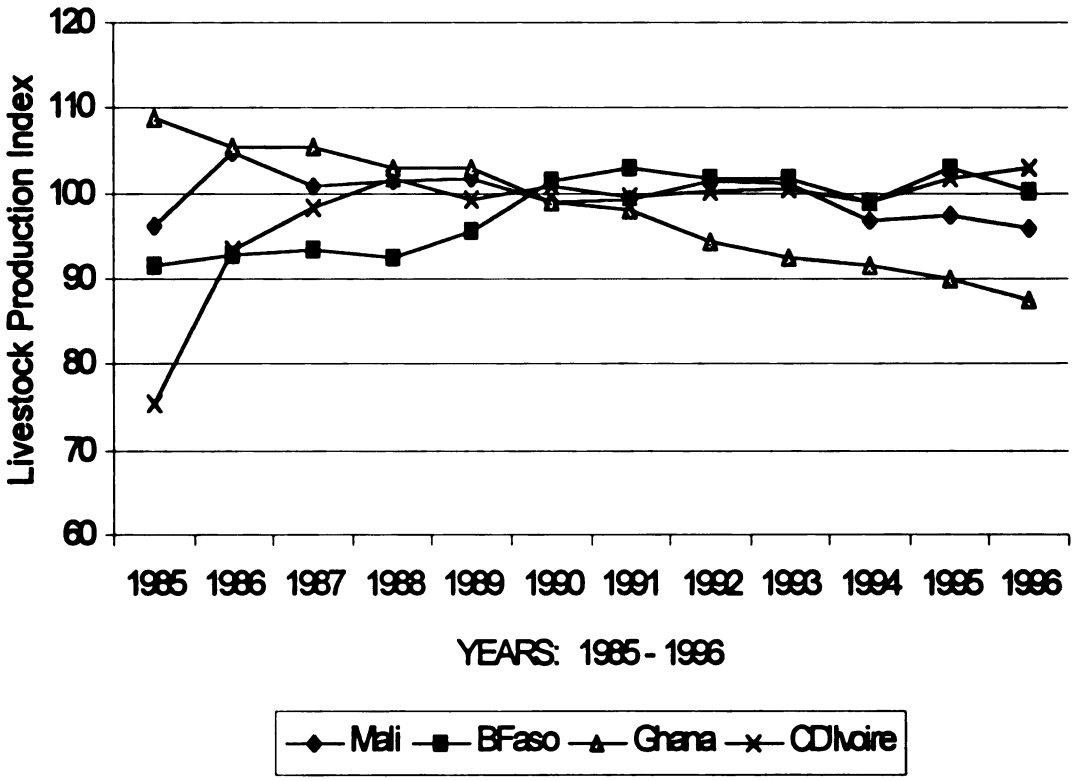
Source: FAO Agrostat Database

Based on the GDP, Cote d'Ivoire is the largest economy in the Central Corridor, with Ghana about two-thirds of its size (Table 4.1b). By comparison, the economies of Mali and Burkina Faso are each only a quarter of that of Cote d'Ivoire and a third of that of Ghana. Agricultural growth has been modest for both Ghana and Cote d'Ivoire during the twenty-year period between 1975 and 1995, with the highest growth occurring in 1995 for the two countries at 4.2% and 5.5% for Ghana and Cote d'Ivoire, respectively. And while agriculture accounts for almost half of Ghana's GDP annually, it contributes about a third to the GDP of Cote d'Ivoire.

Even though Ghana's food imports in value terms was only about a tenth of that of Cote d'Ivoire in 1995, food imports continue to grow in both countries, attesting to the potential markets in the two countries. The two countries are not exporters of livestock except negligible levels of livestock products (e.g., hides); but as has been indicated earlier, both countries import live animals as well as frozen meat.

A comparison of the trends in per capita food and livestock production in the Central Corridor indicates that both have remained relatively stable during the mid 1980s to 1990s in all four countries except Ghana (Figures 4.1a & 4.1b). Ghana shows considerable increase in per capita food production during the period, particularly in the 1990s, but a declining trend for per capita livestock production. Cote d'Ivoire also shows more increase in food production relative to livestock production from 1994 onwards. The trend analysis suggests that the coastal countries

Figure 4.1b. Livestock Production Index per Capita (1989 - 91 = 100)



Source: FAO Agrostat Database.

may be paying more attention to food crops rather than livestock production, which could make them more dependant on livestock and meat imports to satisfy domestic demand.

4.2. General Overview of major Cattle Production Systems in the Central Corridor

In Table 4.2, the general characteristics of some livestock production systems in the Central Corridor are provided. In practice, there exist several types of production systems, ranging from traditional transhumant systems in the Sahel where the herd production unit moves seasonally in search of pasture; to more intensive peri-urban types around large urban centers such as Bamako or Accra, in which case the animals are fed high-value commercial feeds and fodder, and are raised primarily as dairy cattle.

This study focuses on 'beef' cattle production in the Central Corridor, and therefore systems that are more common and more representative of 'beef' cattle production in the various countries in terms of their contribution to aggregate production are discussed. We should note here that most cattle in the Central Corridor, particularly in the Sahelian Countries, are raised as dual-purpose animals. The herds are managed for both dairy and beef, and some are also used as draft animals. Cattle in this study therefore refers to all cattle that are eventually sold on the market for slaughter since most cattle production systems do not differentiate cattle types.

Table 4.2. Important Characteristics of some Cattle Production Systems in the Central Corridor

Location	Breed	Rainfall(mm)	Management	Feed Source
MALI				
Mopti	Zebu	300	Transhumant Agro-pastoral	Open range, Flood plain
Sikasso	Zebu	1000	Sedentary	Village Pasture, Crop byproducts Commercial feeds
BURKINA FASO				
Dori	Zebu	450	Transhumant Agro-pastoral	Village Pasture, Crop byproducts Commercial feeds
Yako	Zebu	600	Sedentary Agro-pastoral	Village Pasture, Crop byproducts Commercial feeds
Pouytenga	Zebu	600	Fattening	Crop byproducts Commercial feeds
GHANA				
Kpong-Tamale	WASH*/ Sanga	1500	Sedentary	Village Pasture, Crop byproducts
Accra Plains	Zebu cross	1000	Sedentary	Village Pasture, Commercial feeds
COTE D'IVOIRE				
Kohorgo-Ferke	Zebu cross/ Baoule	1000	Sedentary	Village Pasture, Commercial feeds

***WASH means West African Short Horn**

Source: Metzel et al. 1994.

In the transhumant systems of livestock production as practiced in the Mopti and Nara regions of Mali, as well as the cattle producing areas of Dori in Burkina Faso, many of the herders follow the seasons and the availability of grazing grounds for their cattle. This system is typical of cattle production in the semi-arid zone of the Sahel, but due to intense competition with food and cash crop production, and the fragile nature of the environment, there are serious questions about the sustainability of the system.

The transhumant systems (including agro-pastoral systems in which herders income are derived from both livestock and cropping activities) are therefore classified under sedentary production systems in this study since more herders continue to cultivate the land as common in Mopti and Nara areas in Mali. That is, even though the transhumant, agro-pastoral, and sedentary systems represent different methods of cattle raising in the Central Corridor in terms of management practices, their underlying cost structures are similar. Cost estimates for the three systems are therefore aggregated.

The livestock production system in which herders raise their animals in a specified location without moving them over long distances with seasonal changes is what is referred to as the *sedentary system*. Cattle owners in the sedentary system typically cultivate a variety of rainfed crops (cereals, pulses, tubers, etc), and supplement range pasture grazing with crop residues and byproducts from their farms.

Due to the smallness of family herds, cattle owners usually group their animals together and employ hired labor for herding, even though family labor is also extensively used. The animals are more carefully controlled through the use of corrals, sheds, and pens so as to protect them from harsh weather conditions such as heavy rains, and also due to the proximity of crops; and farmers often provide veterinary services against animal diseases and parasites. Commercial feed, notably cotton seed and cotton seed cake, bran, molasses, etc, are sometimes provided for the animals depending on location and availability of feed.

An important consideration of the sedentary system of cattle production in the Central Corridor has been the keeping of animals for animal traction purposes. In most cases, farmers train and use select animals among the herd as draft animals, which after a few years of work are typically sold for slaughter. Such draft animals may be provided more purchased feed than the rest of the herd to boost their draft power, even though they are usually kept together with the rest of the herd.

Another system of cattle production which has continued to gain importance in the Central Corridor in recent years but directed specifically to dairy cattle production is the *Peri-Urban* production system. Increased urbanization in large Sahelian towns such as Bamako in Mali has brought in its wake increased demand for fresh milk and other dairy products. The peri-urban systems are basically dairying enterprises that have developed to meet this increasing urban demand for dairy products, and are highly intensive systems which depend mainly on commercial

feeds. The favorable sub-humid micro-climate of the Accra plains in Ghana has also facilitated the establishment of viable peri-urban systems to feed the Accra-Tema metropolis. Because these peri-urban systems are location specific, and more focused on dairy rather than cattle for beef which is the subject of this study, they are not included in the analysis as separate production systems.

4.3. Cattle Production and Marketing in Mali

Mali extends from the fringes of the Sahara desert in the north to the Guinean zone in the south covering an area of some 1,240,000 km^2. The northern portion, which lies in the Sahelian zone and constitutes about a quarter of the country, has traditionally been the main livestock production region; and the southern portion that lies in the Sudanian and Guinean zones (also about a quarter of the country) has adequate rainfall (about 1,300 mm between June and October) for crop production agriculture. However, in recent years, cattle production in Mali seemed to have shifted more to the north east (around Mopti) and south east (around Sikasso) as persistent drought caused northern herders to de-stock their cattle while the more favorable south built up stocks.

Also, the Niger river flows for about 1,700 km from west to east within Mali, and together with its tributary the Bani river, regularly overflowed its bank during the rainy season (until it was dammed) to form a large interior delta that extended from

Segou in the southwest to Timbuktou in the northeast. This delta area provides large areas for irrigated agriculture and pasture during the dry season.

Cattle production in Mali has traditionally been by semi-nomadic herders who have followed seasonal north-south movements based on rainfall and availability of pasture. However, this transhumant system has gradually changed over time due to population increases and competition from crop farmers in traditional nomadic zones; and more and more herdsmen and their families have become fully or partially sedentarized over time.

The commercialization of the traditional system where cattle herders and their families lived off the milk of their animals or exchanged some for food and seldom sold their animals except for ceremonies was precipitated by two fundamental changes in the country. The first change was increased urbanization as the French colonial government administration established and expanded, increasing the demand for meat by urban dwellers. The second factor was that cattle owners were obliged to sell some of their cattle each year to meet their tax obligations, which the colonial government assessed per head. Thus, the foundation was laid for commercial cattle production in Mali.

In recent years, the Malian government has sought to reduce its intervention in the livestock sector as part of the structural adjustment program (*Programme d'Adjustment Structurel Agricole II, 1992*) and to promote private sector participation.

The two government institutions, DNE (*Direction Nationale d'Elevage,* which has been responsible for animal production and health) and OMBEVI (Office Malien du Betail et de la Viande, in charge of marketing and transformation) now play the role of service providers to the private sector to make them more competitive in the production and marketing of livestock and other livestock products.

For the purposes of this study, important cattle producing areas in Mali have been classified into two zones: ***Zone Centre-Est*** – covering Sikasso, Koulikoro, Segou, and Mopti areas; and ***Zone Nord*** — which includes Tombouctou, Gao, and surrounding areas. A third zone, ***Zone Ouest*** – including Kayes and western Mali add on to the first two zones to cover the entire country as the cattle consumption zones for Mali.

The available statistics indicate that Malian cattle stocks increased by an average of 2.8% annually between 1985 and 1990, while annual local slaughter and exports both declined, on the average, by -3.2% and -3.5%, respectively. In the 1990s, however, stock increases has been marginal, only 0.2% annually between 1991 and 1996; while slaughter and exports recovered, increasing annually by 0.8% and 3.6%, respectively (Table 4.3). The change between the 1980s and 1990s may be attributed to the dumping of beef in the coastal markets by the European Union in the 1980s which made Sahelian cattle uncompetitive; but the situation changed when the EU reduced its subsidy by about 30% and Cote d'Ivoire also set up a compensatory tariff system against beef imports, as well as the 50% devaluation of the CFA franc in

Table 4.3. Officially Recorded Annual Average Stock, Slaughter, and Prices of Cattle in Mali (1985 - 1996)

Year	Stock (Numbers)	Slaughter (Numbers)	Exports (Numbers)	Cattle Price* (FCFA/head)
1985	4,344,000	196,209	224,000	50,000
1986	4,475,000	158,888	207,000	74,000
1987	4,589,000	146,606	180,000	80,000
1988	4,703,000	145,111	195,000	77,000
1989	4,826,000	136,847	190,000	76,000
1990	4,996,000	160694	185,000	80,000
1991	5,092,132	168,828	190,000	84,000
1992	5,226,893	193,370	195,000	70,000
1993	5,380,281	185,102	188,000	63,000
1994	5,540,633	186,743	235,000	80,000
1995	5,471,000	129,561	210,000	98,000
1996	5,036,817	148,833	222,000	110,000
Average Annual Growth Rates				
1985 - 1990	2.8 %	- 3.2 %	- 3.5 %	
1991 - 1996	0.2 %	0.8 %	3.6 %	
1985 - 1996	1.4 %	- 1.4 %	0.4 %	

* Average Prices quoted at Nioro (a cattle production region) for Zebu cattle.

Sources: *Recueil des Statistiques du Secteur Rural Malien.* Ministere du Developpment Rural et de l'Eau. Republique du Mali. March 1998.
OMBEVI, Statistique du Betail et de la Viande, Rapports Annuels.

January 1994 that improved the competitiveness of Sahelian cattle.

The distribution of cattle stocks based on 1993 figures also show that about 71% were found in the Central-East Zone (which includes both Sikasso and Mopti regions), and only 14% or 15% each found in the North and West zones (Table 4.4). The Central-East Zone also slaughtered about 90% of cattle in Mali, compared to 4% to 6% in the other zones. This indicates that the importance of cattle in Mali has shifted from the traditional north to the central and eastern provinces, mainly due to favorable conditions in these zones especially during periods of drought.

Cattle marketing in Mali, and livestock marketing in general, involves a complex network that effectively links the farmer or herder in rural Mali to the consumers in urban centers. Cattle flow has traditionally followed a north-south

Table 4.4 Human Population, and Officially Recorded Cattle Stock and Slaughter by Zones in Mali – 1993

	Pop. (Mil.)	Stock (Num.)	Stock (%)	Slaughter (Num.)	Slaughter (%)	Cattle Price FCFA/ head
Zone Centre-Est	6.55	3,817,920	71 %	133,823	90 %	85,000
Zone Nord	0.89	746,876	14 %	8,329	6 %	60,000
Zone Ouest	1.21	815,485	15 %	6,047	4 %	78,000

Source: *Recueil des Statistiques du Secteur Rural Malien.* Ministere du Developpment Rural et de l'Eau. Republique du Mali. March 1998.

direction, with cattle traders and intermediaries assembling cattle in small lots over a large area in the cattle producing areas, and moving them (usually by trekking) to the large urban consuming areas in the south (both within Mali and in the neighboring countries). The marketing chain starts with numerous small markets scattered all across the production zones, where exchange of cattle occurs among herders, local butchers, and intermediaries. Two important nodes in the marketing chain are the *marches de collecte,* where cattle trade occurs between herders, herders and traders/intermediaries, and between traders; and the *marches de groupement,* which trade cattle mainly for slaughter or for export. These markets are mostly weekly markets and under government control to facilitate veterinary inspection/certification and for tax purposes.

Sahelian cattle markets in general, and particularly Malian cattle markets, may exhibit some level of seasonal variation in activity. This, however, is not universal across the country but influenced by specific types of migration tied to the lengths and intensities of the rainy and dry seasons. For example, activities in most cattle markets in Mali are greatest just after the rainy season ends, when the animals are in their best condition (especially if rainfall has been deficient), and least during the rainy season itself because herders move their cattle frequently to find fresh pasture. But in Mopti area markets, activity is greatest at the end of the dry season, when cattle and their owners are concentrated in the interior delta area (Stryker, 1973).

Trekking cattle is the main mode of transporting cattle from the interior collection markets in the north and north-eastern Mali to the urban markets in the south and for export. Together with cattle that cross the borders from Mauritania, most of the cattle from the west pass through the Kati market (near Bamako) and are sold for slaughter or continue on to coastal markets. Cattle coming from the northeast trek down to Bamako and Sikasso as slaughter cattle or en route to Cote d'Ivoire by crossing the borders to Kohorgo, or Bobo-Dioulasso in Burkina Faso to be shipped southwards by rail. Most of the cattle from the east of the Niger Delta (e.g., N'Gouma, Kona, Fatoma near Mopti) trek across the border to Burkina Faso from where they are shipped by train to Cote d'Ivoire, or trek across the borders to Ghana and Togo, or even to Nigeria. In recent years, however, fewer cattle use the route across Mali's eastern border mainly due to the decline in the Ghanaian market.

Trekking cattle in Mali is usually done along specified routes, covering an average of about 25 to 30 kilometers per day depending on the size of the herd, and may incur some losses due to diseases and weight loss of animals. However, trucking and/or shipment by rail from Burkina Faso is gradually replacing trekking for exported cattle from Mali to the coastal countries.

4.4. Cattle Production and Marketing in Burkina Faso

Burkina Faso is a landlocked country covering an area of 274,200 km^2 within the Sahelian (15%), Sudanian (43%) and Guinean (42%) zones of West Africa. The

annual rainfall ranges between 600 mm in the Sahelian zone of the north to 1,300 mm in the Guinean zone in the southwest; rainfall being mostly erratic and irregular, and concentrated within a four to five month period between May and October. Agriculture is the mainstay of the Burkinabe economy, and livestock, which was the country's major export earner in the 1960s and early 1970s, has since been overtaken by cotton as the country's most important export commodity. Nevertheless, livestock and livestock products continue to play a major role in the economy, accounting for about 22% of total export revenue in 1995 (see Table 4.1a), besides being an important source of government revenue through the various cattle and other livestock trade related taxes and fees.

Livestock production in Burkina Faso varies across the country in terms of the production system adopted in each production zone. However, all the various systems could more or less be classified under the sedentary system of production based on their cost structures. Moreover, environmental degradation and population pressure have limited cattle production under the traditional transhumant system in the north of the country in recent years. Also, biological, climatic, and economic factors have all affected the traditional approach to cattle production, particularly in the Sahel, and motivated most herders to become less mobile and more dependent on crop production agriculture.

In the north and northwest, extensive cattle production systems are more prevalent and rangelands communally owned, leading sometimes to overstocking and

overgrazing with little incentive on the part of herders to adopt responsible rangeland management practices (World Bank, 1975). The nature of rangelands as an 'open pool resource', coupled with competition from crop production agriculture even in these Sahelian grasslands, has increasingly become a major constraint to livestock production under the transhumant system in this area. The larger Zebu breeds are predominant in this zone, even though the Zebu-Taurin crosses are also common in certain pockets in the zone. Herman (1983) notes that the Burkinabe government and donor agencies interested in livestock agreed in the early 1980s that the future of livestock development depended critically on improved range management to increase the carrying capacity per hectare.

The central and southern parts of Burkina Faso have predominantly sedentary system of cattle production, with a few more intensive systems for fattening animals for the market such as found at Pouytenga near Ouagadougou. The zebu-taurin cross and the smaller taurin which are more resistant to trypanosomiasis, are more common in the region (trypanosomiasis and onchocerciasis are endemic in some zones in the region and constitute a major constraint to cattle production). Pasture and locally available crop by-products form the bulk of feed for cattle in Burkina Faso. Government action in recent years has been more towards livestock productivity improvement, with livestock health as one of the major activities.

This study divides Burkina Faso into four main zones for the purposes of cattle production and beef consumption in the country as follows (see Diebre and Pavy, 1996):

Zone Amenagee — includes 12 administrative provinces with Ouagadougou-Pouytenga as the reference area — Sissili, Sanguie, Boulkiemde, Passore, Oubritenga, Bazega, Ganzourgou, Kourittenga, Kadiogo, Boulgou, Zoundweogo, and Nahouri.

Zone Cotonniere — includes 8 administrative provinces with Bobo Dioulasso as the reference area — Kossi, Sourou, Mouhoun, Kenedougou, Houet, Comoe, Poni, and Bougouriba.

Zone Sahelienne — includes 8 administrative provinces with Dori as the reference area — Seno, Ganga, Namentenga, Sanmatenga, Bam, Oudalan, Soum, and Yatenga.

Zone Est — includes 2 administrative provinces with Fada-Ngourma as the reference area — Gourma and Tapoa.

Burkinabe livestock data show that cattle stock numbers, slaughter, as well as exports, all increased in the 1980s and 1990s, with the highest overall increase of about 23% between 1985 and 1996 being cattle exports (Table 4.5). However, the large shifts in the export numbers suggest that official statistics did not capture many of the exports prior to 1990, especially given the decline in slaughter. Caution is

therefore needed in using the growth rate figures.

In terms of production, cattle stock numbers seem to be fairly evenly distributed among the three main production zones – Zone Amenagee (which includes Ouagadougou metropolis), Zone Sahelienne (including Dori and surrounding areas), and Zone Cotonniere (which includes Bobo Diolasso); with more than 80% of cattle slaughter occurring in Zone Amenagee and Zone Cotonniere (Table 4.6).

Cattle and beef marketing in Burkina Faso is composed of a complex network of small and large markets scattered across the country similar to what pertains in Mali. There are three market types within the network: (a) collection or primary markets, (b) regroupment or redistribution markets, and (c) terminal or slaughter markets. The animals usually enter the marketing chain through the small collection markets where sellers are mainly herders, and buyers include mostly herders and traders, with butchers playing a minor role. In the redistribution markets, sellers are predominantly traders who buy from collection markets and sell to other traders that serve the terminal markets, as well as to butchers; while cattle that reach the terminal markets are either slaughtered or exported (some after some fattening).

In all the cattle markets in Burkina Faso trading takes place at a designated place in the open, usually under the control of government agencies responsible for maintaining the marketplace and collecting taxes. Animal purchases are made per head or in groups (but not by weight), so the price is always quoted on per head basis; and brokers or intermediaries negotiate the price for the seller who

Table 4. 5. Officially Recorded Annual Average Stock, Slaughter, and Prices of Cattle in Burkina Faso (1985 - 1996)

Year	Stock (Numbers)	Slaughter (Numbers)	Exports (Numbers)	Transit* Cattle	Cattle Price** (FCFA/head)
1985	3,045,000	168,020	39,700	na	75,000
1986	3,106,000	77,925	41,000	na	102,000
1987	2,754,000	62,179	24,308	29,492	120,000
1988	2,809,000	105,506	20,463	48,364	108,000
1989	3,860,000	105,373	32,372	56,979	105,000
1990	3,937,200	117,460	88,712	14,881	120,000
1991	4,015,600	139,924	92,029	4,815	128,000
1992	4,095,900	149,282	92,422	2,295	105,000
1993	4,177,500	161,476	101,558	935	84,600
1994	4,260,900	131,705	173,023	1,956	125,000
1995	4,345,900	112,435	147,929	945	149,400
1996	4,432,900	126,043	150,351	352	163,400
Average Annual Growth Rates					
1985 - 1990	6.4 %	1.4 %	35.8 %		
1991 - 1996	2.0 %	2.2 %	11.9 %		
1985 - 1996	4.0 %	1.8 %	22.8 %		

Note: Large changes in officially recorded export numbers suggest official statistics did not capture many of the exports prior to 1990.

* Refer to officially recorded cattle exported from neighboring countries such as Mali and Niger through Burkina Faso.

** 1993 to 1996 refer to annual average prices quoted at Pouytenga; 1985 to 1992 are estimates based on prices in Mali.

Sources: *Les Statistiques de L'Elevage au Burkina Faso. 1996*, Ouagadougou.B.F. *Annuaire Statistique du Burkina Faso, 1994*. INSD, Ouagadougou, B. Faso.

Table 4.6 Human Population, and Officially Recorded Cattle Stock and Slaughter by Zones in Burkina Faso – 1993

	Pop. (Mil.)	Stock (Num.)	Stock (%)	Slaughter (Num.)	Slaughter (%)	Price FCFA/ head
Zone Amena-gee	3.09	1,357,000	32 %	86,273	54 %	80,564
Zone Coton-niere	2.45	1,155,000	28 %	50,213	31 %	82,310
Zone Saheli-enne	2.27	1,245,000	30 %	16,847	10 %	85,839
Zone Est	0.55	420,000	10 %	8,143	5 %	90,500

Sources: *Les Statistiques de L'Elevage au Burkina Faso. 1996*, Ouagadougou.B.F. *Annuaire Statistique du Burkina Faso, 1994.* INSD, Ouagadougou, B. Faso.

retains the right to approve any price and authorize sale. Bargaining takes place openly between buyers and sellers, making information flow easy in each market, though information does not necessarily flow freely between one market and another.

Again, as in the case of Mali, trekking is the most predominant means of transporting cattle to marketing centers throughout Burkina Faso. Herders usually trek their cattle to nearby collection market a few kilometers from their bases, and may sell only a few cattle at a time. Cattle traders may buy cattle in singles or in small groups from various collection markets until a "commercial" herd is assembled for shipment to redistribution and/or terminal markets either for slaughter or for export to coastal countries. In recent years, most of the cattle from Burkina Faso are exported by rail and truck from Ouagadougou and Bobo-Dioulasso to Cote d'Ivoire; or by truck to Ghana. Fewer cattle officially enter Ghana due to stringent quarantine procedures, and it is believed that most of the cattle from Burkina Faso and Mali trek across the Ghana borders illegally to avoid official scrutiny, and then are shipped south to Kumasi and Accra by trucks. (Ghana has banned trekking livestock across the country).

The strategic position of Burkina Faso in the Sahel region bordering all six countries – Mali and Niger to the north and north west; and Cote d'Ivoire, Ghana, Togo, and Benin to the south and south east – makes it a natural transit center for cattle trade in the sub-region. As has already been noted, Malian cattle, particularly from the eastern provinces, as well as cattle from Niger in limited numbers, have

regularly trekked through Burkina Faso for transshipment to the coastal countries including Cote d'Ivoire, Ghana, Togo, Benin, and even Nigeria.

4.5. Cattle Production and Marketing in Ghana

The total area of Ghana is about 238,540 km^2, divided into three main vegetational zones that determine the livestock production patterns in the country. These include the Guinea savannah zone in the north, which covers more than half (52%) of Ghana's land area, the Forest belt that covers the middle to most of the south of the country and represents about 34% of the total land area, and the semi-arid coastal zone that stretches from the area around Cape Coast to the Togo border covering some 14% of Ghana's land area. Most of the cattle produced in Ghana are of the indigenous West African Short Horn (WASH) type which show considerable resistance to trypanosomiasis, even though the Zebu-WASH cross (called *Sanga*) are also common.

Most of Ghana's cattle come from the Guinea savannah zone, where production is concentrated around Kpong-Tamale, even though cattle and other livestock are raised throughout the zone. The sedentary production system is the most common practice, and most cattle farmers commonly produce cereals also (mainly sorghum and millet and/or maize). Herders generally keep their cattle in kraals to protect them from harsh environmental conditions and thieves, and also keep the animals from straying into nearby food crop farms.

There exists great potential in the coastal belt for increased cattle production due to the favorable climatic conditions of the area that reduce the incidence of trypanosomiasis, and its proximity to urban centers. Most of the cattle raised in this zone are primarily dairy cattle which are later sold for slaughter, even though a considerable percentage of the herd is raised as beef cattle. A few peri-urban dairy enterprises have emerged in this zone in recent years to feed the expanding urban centers in the area, and these systems are generally very intensive. Nevertheless, most of the herders can be classified under the sedentary production system which is the more common practice.

In the forest belt, high humidity and high rainfall create conditions for common tropical diseases such as trypanosomiasis, which is a major constraint to cattle production. Few cattle thrive well in this zone, even though recent efforts by the government and other agencies aimed at controlling these tropical diseases seem to increase the cattle population in the zone, particularly around Ejura in the Ashanti region and Afram Plains in the Eastern region. For example, interviews with farmers and extension agents in the Ashanti region revealed that in recent years, most cereal farmers (mainly maize) invested their proceeds in cattle after selling their crops. The animals are fattened and then sold at the beginning of the planting season for much-needed cash.

This study identifies two main cattle production zones in Ghana:

Northern Zone – includes 3 administrative regions with Kpong Tamale-Tamale as the reference area -- Northern, Upper East, and Upper West regions.

South-East Zone -- includes 3 administrative regions with Accra Plains as the reference area – Greater Accra, Eastern, and Volta regions. A third zone,

Central-West Zone – which also includes 4 administrative regions with Kumasi as the reference area – Ashanti, Central, Western, and Brong Ahafo regions, has been identified so that together the three zones constitute the beef demand or consumption zones in Ghana.

The data presented in Table 4.7 show that in Ghana, cattle stock numbers increased twice as much as the slaughter numbers in the mid- to late-1980s, but this trend in growth reversed in the 1990s. The increase in slaughter numbers may be attributed to more cattle imports from the Sahel region, particularly Burkina Faso, in response to the CFA franc devaluation; and also increases in the off-take of local cattle, whose prices might have been given a boost because demand increased for all cattle types (imported animals are larger animals which are priced higher than smaller local animals), coupled with a reduction in European beef imports. Also, the data (Table 4.8) show that while the Northern Zone is the major center of cattle production in Ghana, accounting for about 75% of the total cattle stock, the Central-West Zone (that includes the Kumasi metropolis) and South-East Zone (including the Accra-Tema metropolis) are the most important consumption centers.

Table 4. 7. Officially Recorded Annual Average Stock, Slaughter, and Prices of Cattle in Ghana (1985 - 1996)

Year	Stock (Numbers)	Slaughter[a] (Numbers)	Imports[b] (Numbers)	Cattle Price[c] C/head	FCFA/head
1985	1,064,778	92,073	1,268	15,865	130,976
1986	1,134,870	70,957	1,200	27,503	90,953
1987	1,170,805	71,123	1,000	53,806	100,284
1988	1,125,812	93,333	1,000	70,823	105,118
1989	1,136,421	98,815	1,000	94,500	115,644
1990	1,144,787	88,918	299	180,000	152,486
1991	1,194,633	97,916	1,992	210,000	162,291
1992	1,159,431	95,306	3,286	230,000	145,931
1993	1,168,640	105,938	7,192	230,000	103,416
1994	1,217,077	121,874	47,176	280,000	157,361
1995	1,112,106	109,145	31,541	340,000	143,819
1996	1,247,861	108,006	37,201	450,000	141,115
Average Annual Growth Rates					
1985 - 1990	1.5 %	0.9 %	- 18.4 %		
1991 - 1996	1.7 %	3.7 %	215.1 %		
1985 - 1996	1.6 %	2.4 %	108.9 %		

[a] Slaughter figures include imported animals

[b] FAO Figures – 1985 to 1989; Les Statistiques de l'Elevage au Burkina Faso (1996) – 1990 to 1996.

[c] FAO Figures – 1985 to 1989; Estimated from field data: 1990 - 1996.

Sources: Livestock Planning and Information Unit (LPIU), and Veterinary Services Division of the Ministry of Food and Agriculture, Accra, Ghana.

Table 4.8. Human Population, and Officially Recorded Cattle Stock and Slaughter by Zones in Ghana -- 1993

	Pop. (Mil.)	Stock (Numbers)	Stock (%)	Slaughter* (Numbers)	Slaughter (%)	Price** C/head
Northern Zone	3.25	876,781	75 %	24,142	23 %	180,000
Central-West Zone	7.41	73,327	6 %	46,755	44 %	230,000
South-East Zone	5.73	218,523	19 %	35,039	33 %	230,000

*Slaughter figures include domestic production and imports

** Prices are estimates from field data.

Sources: Computed from figures obtained from the Livestock Planning and Information Unit (LPIU), and Veterinary Services Division of the Ministry of Food and Agriculture, Accra, Ghana.

The marketing of cattle has had a long history in Ghana, linking back to the nineteenth century north-south West African trade routes that exchanged livestock for forest products. Traditionally, cattle had flowed freely from the cattle-surplus regions of the Sahel on hoof across the borders to Kumasi, and then further down south to Accra-Tema and Cape Coast or Secondi-Takoradi.

The first break with this traditional system occurred in 1968, when the Ghana government passed the Alien Compliance Act, which effectively removed all foreigners from a wide range of commercial activities including the cattle trade. Cattle marketing suffered as a result of the implementation of this Act, and the government subsequently established the Cattle Development Board (which later became the now-defunct Meat Marketing Board). The functions of the Board, among others, were to purchase, handle, and transport all cattle imported for consumption in Ghana; and to arrange payments of proceeds from cattle sales to dealers as well as distribute imported cattle to government recognized butcher associations in the country (Josserand and Sullivan, 1979). The bureaucracy that became the hallmark of the Meat Marketing Board (MMB) contributed in no small way in cutting the flow of cattle from the Sahel to Ghana in the 1970s.

When Sahelian cattle imported to Ghana began to dwindle from the mid-1970s, the Meat Marketing Board began to import cheaper frozen beef from South America and Europe, among others, which were distributed to Butcher Associations for sale to consumers together with local cattle slaughtered. The only other agency that

imported beef during the period was the Ghana Industrial Holding Corporation (GIHOC), whose beef imports went directly to feed its corned beef factory at Bolgatanga in Northern Ghana.

The government control of the domestic cattle trade resulted in chronic shortages of beef on the market throughout the mid-1970s to early 1980s, until trade liberalization under structural adjustment allowed the private sector to regain control of the domestic meat market. There are three major markets for both domestic and imported cattle in the 1990s, which include the Kpong-Tamale cattle market in the north, the Kumasi cattle market in the middle or forest belt, and the Ashaiman cattle market in the south near Accra-Tema.

4.6. Cattle Production and Marketing in Cote d'Ivoire

With a total area slightly bigger than that of her coastal neighbor Ghana, Cote d'Ivoire covers an area of 332,463 km^2 and shares borders with all the other countries in the Central Corridor – Ghana to the east, and Burkina Faso and Mali to the north; as well as Guinea and Liberia to the west. Most of her land area falls within the forest belt, stretching from the Atlantic coast in the south and tapering into the Guinea savannah in the north. Trypanosomiasis and other cattle diseases, which are endemic in the humid forest zones of sub-Saharan Africa, are a major constraint to cattle production in Cote d'Ivoire as it is the case in Ghana.

Most of the cattle produced in Cote d'Ivoire come from the three regions of the North (Korhogo, Ferkessedougou, and Boundiali), the North-Central (Bouake and Katiola), and the West-Central (Gagnoa, Divo, and Lakota). In addition, a considerable number of Sahelian herders and their cattle frequently cross the border to northern Cote d'Ivoire, either in search of grazing fields or as 'illegal' exports. The Ministry of Agriculture's *Livestock Service* and a parastatal, *La Societe pour le Developpement des Productions Animales* (SODEPRA), are the two organizations that have been responsible for the livestock sector (including cattle) in Cote d'Ivoire. SODEPRA in particular has over the years run projects that have aimed at creating a tsetse-free environment in the cattle production zones to promote productivity, as well as provide services for herders.

In the more typical traditional Ivorian herds which occur in the northern and central regions, the smaller Baoule and/or Taurin breeds together with Zebu-Taurin and Zebu-Baoule crosses are extensively raised since they are more resistant to the trypanosomiasis and other diseases. Near the northern border and around Korhorgo-Ferke area, however, the larger Zebu cattle and Zebu-Taurin crosses are more common. The sedentary system of cattle production is more typical in raising cattle in Cote d'Ivoire, even though various forms of the transhumant systems exist throughout the region.

For the purposes of this study, Cote d'Ivoire has been divided into two zones representing both production and consumption areas. These are:

Zone Savane (Nord) — which includes Nord (Ferke-Kohorgo), Nord-Ouest (Odienne), Nord-East (Bondoukou), and Centre-Nord (Bouake) constitutes the production zone; and together with

Zone Foret (Sud) — including, Centre-Ouest (Daloa), Centre (Yamoussoukro), Ouest (Man), Est (Abengourou); Sud (Abidjan), and Sud-Ouest (San-Pedro) constitute the demand or consuming zones in Cote d'Ivoire.

Cote d'Ivoire livestock data show that both cattle stock and slaughter numbers grew in the 1980s as well as the 1990s; but while the average annual growth rate was higher for cattle stocks than slaughter in the 1980s, the reverse was the case in the 1990s. On the other hand, the average growth rate for cattle imports from the Sahel were negative in the 1980s but positive in the 1990s by about the same margin (14%).This is consistent with the experience of Cote d'Ivoire in the 1980s when most of her cattle imports from the Sahel were substituted with cheap European beef imports; and in the 1990s, when the CFA franc devaluation made cattle from the Sahel more competitive again.

The Savannah Zone of the north also produces most of Cote d'Ivoire's local cattle (94%), but consumes about 27%; compared to the south (Zone Foret), which produces only about 6% of the total cattle stock but consumes about 73%. The Abidjan metropolis, for instance, is a major beef consuming center in Cote d'Ivoire.

Table 4. 9. Officially Recorded Annual Average Stock, Slaughter, and Prices of Cattle in Cote d'Ivoire (1985 - 1996)

Year	Stock (Numbers)	Slaughter* (Numbers)	Imports (Numbers)	Cattle Price (FCFA/head)
1985	954,000	210,000	182,996	134,778
1986	899,000	200,000	155,393	107,738
1987	935,000	205,000	129,291	106,191
1988	993,000	215,000	118,576	101,956
1989	1,049,000	225,000	123,382	116,597
1990	1,108,000	226,591	83,807	102,155
1991	1,145,000	238,674	129,112	109,533
1992	1,180,000	249,464	146,442	117,636
1993	1,205,000	249,823	137,754	110,585
1994	1,231,000	251,353	144,000	230,011
1995	1,258,000	270,000	148,000	181,509
1996	1,285,550	290,000	173,000	185,873
Average Annual Growth Rates				
1985 - 1990	3.1 %	1.6 %	- 13.6 %	
1991 - 1996	2.5 %	4.2 %	14.3 %	
1985 - 1996	2.8 %	3.0 %	1.6 %	

*Slaughter figures include imported animals.

Sources: Stock and Import figures obtained from Berte and Zongo, 1996
Slaughter figures and prices estimated from FAO Production Yearbooks, various issues.

Table 4.10 Human Population, and Officially Recorded Cattle Stock and Slaughter by Zones in Cote d'Ivoire – 1993

	Pop. (Mil.)	Stock (Number)	Stock (%)	Slaughter (Number)	Slaughter (%)	**Price** FCFA/head
Zone Savane (North)	3.4	1,127,000	94 %	67,452	27 %	95,200
Zone Foret (South)	9.3	78,000	6 %	182,371	73 %	110,000

Sources: Population estimated from *Memento Chiffre De La Cote d'Ivoire, 1986 - 1987. Ministere de l'Industrie et du Plan.* Cote d'Ivoire.
Stock and Slaughter figures estimated from Berte and Zongo, 1996
Prices obtained from Metzel *et al, ibid.*.

Livestock marketing in general and cattle marketing in particular have been quite open in Cote d'Ivoire, compared to other livestock markets in the sub-region. Staatz (1979), for example, states that large numbers of cattle imported into Cote d'Ivoire from Mali between 1970 and 1974 (most of which would have gone to Ghana otherwise) resulted from economic instability and a reorganization of the cattle market in Ghana during the period. Starting in the mid-1960s, Cote d'Ivoire gradually increased her imports to become one of the most important markets for Sahelian cattle in West Africa.

Cattle continue to flow in a north-south direction in Cote d'Ivoire. However, unlike the 1960s and 1970s when there existed four major cattle trade routes (see Staatz, *ibid.*), there now appears to be one major route by rail and truck from the north through Bouake and then to Abidjan (cattle trekking south of Bouake has been banned in Cote d'Ivoire). All cattle shipments through the eastern and western routes during the 1960s and 1970s have been reduced to trickles due partly to dwindling numbers of cattle that cross the borders, and partly due to reduced profitability. For example, the eastern route through the border towns of Doropo and Bondoukou which used to serve Ghanaian markets is almost now non-existent because Ghanaian markets have become relatively unprofitable in recent years.

As common in most West African countries, cattle farmers and herders sell their animals in singles or a few at a time to itinerant traders in nearby 'collection markets'; which these traders subsequently sell in larger markets to butchers for

slaughter, or to other traders for export to deficit regions. Tingrela is the most important crossing point for cattle in Cote d'Ivoire, and also the largest cattle market in the north of the country; so that most of the cattle from northern Cote d'Ivoire as well as Mali and Burkina Faso are sold and shipped to Bouake and the south from here. Cattle traders and butchers based in the south and central Cote d'Ivoire routinely travel to Tingrela to buy cattle, particularly during periods of shortages of slaughter animals in the south.

4.7. A Summary of Cattle Production and Marketing Costs in the Central Corridor

Even though a complex array of cattle production systems exist in the West African sub-region (e.g., transhumant, sedentary, semi-intensive and intensive systems), the sedentary system of production seems to predominate now as competition between access to land for grazing and crop production intensifies; and soil degradation and environmental concerns, as well as population increases exert pressure on land use in most parts of West Africa. For example, Herman (*ibid., pp 8*) argues that there has been a great misconception about herders in the Sahel, that the Sahel "continues to be populated by nomadic herders who live almost exclusively off their livestock through subsistence consumption of milk and exchange of animals for money to purchase grain .....". He states that the reality is that historic, climatic, biologic, and economic factors have combined to motivate most herders who were traditionally mobile to be increasingly stationary and more dependant on crop

production. In addition, the major droughts of the 1970s and 1980s redistributed cattle ownership from more nomadic herders (who had to sell their animals to buy grain, at very unfavorable terms of trade) to farmers (who had grain to sell).

Moreover, intensive systems of cattle production (e.g., peri-urban dairy enterprises) have been shown to be less profitable as sources of slaughter cattle on a large scale compared to the more labor intensive sedentary systems (Metzel et al., *ibid.*). Estimates of production and marketing costs in the Central Corridor were therefore based on the sedentary system of cattle production, with the assumption that future expansion in cattle production in the sub-region will derive more from the sedentary rather than any other existing systems of cattle production.

Since the focus of this analysis is on the number of cattle that are produced and shipped from one region or country to another, the unit applied in the cost estimates is the 'Animal Unit' (AU), which means a head of cattle one year or older (World Bank, 1975). This differs slightly from the 'Reproductive Unit' (RU), which refers to one adult female and the fraction of adult males and non-reproductive offspring per adult female in the herd (Metzel et al. *ibid.*); or the Unite Betail Tropicale (UBT) referring to one lactating cow or 1.1 adult steer (Herman, *ibid*) used in other studies.

In Table 4.11, cattle production cost estimates based on 1993 prices are presented for the four countries in the Central Corridor – Mali, Burkina Faso, Ghana, and Cote d'Ivoire (See Appendix A4.1 for details of estimates).

Figure 4.11. Cattle Production Cost Estimates for the Central Corridor (based on 1993 Prices)

Cattle Production Cost Estimates (assumes maturity in 5 years)					
	Mali (FCFA/head)	**Burkina Faso** (FCFA/head)	**Cote d'Ivoire** (FCFA/head)	**Ghana** C/head	FCFA/head
Repd. Stock	16,019	15,584	12,330	19,729	8,887
Fixed Inputs	133	265	482	7,709	3,470
Labor	18,765	30,705	24,598	20,146	9,075
Comm.. Feeds/Inputs	5,235	1,459	2,000	15,308	6,896
Misc.	6,280	1,248	3,364	9,273	4,177
Total Cost	**46,432**	**49,261**	**42,774**	**72,154**	**32,505**

Note: Cattle produced in Mali and Burkina Faso are Zebu types, with average live weight of 250 kg per animal; Cattle produced in Ghana and Cote d'Ivpire are mainly West African Short Horns (WASH) and the Taurin, respectively, with average live weight of 165 kg per animal. The 1993 Nominal Exchange Rate used is C2.22 per 1FCFA.

Source: Computed from data provided in Metzel et al.(*ibid.*), Vol III, 1994.

An important difference between cattle produced in the Sahelian zone (Mali and Burkina Faso) and those produced in the coastal countries (Ghana and Cote d'Ivoire) is that the Zebu cattle of the Saheian zone are larger animals (live weight average 250 kg per animal) compared to those of the coastal countries (live weight

average 165 kg per animal). This has implications for the estimated cost of production figures. For example, even though there are differences in feed costs, veterinary costs, etc, depending on the type of animal, one could normalize these costs on per unit live-weight basis. Then if we assume, based on the live weight differences, that the yield from cattle from the coastal countries is 34% less than those from the Sahelian zone, the production cost per unit of the smaller animals will be proportionately higher than the estimated costs of Sahelian animals. Thus, for comparable animals, the cost of cattle production in the Central Corridor is lowest in Mali (30,645 FCFA) and highest in Cote d'Ivoire (42,774 FCFA).

The marketing cost of cattle, on the other hand, does not differentiate between relative sizes (i.e., large and small cattle), and therefore the cost estimates per head represent the actual averages across all countries. Except the transport per head, which is highest (about one-and-a-half times higher) in Ghana (cattle shipment in Ghana is done by truck only), among the four countries in the Central Corridor Ghana has the lowest cost in most of the important cost items in cattle marketing (e.g., labor since trucking requires less labor). Mali also has a relatively lower cost in cattle marketing compared to the other francophone countries except in the cost of labor, apparently because Malian cattle travel longer distances from farm-to-market, on the average, relative to cattle in the other three countries. Again, in general, Cote d'Ivoire has the highest cattle marketing cost in the sub region.

Table 4.12. Elements of Cattle Marketing Cost Estimates for the Central Corridor (based on 1993 Prices).

	Mali (FCFA/head)	Burkina Faso (FCFA/head)	Cote d'Ivoire (FCFA/head)	Ghana C/hd	Ghana FCFA/hd
Transport					
-trekking	18 FCFA/km	17 FCFA/km	21 FCFA/km	na	
-truck	20 FCFA/km	19 FCFA/km	23 FCFA/km	67 C/km or 30 FCFA/km	
-train	na	20 FCFA/km	20 FCFA/km	na	
Capital Inputs	173	146	24	63	28
Labor	1000	625	790	700	315
Feed	20	25	53	100	45
Taxes	460	1,150	800	1,300	586
Broker's fees	500	1,000	1,000	500	225
Tips	140	750	800	1,000	450
Misc.	750	670	850	800	360

Source: Computed from data provided in Metzel et al.(*ibid.*), Vol III, 1994.

Transforming cattle into beef and beef marketing in all four countries typically involve bouchers, wholesalers, and retailers, who form the final link between cattle traders and consumers. Also in all four countries, cattle slaughter are required by law to be done in abattoirs (or slaughter houses) and be subjected to veterinary inspection before they are sold to the public (even though many slaughters occur outside the abattoirs in each country). The expenses that are associated with these requirements, together with other transformation and marketing costs are summarized in Table 4.13. Again, the beef marketing costs are higher in Burkina Faso and Cote d'Ivoire than in Mali and Ghana. The per kilogram average beef prices at the retail level are presented in Table 4.14.

Table 4.13. Elements of Beef Marketing Cost Estimates for the Central Corridor (based on 1993 Prices).

	Mali (FCFA/kg)	**Burkina Faso** (FCFA/kg)	**Cote d'Ivoire** (FCFA/kg)	**Ghana** C/kg	FCFA/kg
Capital Inputs	173	21	52	45	28
Labor	1000	1,500	1,000	1,000	450
Feed	20	300	500	800	360
Taxes	460	7,500	1,100	200	90
Abat.+ Mat.	-	2,000	1,000	1,000	450
Tips	140	375	375	0	0
Misc.	750	200	1,200	1,500	680

Source: Computed from data provided in Metzel et al.(*ibid.*), Vol III, 1994.

Table 4.14 Prices of Local Beef in the Central Corridor: 1990 - 1996

	Mali (FCFA/kg)		Burkina Faso	Cote d'Ivoire	Ghana	
	W/bone	Boneless	FCFA/kg	FCFA/kg	C/kg	FCFA/kg
1985	650	700	700	950	na	
1986	690	700	700	942	na	
1987	745	800	700	900	na	
1988	700	950	700	928	na	
1989	710	1,000	553	913	na	
1990	670	980	527	885	985	835
1991	635	805	484	900	954	740
1992	640	790	469	545	977	618
1993	690	800	455	522	1,295	583
1994	900	1,000	738	968	1,618	910
1995	970	1,075	1,025	1,174	2,536	1,075
1996	1,070	1,255	801	1,225	3,544	1,110

Note: These prices are officially recorded national averages, and do not refer to prices in any particular city or town.

Sources:

- Mali data is from *OMBEVI, Statistique du Betail et de la Viande, Rapports Annuels.* Bamako, Mali.
- Burkina Faso data is from (a) *Annuaire Statistique du Burkina Faso, 1994.* INSD, Ouagadougou, B. Faso; and (b) *Les Statistiques de L'Elevage au Burkina Faso. 1996*, Ouagadougou.B.F.
- Ghana data is from Livestock Planning and Information Unit (LPIU), Ministry of Food and Agriculture, Accra, Ghana.
- Cote d'Ivoire data is from (a) Holtzman, J. S. and N. P. Kulibaba.1992; and (b) Berte, K. and D. Zongo. 1996.

CHAPTER V

Data, Model Analysis, and Discussion

5.0. Introduction

Modeling cattle trade in the four countries of the Central Corridor – Mali, Burkina Faso, Ghana, and Cote d'Ivoire – necessitated assembling relevant data from different sources, including recent studies, published reports, surveys and personal interviews. A diverse set of coefficients were required to parameterize an initial programming model, which was then calibrated to reflect the economic conditions that prevailed in the base period (1993) as a point of reference for other scenarios. Since the study combined individual as well as cross-country analysis, a fundamental consideration was to determine techniques of production and marketing as well as variable resources that caused cost structures to differ across regions within a country or across countries. This helped to identify relative cost differentials that formed the basis of shipments of cattle and beef from one region to another, or from one country to another.

This chapter discusses the underlying data for the different scenarios considered, and the rationale for each scenario. Comparative analysis is then made of the model outputs per country and across countries in the Central Corridor.

5.1. Data and Analytical Procedure

Data for this study have been gathered mainly from secondary sources, augmented by personal interviews of some practitioners, researchers, and other stake holders in the beef cattle sub-sector of the West African Central Corridor. In October 1997, a short survey of cattle farmers in the Accra Plains and Northern Ghana was conducted to investigate their cultural practices and production cost structures to verify and/or support the existing data on cattle production in Ghana. With regard to such published data as population, land use, etc, the National Statistical Services of the countries involved, as well as the Food and Agricultural Organization (FAO) and the World Bank were the primary sources.

Production and Consumption Regions

The modeling of beef and cattle trade in the Central Corridor is based on the essential elements of traditional spatial equilibrium analysis. Concentration of cattle production in the various regions in the countries of the Central Corridor form the basis for identifying certain areas as production regions in each country. However, since beef is consumed by all the population, all regions in each country form part of the consuming regions based on whether such regions are net exporters or net importers of cattle. Table 5.1 provides a summary of the various consuming and producing regions specified in the Central Corridor (as discussed in the previous chapters) and used for the trade model.

Eight cattle producing regions were identified (based on cattle stocks in the 1990s)for the central Corridor – two in Mali, three in Burkina Faso, two in Ghana, and one in Cote d'Ivoire. Some of these regions were then combined in each country because only minimal differences in cattle production existed across such regions within the same country; and also to simplify the model and make it more tractable. Four producing regions, one in each country, were finally specified for the model. These included Mali (Zone Centre-Est and Zone Nord), Burkina Faso (Zone Amenagee, Zone Cotoniere, and Zone Sahelienne), Ghana (Northern Zone), and Cote d'Ivoire (Zone Nord).

On the other hand, there were six consuming or demand regions specified – one in Mali (all Zones), one in Burkina Faso (all Zones), two in Ghana (all Zones), and two in Cote d'Ivoire (all Zones). The two demand regions each specified for Ghana and Cote d'Ivoire reflected the savannah north in each country where cattle production is important, and the forest south where it is not.

A major determinant of whether shipments of cattle occur or not among regions and across countries is the cost of transport in moving cattle from one point to another within the Central Corridor. There are two cost elements which define the total transportation cost based on the distances covered by marketing agents: (a) the assembling cost, which consists of gathering the animals from various collection markets to a regrouping market; and (b) the shipment cost from regrouping markets to terminal markets either within the same country or across borders from one country

Table 5.1. Cattle Producing and Beef Consuming Regions of the Central Corridor

Cattle Producing Regions by Country	Cattle Consuming Regions by Country
MALI	**MALI**
Zone Centre-Est -- Sikasso, Koulikoro, Segou, Mopti (Sikasso -Mopti)	***Zone Centre-Est*** -- Sikasso, Koulikoro, Segou, Mopti (Bamako-Sikasso)
Zone Nord — Tombouctou, Gao (Tombouctou).	***Zone Ouest*** -- Kayes (Kayes)
	Zone Nord — Tombouctou, Gao (Tombouctou).
BURKINA FASO	**BURKINA FASO**
Zone Amenagee — Sissili, Sanguie, Boulkiemde, Passore, Oubritenga, Bazega, Ganzourgou, Kourittenga, Boulgou, Zoundweogo, Nahouri (Ouagadougou-Pouytenga)	***Zone Amenagee*** — Sissili, Sanguie, Boulkiemde, Passore, Oubritenga, Bazega, Ganzourgou, Kourittenga, Boulgou, Zoundweogo, Nahouri (Ouagadougou-Pouytenga)
Zone Cotonniere — Kossi, Sourou, Mouhoun, Kenedougou, Houet, Comoe, Poni, Bougouriba (Bobo Dioulasso)	***Zone Cotonniere*** — Kossi, Sourou, Mouhoun, Kenedougou, Houet, Comoe, Poni, Bougouriba (Bobo Dioulasso)
Zone Sahelienne — Seno, Ganga, Namentenga, Sanmatenga, Bam, Oudalan, Soum, Yatenga (Dori)	***Zone Sahelienne*** — Seno, Ganga, Namentenga, Sanmatenga, Bam, Oudalan, Soum, Yatenga (Dori)
Zone Est — Gourma, Tapoa (Fada-Ngourma)	***Zone Est*** — Gourma, Tapoa (Fada-Ngourma)
GHANA	**GHANA**
Northern Zone -- Northern, Upper East, Upper West (Kpong Tamale -Tamale)	***South-East Zone*** -- Greater Accra, Eastern, Volta (Accra - Tema)
South-East Zone -- Greater Accra, Eastern, Volta (Accra Plains)	***Central-West Zone*** -- Ashanti, Central, Western, Brong Ahafo (Kumasi)
	Northern Zone -- Northern, Upper East, Upper West (Tamale - Bolga)
COTE D'IVOIRE	**COTE D'IVOIRE**
Zone Savane (Nord) — Nord (Ferke - Korhogo), Nord-Ouest (Odienne), Nord-East (Bondoukou), and Centre-Nord (Bouake)	***Zone Foret (Sud)*** -- Sud (Abidjan), Sud-Ouest (San-Pedro), Centre-Ouest (Daloa), Centre (Yamoussoukro), Ouest (Man), Est (Abengourou)
	Zone Savane (Nord) — Nord (Ferke-Kohorgo), Nord-Ouest (Odienne), Nord-East (Bondoukou), and Centre-Nord (Bouake).

to another. For each of the regions specified, a central reference point (usually a major city) has been chosen.

The regrouping markets in each cattle producing center was assumed to be within a 50-kilometer radius, and the cattle normally trekked to these markets. The assembling cost per head of cattle is therefore computed based on a 50-kilometer distance from the regrouping market.

In Table 5.2 the distances between regions in the Central Corridor and major cities which are the reference points for the regions are shown. The per kilometer transport cost per head of cattle used in the model have been estimated as 20 FCFA/km for truck shipments and 18 FCFA/km for trekking in Mali; 19 FCFA/km, 17 FCFA/km, and 20 FCFA/km for truck, trekking, and train shipments, respectively, in Burkina Faso; 23 FCFA/km, 21 FCFA/km, and 20 FCFA/km for truck, trekking, and train shipments, respectively, in Cote d'Ivoire; and 67 Cedis/km (or 30 FCFA/km) for truck shipments in Ghana (see Table 4.12).

The transport cost per head of cattle in the sub-region therefore depends on the distance the animal is shipped between markets and across countries. Moreover, there exist numerous unquantifiable exigencies along the routes that cattle are shipped within the Central Corridor, such that the cash cost of shipments may underestimate the actual transaction cost incurred by marketing agents in the cattle trade. For example, undue delays may be caused by over-zealous custom officers at the border crossing points, and this may result in deaths of some animals, or weak animals

Table 5.2.. Estimated Distances (km) between Cattle Producing and Beef Consuming Centers in the Central Corridor

	Producing Centers										
Consuming Centers	Nioro Nara	Mopti	Sikasso	Timbouctou	Bobo Dioulasso	Dori	Fada Ngourma	Yako Pouytenga	Kpong/ Tamale	Accra Plains	Ferke Korhogo
Bamako	432	767	374	912	611	1328	1197	1054	1330	2167	482
Sikasso	643	478	50	988	170	955	823	838	1064	1775	272
Nioro-Nara	180	920	743	720	813	1551	1629	1536	1762	2473	914
Mopti	920	50	478	409	446	561	733	583	709	1320	749
Timbouctou	720	409	887	150	952	970	1211	992	1118	1729	1158
Ouagadougou-Pouytenga	1479	426	781	992	463	341	299	120	443	1154	694
Bobo Dioulasso	1043	486	168	895	180	617	655	483	719	1430	258
Dori	1551	561	955	970	697	50	266	269	643	1354	875
Fada Ngourma	1698	645	1057	1211	702	266	80	219	458	1169	913
Accra-Tema	2423	1270	1725	1679	1523	1304	1198	1040	711	100	1171
Kumasi	2150	1067	1422	1476	1220	1001	845	737	358	353	979
Tamale-Bolga	1762	709	1064	1118	590	643	487	379	100	811	977
Abidjan	1468	1303	825	1712	1356	1429	1554	1335	780	656	614
Bouake	1115	950	472	1359	459	1076	1201	982	943	1009	261
Ferke-Kohorgo	914	749	272	1158	258	875	970	751	977	1221	50

Source: Estimated from Michelin Map No. 953 : Africa — North and West. 1989. PNEU MICHELIN, Paris, France.

which then are sold at a discount; or even loss by traders because their animals arrived too late at the market, etc.

Price Elasticities of Demand

Beef demand studies in the countries of the Central Corridor are limited. The price elasticities of demand used in this study (except for Cote d'Ivoire) were therefore derived price elasticities based on figures reported in individual studies in the countries concerned between 1992 and 1997 (see sources from Table 5.3). The studies cited (again, except that for Cote d'Ivoire) did not also differentiate between local and imported beef at the retail level. Such a distinction would have been useful particularly for Ghana, which together with Cote d'Ivoire has imported substantial amounts of beef annually in the 1980s and 1990s, and where price differences exist between imported and local beef that consumers buy on the market. Also, most of the consumption studies usually report price elasticities for meat rather than specifically for beef (e.g. Reardon et al., 1992; Metzel et al., 1997).

Since meat in all four countries includes goat meat, mutton, chicken, etc., one would expect the price elasticity of demand for beef in each country to be greater than the 'aggregate' elasticities for meat reported. Elasticities used for the analysis were derived through sensitivity analysis, using the reported figures as the lower limit in each case. In general, the price elasticity for beef in each country was assumed to be about 10% higher than the price elasticity for meat reported.

In Table 5.3 meat demand elasticities as reported in the studies cited are given; and then the derived elasticities used in the model for the base period analysis. All four countries show price elasticities of demand for meat that are greater than one (i.e., elastic), implying that there are important substitutes to meat in these countries, especially Ghana and Cote d'Ivoire, where fish consumption plays an important role in providing the protein needs of the populations. The derived elasticities for beef are all greater than one and assumed more elastic than the elasticities for meat since on its own beef will have more substitutes (such as mutton, goat meat, chicken, etc.). The own-price elasticities for beef demand used for the analysis thus ranged between -1.1 in Ghana and -1.5 in Burkina Faso.

Also presented in Table 5.3 are average prices per kilogram beef in the Central Corridor in 1993. It is important to note that beef prices in the Central Corridor differ by location within a country, and across countries due to differences in distances between cattle producing centers and markets, and the different taxes imposed by different provincial areas. The national average beef prices quoted therefore give an indication of the average prices consumers pay across each country rather than a location specific price (see Table 5.3 for data sources).

Quantities of local beef (local slaughter of cattle converted into beef, which is the sum of national production plus imported live-cattle that are slaughtered) and imported beef (beef imports coming from outside the sub-region) obtained form published data are also presented to give an indication of the quantities and volume

Table 5.3. Beef Price Elasticities of Demand and Initial Model Values for the Central Corridor (prices and quantities are 1993 figures)

Demand Centers	Elasticity (meat)	Elasticity (beef)	Price/kg(FCFA) Local	Price/kg(FCFA) Imports	Beef Quantities (mt) Local*	Beef Quantities (mt) Imports**	Beef Quantities (mt) Total
MALI[a]	- 1.17	-1.3	690	-	32,393	0	32,393
BURKINA FASO[b]	-1.40	-1.5	455	-	28,258	0	28,258
GHANA[c]							
-Southern Zone	-1.04	-1.1	508	457	18,539	19,123	37,662
-Northern Zone	-1.04	-1.1					
COTE D'IVOIRE[d]							
-Zone Foret (Sud)	-	-1.3	522	470	42,975	16,768	59,743
-Zone Savane (Nord)	-	-1.3					

*local refers to the sum of national production plus imported live-cattle that are slaughtered.
**imports refer to beef imports coming from outside the sub-region

Sources: Elasticity figures obtained from

[a]Metzel et al. 1997. Perspectives de Croissance des Exportations de Betail Malien. Equite et Croissance par le Biais de la Recherche Economique: Volet Regimes et Croissance du Commerce. Rapport Finale. Associates for International Resources and Development (AIRD). Massachusetts, USA.

[b]Reardon, T., C. Delgado, and T. Tiombiano. 1992. Substitution by Urban Sahelian Consumers between Coarse Grains and Imported Rice and Wheat: The Case of Ouagadougou. Mimeo. IFPRI. USA.

[c] Devcourt Ltd. 1997. Food Needs Assessment and Potential Disincentive Effects of PL 480 Title II Program: 1997 - 2001. USAID, Accra, Ghana.

[d]Kouamela K. 1996. Devaluation et Produits de L'elevage en Cote d'Ivoire: Une Etude Quantitave. Consultant CAPEC, Abidjan, Cote d'Ivoire.

Price and quantity figures for Mali were obtained from OMBEVI, Statistique du Betail et de la Viande, Rapports Annuels.Price and quantity figures for Burkina Faso were obtained from *Les Statistiques de L'Elevage au Burkina Faso. 1996*, Ouagadougou.Burkina Faso; and the *Annuaire Statistique du Burkina Faso, 1994*. INSD, Ouagadougou, Burkina Faso.

Price and quantity figures for Ghana were obtained from the Livestock Planning and Information Unit (LPIU) of the Ministry of Food and Agriculture, Accra, Ghana.

Price and quantity figures for Cote d'Ivoire were obtained from Berte and Zongo, 1996.

of trade in cattle and beef within the Central Corridor. Both Mali and Burkina Faso are each self-sufficient in beef, except that minimal quantities of high quality beef are imported to serve some niche markets. Ghana and Cote d'Ivoire, on the other hand, can satisfy only about one-third each in beef consumption from local production, and the rest are met through live cattle imports from the Sahelian countries, or beef imports from the European Union and elsewhere. In the 1980s both countries imported large quantities of cheap low-quality beef from the European Union, but this has declined substantially in the 1990s.

5.2. Accounting for Risk in the Trade Model

As has already been discussed (Chapter II), this study applies a variant of the more commonly used mean-variance (E, V) method to account for the risk-averse behavior of cattle producers in the Central Corridor of West Africa. The basic assumption here is that the coefficient for aggregate risk aversion for a region or country should be equal to the sum of the individual risk aversion coefficients (Hazell and Scandizzo, 1974). This may be expressed as:

$$\Sigma_n \phi_n y_n' \omega_n y_n \quad = \quad \Phi\, Y'\, \Omega\, Y$$

where **Y** is a vector of the aggregate of cattle numbers supplied (off-take) in each region; **Ω** is the aggregate ***n**n*** covariance matrix of "activity" revenues with diagonal elements for all cattle producing regions; and **Φ** is the aggregate risk aversion parameter.

The revenue covariance matrix, Ω, was estimated for each region/country using the number of cattle off-take per year and the respective average prices per head for the period 1985 to 1996. Ordinary least squares (OLS) regression analysis was done on the price and off-take numbers separately to remove any trend or other systematic movements inherent in the series to ensure that any variations observed reflected the true stochastic variations. The aggregate risk aversion parameter, Φ, was derived through sensitivity analysis (see Hazell and Norton, *ibid.*) of different values of Φ between 0 (indicating risk neutrality of producers) and 2.5 (indicating producers are risk averse). A value for Φ found to be consistent for this analysis was 1.5. Table 5.4 shows the value of Φ, detrended cattle off-take numbers, prices, and revenues (a product of the detrended cattle numbers and prices for each country/region) used in the analysis (see Hazell and Norton, *ibid.*).

In relative terms, lower mean, variance, and standard deviation figures indicate less risky enterprises (Hazel and Norton, *ibid.*). Table 5.4 shows that for the cattle exporting countries, cattle production is more risky in Burkina Faso than in Mali, based on farmers' expected revenue from cattle production. Similarly, for cattle importing countries, production is riskier in Ghana than in Cote d'Ivoire. For the Central Corridor, therefore, the data suggest that cattle farmers in Burkina Faso face higher production risk than their counterparts in Mali or elsewhere; while cattle farmers in Cote d'Ivoire face the least risk in terms of the variability of income from cattle production.

Table 5.4. Detrended Cattle Off-take, Prices, and Revenues for Countries in the Central Corridor

Year	Mali			Burkina Faso			Ghana			Cote d'Ivoire		
	10%Stk	P/hd	Det-M-Rev	10%Stk	P/hd	Det-B-Rev	10%Stk	P/hd	Det-G-Rev	10%Stk	P/hd	Det-C-Rev
1985	9224	13269	1.22E+08	16609	14969	2.49E+08	4405	34061	1.5E+08	5122	42340	2.17E+08
1986	5891	7961	46898251	7113	7397	52614861	1739	9322	16210958	4027	7795	31390465
1987	4257	11192	47644344	43681	20765	9.07E+08	4469	750	3351750	4078	1255	5117890
1988	2623	5423	14224529	53777	4132	2.22E+08	994	20110	19989340	1928	12995	25054360
1989	90	1653	148770	35727	3500	1.25E+08	697	32809	22867873	20	5859	117180
1990	7143	2884	20600412	27851	6866	1.91E+08	724	16313	11810612	2270	27806	63119620
1991	6990	4115	28763850	20096	10233	2.06E+08	3395	9936	33732720	2320	27932	64802240
1992	10700	12653	1.35E+08	12531	17399	2.18E+08	988	6439	6361732	2169	27334	59287446
1993	16272	22423	3.65E+08	5095	42432	2.16E+08	931	42816	39861696	1019	41890	42685910
1994	22541	8192	1.85E+08	2159	6665	14389735	3048	29192	88977216	30	70030	2100900
1995	5812	7038	40904856	9255	13102	1.21E+08	8312	5569	46289528	981	14024	13757544
1996	47372	16269	7.71E+08	16150	22469	3.63E+08	4398	68054	2.99E+08	1876	10883	20416508
Mean			1.48E+08			2.4E+08			61566135			45392962
Variance			4.49E+16			4.82E+16			6.73E+15			3.17E+15
Std Dev			2.21E+08			2.29E+08			81034433			23352803
Φ			1.5			1.5			1.5			1.5

Note: 10%Stock represents 10% of officially recorded stock levels, which were detrended; P/hd is the detrended price per animal; and Det-Rev is the detrended total revenue computed as 10%Stk * P/hd; Φ is a risk-aversion parameter derived by sensitivity analysis.

Source: Computed from Tables 4.3, 4.5, 4.7, and 4.9 (see Chapter 4).

5.3. Accounting for the Effect of Exchange Rate Changes in the Trade Model

The theoretical underpinnings of how exchange rate changes in each country in the Central Corridor will affect the flow of cattle and beef in the sub-region has been discussed in Chapter II. Essentially, the adjusted effective exchange rate (EER_a) operative in each country is what will be relevant for trade transactions at any period. The EER_a in a country with a *flexible exchange rate* regime (such as in Ghana) may be expressed as:

$$EER_a = (1+ e)\, E\, (1 + t_{mi} - t_{xi}) ;$$

or

$$\mathbf{EER_a = E\,(1 + e)(1 + t_{mi} - t_{xi})} \qquad \text{(See equation 36)}$$

where **E** is the nominal exchange rate, **e** is the rate of change of the nominal exchange rate, t_{mi} and t_{xi} are the prevailing import tariff rate and export tax rate on cattle or beef in each country, respectively.

Under a *fixed exchange rate* regime, the nominal exchange rate, **E**, is exogenously determined. The EER_a applicable therefore is the effective exchange rate (see equation (25)) adjusted for the rate of change, **v**, in the cross-border exchange rate transaction cost:

$$\mathbf{EER_x = E\,(1 + v)(1 + t_{mi} - t_{xi})} \qquad \text{(See equation 37)}$$

where **v** is computed as the rate of change of the exchange rate premium (official rate minus the parallel rate).

This study applies the EER concept to determine the effects of exchange rate changes on trade flows, production of cattle, and consumption levels of beef in the Central Corridor through the use of simulation analysis within the framework of the trade model. In Table 5.5 the rate of change of the Cedi relative to both the US Dollar and the CFA Franc have been computed. The value of **e** was **0.16** and **0.08** for the rate of change of the Cedi relative to the Dollar and the CFA Franc, respectively.

The difference in **e** for the two currencies is expected since, unlike the Cedi which is 'floating', the CFA Franc is tied to the French Franc and therefore responds to changes in the US Dollar-French Franc rate. Also, the January 1994 devaluation of the CFA Franc relative to the French Franc by 50% resulted in a negative change for the value of the cedi relative to the CFA Franc.

The value of **e** used for this analysis is that for the Cedi-FCFA since the two are the relevant currencies for transactions in the sub-region. On the other hand, the value for **v** in terms of the CFA Franc is assumed zero since its rate of change relative to the US Dollar is zero and there is no significant parallel market for it. This implies that when trade occurs across currency zones (i.e., trade that involves the CFA Franc zone countries and Ghana), **e** captures the effect of transaction cost involved; but trade among the CFA Franc zone countries assumes no other transaction costs in currency exchange or transfer.

Table 5.5. Rates of Change in the Cedi and the CFA Franc – 1985 to 1997.

Year	Cedis/$1.00	FCFA/$1.00	Cedis/FCFA
1985	0.06	- 0.08	0.14
1986	1.20	- 0.05	0.35
1987	0.19	- 0.04	0.08
1988	0.07	- 0.04	0.06
1989	0.06	0.01	0.06
1990	0.04	- 0.05	0.10
1991	0.03	0.03	0.01
1992	0.03	- 0.01	0.09
1993	0.11	0.02	0.07
1994	0.08	0.23	- 0.05
1995	0.08	- 0.02	0.09
1996	0.06	0.01	0.05
1997	0.07	0.04	0.03
Ave. Rate of Change	**0.16**	**0.00**	**0.08**

Source: Computed from Appendix A5.1

5.4. The Base Model and Scenarios Analyzed

The initial model was first calibrated to simulate 1993 beef and cattle trade in the Central Corridor under the existing trading conditions (where Ghana's currency is the Cedi and the other three countries use the CFA Franc). The optimal solution values of the base model were compared with published 1993 statistics on cattle production and trade as well as beef imports and consumption in the sub-region. The essence of this comparative analysis was to validate the model by demonstrating how close the model values corresponded to reality. By replicating the 1993 statistics on cattle production, trade, prices, and consumption for the countries of the Central corridor, the model was deemed validated and therefore applied to simulate scenarios that reflected more open trade and exchange rate effects in the sub-region. The results of the validation are discussed in the next section.

The base model was run under three scenarios: (a) all four countries had more open trade in cattle (i.e. all existing cattle trade barriers removed); (b) all four countries adopted the same currency (CFA Franc in this case); and (c) all four countries had more open trade and also adopted a single currency (a combination of scenarios (a) and (b) above). This was accomplished by changing the initial parameters and model constraints to reflect the intended scenario. The model solution results were then compared with the base model and/or other scenario results. Welfare analysis using producer and consumer surpluses computed from the model for the various scenarios were then analyzed for countries of the Central Corridor.

5.4. 1. Results and Validation of the Base Model

The base model incorporated the existing conditions of beef and cattle trade in the Central Corridor. This implies that trade transactions were conducted in CFA Francs among the three countries that belong to the CFA Franc zone (Mali, Burkina Faso, and Cote d'Ivoire); and in CFA Francs and Cedis (Ghana's currency) when such trade transactions involved Ghana. In the case of imported beef into the region, trade transactions typically involved the US Dollar, the CFA Franc, and/or the Cedi. The base model analysis therefore incorporated exchange rate differentials and the transaction cost associated with currency transfers or exchanges from one currency to another, particularly from the Cedi to the CFA Franc and vice versa.

Also incorporated into the base model were administrative and technical barriers including business taxes, market presentation taxes (or sales taxes), health certification taxes, unofficial tips and bribes along the trade routes, etc; which together constituted about 10% of the market price of an animal in 1993. As has already been discussed (see Chapter III), countries in the Central Corridor have used both tariffs and non-tariff instruments to affect cattle trade in the sub-region until recently. Under the current global and regional trade environment, border tax adjustments (i.e., indirect taxes shifted to consumers in the final price of goods and services), together with administrative and technical regulations, are the most important barriers to intra-regional trade in cattle in the sub-region. Moreover, each

country in the Central Corridor maintained an average of about 15% tariff on imported beef during 1993, and this was also accounted for in the base model.

The validation of the base model was done by comparing and determining how accurately the model generated cattle off-take levels, cattle prices, and cattle slaughter relative to the base year (1993) figures; whether the published cattle exports and imports, as well as beef imports and consumption figures were replicated by the model; and how sensitive the optimal solution values were to changes in the price elasticities of demand for the various countries (see McCarl and Spreen, *ibid.*). The base model results compared with published statistics on the relevant variables are presented in Table 5.6.

In general, the price and quantity values endogenously determined by the model compared well with the reported 1993 data for each country in the Central Corridor. It is noteworthy from the onset that country statistics for the Central Corridor and for Africa in general are either unavailable or incomplete in most cases, so that some data are estimated from what is available. Reported statistics from different sources therefore vary significantly (e.g. country data versus FAO data), such that the reliability of published data is constantly in doubt. Nevertheless, published data can serve as very useful bench mark for analysis, and variations of 10% to 20% depending on the direction of variation, could be considered acceptable based on experts' knowledge when comparing model results and published data. For example, most people in the region believe that official statistics underestimate trade

Table 5.6. Analysis of Regional Beef and Cattle Trade – The Base Model

Production Center

Country or Region	Off-take (numbers)		Slaughter (numbers)		Price (FCFA/head)	
	Stats[a]	Base Model[b]	Stats	Base Model	Stats	Base Model
Mali	373,102	348,390 (7% ⇓)	185,102	216,204 (17% ↑)	74,000	77,816 (5% ↑)
Burkina Faso	263,034	294,000 (12% ↑)	161,476	167,090 (4% ↑)	84,600	83,722 (1% ⇓)
Ghana	116,864	101,940 (13% ⇓)	105,938	187,129 (77% ↑)	62,162	54,496 (12% ⇓)
Cote d'Ivoire	120,500	86,010 (29% ⇓)	249,823	259,922 (4% ↑)	66,351	72,456 (9% ↑)

(Continued on next page)

Consuming/Demand Center

	Exports/Imports (numbers)		Demand (Mt)		Price (FCFA/Kg)	
	Stats	Base Model	Stats	Base Model	Stats	Base Model
	Exports					
Mali	188,000	132,189 (30% ⇓)	32,393	30,268 (7% ⇓)	690	545 (21% ⇓)
Burkina Faso	101,558	126,912 (25% ⇑)	28,258	23,392 (17% ⇓)	455	550 (21% ⇑)
	Imports					
Ghana						
World Beef Imports	19,123 mt	19,850 mt (4% ⇑)				
- Southern Zone	7,192	52,891 (354%⇑)	31,486	36,136 (15% ⇑)	508	455 (10% ⇓)
- Northern Zone	-	32,298	6,176	6,853 (11%⇑)	-	-
Cote d'Ivoire						
World Beef Imports	16,768 mt	16,850 mt(.5%⇑)				
- Zone Foret(Sud)	100,560	105,412 (5% ⇑)	46,599	36,646 (21% ⇓)	522	576 (10% ⇑)
-Zone Savane	37,194	68,500 (84%⇑)	13,143	14,012 (7% ⇑)	-	-

[a] Stats refers to published data.

[b] Base Model refers to the optimal solution values of the base model.

Percentages in parentheses indicate differences in base model figures relative to the published statistics.

Off-take refers to the sum of estimated cattle slaughter and exports for exporting countries; and estimated slaughter (which includes imports) for importing countries.

Slaughter refers to the official estimate of cattle slaughtered per country/region. It includes imports of live cattle for importing countries.

Source: Model values were computed from Appendix A5.2.

trade flows, which is consistent with the results of the trade model. The base model estimates higher trade figures for each country/region except Mali, in which case the official estimates also include exports of cattle to other countries outside the Central Corridor (such as Senegal, Liberia, and others). Worley et al., (*ibid.*) validating trade model figures with data for the USA and Canadian red meat and grains, considered 5% and 10% variation from actual data acceptable, even for the USA and Canadian data that are much more reliable than those of the Central Corridor.

The price per head of cattle as endogenously determined by the base model and the reported average cattle prices vary between 1% of Burkina Faso prices and 12% of prices in Ghana. This is reasonable because cattle prices differ across different regions in the same country in the Central Corridor, and an estimated aggregate price representing an entire region or country may differ from the actual price prevailing on the market. Similarly, the price per kilogram of beef differs by about 10% between the model values and published data for Ghana and Cote d'Ivoire; and about 20% for Mali and Burkina Faso. This is comparable to a price difference of about 11% between the 1993 published national average price[3] per kilogram of beef (with bones) in Mali (690 FCFA/kg) and the price of the same product in Mali's Gao Province (620 FCFA/kg).

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[3]The national average prices are unweighted simple averages of all regions/provinces.

The published slaughter figures for all four countries were lower than those endogenously determined by the model, the variation ranging from 3% in Burkina Faso, 4% in Cote d'Ivoire, 17% in Mali, to as much as over 50% for Ghana. Even though there is a continual flow of Sahelian cattle unto the Ghanaian market, there are no official statistics to indicate this, which explains why there is a wide divergence between the statistical and model slaughter figures for Ghana.

The higher slaughter figures predicted by the model were expected because published slaughter figures represent only animals slaughtered at the abattoirs, and do not account for the many home slaughters in all parts of each country in the Central Corridor. There is also possible under recording of slaughter figures at the abattoirs since per head slaughter taxes are levied at these abattoirs, and it is not uncommon for tax agents and butchers to collude to evade taxes.

Beef demand figures from published data and predictions from the model varied by between 7% and 15% across all the countries, except Southern Cote d'Ivoire, indicating that the endogenously generated values from the model were within a reasonable range. The high beef demand estimate for Southern Cote d'Ivoire seem to come from an over-estimate of the local source cattle slaughtered (about 177,281 cattle) compared to actual statistics indicating total slaughter of 249,823 cattle with a live cattle import component of 137,754 animals.

In terms of off-take figures, most people familiar with livestock in West Africa agree that either the cattle stock levels are overestimated so that the off-take figures

derived from them also get overestimated; or that the actual off-take ratios should be about 5% or 6% rather than the 10% off-take ratio usually assumed by researchers and policy makers. This conclusion is supported by the divergence between off-take figures and slaughter plus exports and/or import figures usually observed in the data.

Except for Burkina Faso which the trade model had a higher estimate (12%) than published data for off-take figures, the model figures were lower than published data by 7% and 15% for Mali and Ghana, respectively; and by 29% for Cote d'Ivoire. Since Mali and Burkina Faso export cattle to other countries in the region (Senegal, Togo, Benin, Nigeria, etc.) but which were not accounted for directly in the model, such exports may account for some of the higher off-take figures. This may also explain the published cattle export figure of about 30% more than predicted by the model for Mali, while more exports than published were predicted by the model for Burkina Faso. In the case of Burkina Faso, it is more reasonable to assume that a significant portion of exported cattle were not recorded, such as between Burkina Faso and Ghana or Cote d'Ivoire.

The issue of Ghana's imports of cattle is another interesting consideration. Whereas official records showed no or very few imports of cattle to Ghana in 1993 (Burkina Faso's official statistics show 7,192 cattle exports to Ghana), the model predicted Ghana's total imports of about 85,000 cattle. This figure, which represents some twelve thousand metric tons of beef, was more close to reality than the zero imports recorded in official documents since it is common knowledge in the sub-

region that thousands of cattle move southwards from Mali and Burkina Faso to Ghana annually. Also, official records indicate that local cattle account for only one-third of the total amount of beef consumed in Ghana annually, and the balance of two-thirds come from imports of live cattle and frozen beef (Metzel, et al. *ibid.*, Vol. II). This two-thirds of beef that is imported is equivalent to about 179,343 Sahelian cattle. What actually pertains in Ghana as far as beef consumption is concerned thus supports the reasonableness of the model-generated figures.

In order to ascertain how stable the model results were, sensitivity analysis was done by changing the price elasticity of demand for each consuming country/region by 10% up and down (i.e. 10% increase in one case, and 10% decrease in another). The sensitivity results indicate that cattle production and shipments in both cases remained the same or changed only slightly; even though beef prices and pay-off values (i.e. consumer and producer surpluses) were modified slightly within 5% of the initial base model values (see Appendix A5.6 and Appendix A5.7).

Based on the stability of the figures endogenously determined by the base model, and the foregoing discussion of these figures relative to published data for the countries in the Central Corridor, the base model results were accepted as valid benchmarks for comparing the outcomes of the open trade scenarios subsequently generated. The welfare implications of what each scenario represented were also analyzed. The caveat here, though, is that due to the inherent weakness of data in the Central Corridor, the strength of the model predictions is more in the direction of

changes in cattle production and flows in cattle trade, rather than the specific magnitudes of these changes.

5.4.2. Results of the More Open Trade Model

The more open trade scenario represented the case where all four countries (Mali, Burkina Faso, Ghana, and Cote d'Ivoire) had all existing cattle trade barriers (representing about 10% of the average price of cattle in the region) removed so that trade among them proceeded as if the whole sub-region was a "single" country; except that Ghana retained her own currency. Under this scenario (Table 5.7), off-take numbers increased relative to the base model figures for Mali (2%), Burkina Faso (11%), and Ghana (11%); but declined for Cote d'Ivoire (28%). However, slaughter figures decreased for Mali (2%), and Burkina Faso (1%); while it increased for Ghana (16%), and for Cote d'Ivoire (2%). On the other hand, the price per head of cattle[4] in the production regions increased for all four countries between 15% and 19% relative to the base model values.

These increases in off-take figures suggest that more open trade could generate increases in cattle production in the sub-region, even though cattle production in Cote d'Ivoire would decline as cheaper imports of cattle are substituted for local

[4]Cattle produced in Mali and Burkina Faso were assumed to be of the larger *Zebu* breed (about 250 kg live-weight), while those produced in Ghana and Cote d'Ivoire were the smaller *WASH* and Baoule breeds (about 165 kg live-weight).

production. Cattle farmers in particular stand to gain in all the four countries, with demand-driven increases in cattle prices at the production centers, even though the case of Cote d'Ivoire is not clear because fewer local cattle would be produced. It implies also that only more efficient cattle producers in Cote d'Ivoire would survive if the sub-region adopted a more open trade in cattle; in which case, higher prices for local cattle could bring higher average returns to farmers.

Also, the decline in slaughter figures in the cattle exporting countries (Mali and Burkina Faso) while those in cattle importing countries (Ghana and Cote d'Ivoire) increased was expected. Consistent with theoretical expectations, the more open trade increased competition from coastal markets in the importing countries, and allowed cattle traders to ship more cattle there which reduced local slaughter.

In terms of exports (Mali and Burkina Faso) and imports (Ghana and Cote d'Ivoire), more open trade increased the volume of trade in cattle as well as beef consumption in all four countries. Total exports from Mali to both Ghana and Cote d'Ivoire increased by 9% relative to the base model; and those from Burkina Faso increased by 28%. This increase in exports from Burkina Faso could include some re-shipments from Mali and/or Niger which the model did not specifically separate out.

At the same time, beef consumption decreased in Mali and Burkina Faso by 3% in each case (beef demand quantities adjust with beef price changes), as higher export demand and higher cattle prices at the production centers encouraged farmers to send more cattle to the market (note that the model assumes a downward sloping

Table 5.7. Analysis of Regional Beef and Cattle Trade – More Open Trade Model

Production Center

Country or Region	Off-take (numbers)		Slaughter (numbers)		Price (FCFA/head)	
	Base[a]	Open Trade[b]	Base	Open Trade	Base	Open Trade
Mali	348,390	356,200 (2% ↑)	216,204	212,300 (2% ⇓)	77,816	89,788 (15%↑)
Burkina Faso	294,000	327,010 (11% ↑)	167,090	164,700 (1% ⇓)	83,722	96,603 (15%↑)
Ghana	101,940	112,820 (11% ↑)	187,129	217,118 (16% ↑)	54,496	64,687 (19%↑)
Cote d'Ivoire	86,010	61,922 (28% ⇓)	259,922	263,832 (2% ↑)	72,456	83,604 (15%↑)

(Continued on next page)

Consuming/Demand Center	Exports/Imports (numbers)		Demand (Mt)		Price (FCFA/Kg)	
	Base	Open Trade	Base	Open Trade	Base	Open Trade
	Exports					
Mali	132,189	143,900 (9% ↑)	30,268	29,722 (3% ↓)	545	546 (0.2% ↑)
Burkina Faso	126,912	162,310 (28%↑)	23,392	23,058 (0.1%↓)	550	551 (0.2% ↑)
	Imports					
Ghana						
World Meat Imports	19,123 mt	16,820 mt (12%↓)				
- Southern Zone	52,891	69,900 (32%↑)	36,136	36,136	455	455
- Northern Zone	32,298	34,400 (6% ↑)	6,853	7,695 (12% ↑)	-	-
Cote d'Ivoire						
World Meat Imports	16,768 mt	15,132 mt (10% ↓)				
- Zone Foret(Sud)	105,412	136,610 (30% ↑)	36,646	36,646	576	576
-Zone Savane	68,500	105,500 (54% ↑)	14,012	13,564 (3% ↓)	-	-

[a] Base refers to the optimal solution values of the base model.
[b] Open Trade refers to the optimal solution values of the open trade model.
Percentages in parentheses indicate differences in more open trade figures relative to the base model figures.

Source: Model values were computed from Appendix A5.3.

demand function and an upward sloping stepped supply function), and traders to export more cattle. Consumers in the exporting countries were therefore hurt as beef prices slightly increased (0.2% in both Mali and Burkina Faso) and thereby decreased beef consumption in the two countries (by 2% in Mali and 1% in Burkina Faso).

The results of the more open trade model thus suggest that as trade barriers are removed, substantial portions of savings accruing to traders and marketing agents are passed on to cattle producers, who gain at the expense of beef consumers in the exporting countries. On the other hand, beef prices remained stable in importing countries while cattle prices increased at the cattle production centers in those countries, because demand increased for all animals, both the larger animals from the Sahel region and the smaller local cattle, which then benefitted local producers.

As already noted, increases in the volume of cattle trading resulted in increased imports of cattle to both Ghana and Cote d'Ivoire. While imports to Southern Ghana increased by some 32% compared to the base model, those to Northern Ghana increased by only 7%; apparently because more open trade allowed more access to markets in Southern Ghana, where beef demand has been traditionally higher. Both Southern and Northern Cote d'Ivoire also received increases in cattle traded from the Sahelian countries (30% and 54% for the south and north, respectively), which suggests that a substantial percentage of local cattle in Cote d'Ivoire were replaced by cheaper imports of Sahelian cattle.

Beef consumption as well as beef prices in both Southern Ghana and Southern Cote d'Ivoire remained the same, as the increase in cattle imports into both zones substituted for decreased beef imports. Beef imports from the rest of the world to Ghana declined by 12% from 19,123 mt to 16,820 mt; and those to Cote d'Ivoire declined by 5% from 16,768 mt to 15,850 mt (see Appendix A5.3). This suggests that more open trade in cattle in the sub-region will improve the competitiveness of Sahelian cattle in the coastal markets.

The decline in imports of beef from the rest of the world resulted from their being substituted by Sahelian cattle (and therefore beef) which had become more competitive. This is also a function of the structure of the model, which incorporates a step-wise supply function rather than a monotonically increasing supply function. In this model, Sahelian cattle are imported up to the point where they are no longer competitive with European imports, at which point the supply curve shifts up a step, and European imports come in at the world price. Thus, with the reduction of transport cost in the Sahel in the more open trade scenario, the model allocated a larger portion of coastal consumption to the now cheaper Sahelian production, with the residual made up by European beef imports. This explains why the model shows imports of European beef falling even though the price in the coastal areas did not change.

On the whole, a more open trade in the Central Corridor will result in increased cattle trade and beef consumption in the sub-region; while beef imports

from outside the region would decline, provided the present tariffs and other restrictions on beef imports into the region remain. Cattle farmers gain through higher prices of local cattle, but beef consumers, particularly in the exporting countries, lose as a result of lower local slaughter and higher beef prices. The effect of more open trade on Cote d'Ivoire producers is indeterminate since more cattle imports from the Sahelian countries would substitute for local slaughter, driving out less efficient cattle producers.

5.4.3. Results of the Base Trade Model Assuming All Countries in the Central Corridor Use a Single Currency (i.e., CFA Franc).

The scenario where all countries were assumed to use a single currency (i.e., the CFA Franc) but with the existing trade barriers in place was designed to mimic the case of a single currency zone for the Central Corridor. Mali, Burkina Faso, and Cote d'Ivoire already belong to the CFA Franc zone, so that under this scenario Ghana is assumed to have adopted the CFA Franc as its national currency. The results of the model analysis based on the "single currency zone" scenario are shown in Table 5.8.

Off-take figures increased relative to the base model (under this scenario) for Burkina Faso (12%) and Ghana (8%), but declined for Mali (2%) and Cote d'Ivoire (10%). Slaughter figures, however, decreased in Mali (3%) and Burkina Faso (3%); but increased in Ghana (5%) and in Cote d'Ivoire (9%).

Table 5.8. Analysis of Regional Beef and Cattle Trade – Trade Model (based on 1993 conditions) Assuming All Four Countries Use the Same Currency (CFA Franc).

Production Center

Country or Region	Off-take (numbers)		Slaughter (numbers)		Price (FCFA/head)	
	Base[a]	Same Currency[b]	Base	Same Currency	Base	Same Currency
Mali	348,390	339,920 (2% ⇓)	216,204	210,664 (3% ⇓)	77,816	89,788 (15% ⇑)
Burkina Faso	294,000	330,000 (12% ⇑)	167,090	162,490 (3% ⇓)	83,722	96,603 (15% ⇑)
Ghana	101,940	109,710 (8% ⇑)	187,129	197,038 (5% ⇑)	54,496	64,687 (19% ⇑)
Cote d'Ivoire	86,010	77,070 (10% ⇓)	259,922	286,505 (10%⇑)	72,456	83,604 (15% ⇑)

(Continued on next page)

Consuming/Demand Center

	Exports/Imports (numbers)		Demand (Mt)		Price (FCFA/Kg)	
	Base	Same Currency	Base	Same Currency	Base	Same Currency
	Exports					
Mali	132,189	129,258 (2% ⇓)	30,268	29,492 (3% ⇓)	545	546 (0.2% ↑)
Burkina Faso	126,912	167,509 (32%↑)	23,392	22,748 (3% ⇓)	550	551 (0.2% ↑)
	Imports					
Ghana						
World Meat Imports	19,123 mt	18,718 mt				
- Southern Zone	52,891	57,408 (15% ↑)	36,136	36,136	455	468 (3% ↑)
- Northern Zone	32,298	29,923 (7% ⇓)	6,853	6,876 (0.3% ↑)	-	-
Cote d'Ivoire						
World Meat Imports	16,768 mt	13,050 mt (22%⇓)				
- Zone Foret (Sud)	105,412	143,350 (36% ↑)	36,646	36,646	576	576
-Zone Savane (Nord)	68,500	66,085 (3% ⇓)	14,012	14,202 (1% ↑)	-	-

[a] Base refers to the optimal solution values of the base model.

[b] Same Currency refers to the optimal solution values of the model that assumes all countries use one currency.

Percentages in parentheses indicate differences in single currency model figures relative to the base model figures.

Source: Model values were computed from Appendix A5.4.

Cattle prices at the producing centers also increased by about 15% in all four countries; and beef prices increased slightly in three countries as well by about 0.2% in both Mali and Burkina Faso, and 3% in Ghana; while in Cote d'Ivoire beef price remained unchanged.

The total volume of trade in the Central Corridor would increase under the single currency scenario, even though both exporting and importing countries might have different experiences. Exports fro Mali, for example, would decline by about 2%, even though Burkina Faso will export more cattle (32%). The strategic geographical position of Burkina Faso as an interlinking-trade node for all the countries, and particularly to Ghana, seems to give it an advantage in cattle trade. Cattle imports to Southern Ghana and Southern Cote d'Ivoire would increase by 9% and 36%, respectively. The Northern Zones of Ghana and Cote d'Ivoire would both decrease their imports of cattle by 7% and 3%, respectively. Also, beef demand would increase in the northern zones of both countries while demand would remain unchanged in the southern zones.

These figures suggest that the adoption of a single currency by all countries in the Central Corridor will benefit them all in terms of the beef trade, particularly because total trade will expand. Burkina Faso, for example, will unambiguously benefit as a result of increased cattle exports, while the case of Mali is inconclusive because exports will decline slightly. In the presence of substantial trade barriers,

adopting a single currency for the sub-region will not automatically lead to expansion in cattle production in the sub-region (e.g., Mali's off-take declined). Even though the disincentives created by trade barriers could make the domestic markets in cattle exporting countries more competitive, their effect seems to be outweighed by the lower transaction cost due to a single currency so that local slaughter would decrease; while at the same time both cattle and beef prices would increase in the sub-region as a result of competition from importing coastal markets for available supplies of cattle.

5.4.4. Results of the More Open Trade Model Assuming All Countries in the Central Corridor Use a Single Currency (i.e., CFA Franc)

The open trade-single currency scenario represents the case where besides using a single currency, all barriers to cattle trade are removed by all four countries of the Central Corridor. The results of this scenario are presented in Table 5.9.

Under this scenario, the off-take values relative to the base model increased for all countries except Cote d'Ivoire. The increases were Burkina Faso (12%), Ghana (9%), and Mali (7%); and the decline for Cote d'Ivoire was 4%.

Similarly, cattle prices at production centers increased for all countries as in the case of other scenarios. However, slaughter in the cattle exporting countries, Mali and Burkina Faso, decreased by 3% and 2%, respectively; while those in the

Table 5.9. Analysis of Regional Beef and Cattle Trade – Trade Model Assuming More Open Trade with Countries Using the Same Currency (CFA Franc).

Production Center

Country or Region	Off-take (numbers)		Slaughter (numbers)		Price (FCFA/head)	
	Base[a]	Open/Currency[b]	Base	Open/Currency	Base	Open/Currency
Mali	348,390	367,030 (5% ↑)	216,204	209,224 (3% ⇓)	77,816	89,788 (15%↑)
Burkina Faso	294,000	330,000 (12%↑)	167,090	163,310 (2% ⇓)	83,722	96,603 (15%↑)
Ghana	101,940	111,210 (9% ↑)	187,129	217,440 (16% ↑)	54,496	64,687 (19%↑)
Cote d'Ivoire	86,010	82,637 (4% ⇓)	259,922	300,897 (16% ↑)	72,456	83,604 (15%↑)

(Continued on next page)

Consuming/Demand Center

	Exports/Imports (numbers)		Demand (Mt)		Price (FCFA/Kg)	
	Base	Open/Currency	Base	Open/Currency	Base	Open/Currency
	Exports					
Mali	132,189	157,804 (19% ↑)	30,268	29,291 (3% ⇓)	545	546 (0.2% ↑)
Burkina Faso	126,912	166,689 (31% ↑)	23,392	22,863 (2% ⇓)	550	551 (0.2% ↑)
	Imports					
Ghana						
World Meat Imports	19,123 mt	15,980 mt (16% ⇓)				
- Southern Zone	52,891	76,572 (45% ↑)	36,136	36,136	455	468 (3% ↑)
- Northern Zone	32,298	29,661 (8%⇓)	6,853	6,949 (1% ↑)	-	-
Cote d'Ivoire						
World Meat Imports	16,768 mt	11,240 mt (33% ⇓)				
- Zone Foret(Sud)	105,412	150,412 (43% ↑)	36,646	36,646	576	576
-Zone Savane	68,500	67,848 (1% ⇓)	14,012	14,239 (2% ↑)	-	-

[a] Base refers to the optimal solution values of the base model.
[b] Open/Currency refers to the optimal solution values of the open trade model assuming one currency in all countries.
Percentages in parentheses indicate differences in single currency with more open trade figures relative to the base model figures.

Source: Model values were computed from Appendix A5.5.
importing countries, Ghana and Cote d'Ivoire, increased by 16% for each country.

In terms of the volume of cattle trade, the figures seem to suggest that there would be an increase under the single currency with open trade scenario. For example, Mali and Burkina Faso will increase their cattle exports by about 19% and 31%, respectively. Sahelian cattle imports would increase in Southern Ghana by as much as 45%, and in Southern Cote d'Ivoire by about the same margin (43%). Imports to the Northern zones of both countries, however, would decline by 8% and 1% for Ghana and Cote d'Ivoire, respectively.

While beef consumption would decline in the exporting countries as beef prices increased, it would increase in the importing countries, particularly in the northern zones of these countries. Beef demand in Mali was down 3%, and that in Burkina Faso also down by 2%; but the increases in Northern Ghana and Northern Cote d'Ivoire were minimal, 1% and 2%, respectively. The implication here is that more open trade using a single currency would reduce transaction cost and cause trade in cattle in the Central Corridor to expand, which will create incentives for more cattle slaughter in the importing countries.

These figures suggest that the adoption of a single currency coupled with a more open trade in cattle will expand the cattle sector (total off-take increases), as well as increase the overall flow of cattle, and the consumption of beef in the Central Corridor. This result is consistent with theoretical expectations that more open trade

(i.e., little or no barriers to trade) increases the volume of goods and services traded; while lower transaction cost due to the use of a single currency facilitates trade by speeding up the flow of goods and services across nations.

5.5. Welfare Analysis

The welfare of economic agents involved in cattle production and trade in the Central Corridor was measured by computing the consumer surpluses for each region/country based on prices, quantities, and demand parameters generated by the trade models; as well as estimating producer profits using the prices, off-take numbers, and production cost of cattle at each production center. Government revenue gains or losses under each scenario were also computed to show the effect of each scenario on government budgets in the respective countries. Similarly, estimates of other transfers, such as tips and bribes cattle traders pay along the trade routes were made.

Consumer Surplus Measures

Since the quadratic programming trade models generated aggregate consumer and producer surpluses representing the entire Central Corridor, it was necessary to compute individual country/region consumer surpluses using the formula below (as discussed earlier in Chapter II):

$$ACS_j = \Sigma_i (a_i - 1/2b_i Q_i^*) Q_i^* - P_i^* Q_i^* \quad \text{(see Equation 43)}$$

where a_i and b_i are intercept and slope, respectively, generated by the trade models for each demand or consuming region; and P_i^* and Q_i^* are prices and quantities, respectively, also generated by the trade models. Figures for changes in consumer surplus relative to the base model are presented in Table 5.10.

The values of consumer surplus measures indicate that while there is decline in consumer welfare in Mali, Burkina Faso, and Southern Ghana, and Southern Cote d'Ivoire showed marginal increases in consumer welfare under all trade scenarios relative to the base model, the results are mixed for Northern Ghana and Northern Cote d'Ivoire. Consumer welfare declined for both Mali and Burkina Faso under the more open trade scenario by about 2% each, while it was only a marginal decrease for Southern Ghana. Consumer welfare declined also for Northern Cote d'Ivoire by 4% relative to the base model. On the other hand, Northern Ghana showed that consumers gained under the more open trade scenario by about 16% in consumer surplus, while Southern Cote d'Ivoire experienced only a marginal increase relative to the base model.

Under both the single currency and single currency with more open trade scenarios, there would again be consumer welfare decrease for Mali, Burkina Faso, and Southern Ghana by about 3% in each case. Northern Ghana would also

Table 5.10. Consumer Surplus Changes Under Different Trade Scenarios in the Central Corridor - Estimates Based on 1993 Figures

	Mali	Burkina	Ghana		Cote d'Ivoire	
Base Model			*South GH*	*North GH*	*South CI*	*North CI*
Q - Qty DD	30269	23393	36136	6853	36647	14012
P - price	545	550	455	455	576	576
CS FCFA	3.9099E+10	2.531E+10	3.693E+10	8.381E+09	5.095E+10	2.442E+10
CS US $	**138 mil.**	**89 mil.**	**131 mil.**	**30 mil.**	**180 mil.**	**86 mil.**
CS as % of GDP	**7%**	**5%**	**2%**	**0.5%**	**2%**	**1%**
Open Trade Model						
Q - Qty DD	29722	23058	36136	7695	36647	13564
P - price	546	551	455	455	576	576
Δ CS FCFA	- 8.53E+08	- 4.232E+08	0	+1.349E+09	+1,442,421	-1.01E+09
Δ CS US $	**- 3 mil.**	**- 2 mil.**	**0**	**+ 5 mil.**	**+5 mil.**	**- 4 mil.**
Base Model assuming a Single Currency (FCFA)						
Q - Qty DD	29493	22749	36136	6876	36647	14202
P - price	546	551	468	468	576	576
Δ CS FCFA	-1.209E+09	- 813050738	-102E+09	-2.05E+08	+1435092	+431989550
Δ CS US $	**- 4 mil.**	**- 3 mil.**	**- 4 mil.**	**- 0.7 mil.**	**+ 5 mil.**	**+ 2 mil.**
Open Trade Model assuming a Single Currency (FCFA)						
Q - Qty DD	29291	22863	36136	6949	36647	14239
P - price	546	551	468	468	567	567
Δ CS FCFA	-1.521E+09	-668600614	-1.02E+09	-93689938	+1435092	+518140857
Δ CS US $	**-5 mil.**	**- 2 mil.**	**- 4 mil.**	**- 0.3 mil.**	**+ 0.005 mil.**	**+ 2 mil.**

Source: Computed from Appendix Table A5.8.

experience decline in consumer welfare under these two scenarios by about 1% to 2%. Southern and Northern Cote d'Ivoire, on the other hand, would gain in consumer welfare under these scenarios. Even though the consumer welfare gains in the south will only be marginal, gains in the north will be relatively higher, about 2% increase each under the single currency and the single currency with open trade scenarios.

These figures suggest that while the welfare of consumers in cattle exporting countries would generally decline under all trade scenarios, the results will be mixed for the cattle importing countries in the Central Corridor. Also, even though a more open trade in cattle in the Central Corridor will improve the welfare of beef consumers in Ghana, the adoption of a single currency for the sub-region would impinge on consumer welfare in Ghana mainly because a single currency is likely to lead to higher beef prices.

For example, the consumer surplus would decline for Mali by US$ 3 million under the more open trade scenario, and would decline further by US$ 4 million for the single currency scenario, and by US$ 5million under the single currency with open trade scenario. Similarly, Burkina Faso consumers would see a welfare decline of US$ 1 million under the more open trade scenario, and higher declines of US$ 2.9 million and US$ 2.4 million under the single currency, and single currency with more open trade scenarios, respectively. In contrast, the magnitude of consumer surplus increase accruing to Cote d'Ivoire relative to the base model would be in the range of US$ 0.05 million to US$ 1.8 million under all trade scenarios. The implication is that

more cattle trade in the Central Corridor and the adoption of a single currency would have mixed effects on the welfare of consumers in the sub-region, particularly consumers in cattle importing countries..

Measures of Producer Profits

The usual approach in determining the producer gains using the quadratic programming method is to compute the shadow price for the fixed factor (land in this case). Such a measure represents the quasi-rent or producer surplus from each economic activity that factor owners or producers enjoy. In this analysis, however, the fixed factor, land, is mostly a communal property with no or only a rudimentary market, making it difficult to impute cash values to the land at the production centers. An alternative way to show producer gains is to estimate cattle producer profits using values generated from the trade model for each scenario.

Profits accruing to cattle producers at the production centers were estimated to give an indication of producer gains under the various trade scenarios. The producer profits for each region/country was computed as the difference between total revenue (i.e., cattle off-take numbers x price per head of cattle) and total cost (i.e., cost of production + cost of marketing at the producer level). Off-take numbers and cattle prices per head were generated by the trade models, while cost figures were the initial parameters of the trade models. Table 5.11 shows the producer profits for cattle producers in the Central Corridor (Mali, Burkina Faso, Ghana, and Cote d'Ivoire).

Table 5.11. Changes in Producer Profits Under Different Trade Scenarios in the Central Corridor - Estimates Based on 1993 Figures

	Mali	Burkina Faso	Ghana	Cote d'Ivoire
Base Model				
Total Cost	2.0854E+10	1.8934E+10	4396162500	4793853360
Total Revenue	2.711E+10	2.4614E+10	5555322240	6231940560
Profits FCFA	6256039230	5680080000	1159159740	1438087200
Profit US$	22 mil.	20 mil.	4 mil.	5 mil.
Profit as % of GDP	1%	1%	0.07%	0.07%
Open Trade Model				
Total Cost	2.1322E+10	2.106E+10	4865362500	3451284592
Total Revenue	3.1982E+10	3.159E+10	7297987340	5176926888
Profits FCFA	1.0661E+10	1.053E+10	2432624840	1725642296
Profits US$	38 mil.	37 mil.	9 mil.	6 mil.
Profit as % of GDP	2%	2%	0.2%	0.08%
Δ in Pf FCFA	4404670570	4849969010	1273465100	287555096
Δ in Pf US$	16 mil.	17 mil.	5 mil.	1 mil.
% Δ in Profit	73%	85%	125%	20%
Base Model assuming a Single Currency				
Total Cost	2.0347E+10	2.1253E+10	4731243750	4295573520
Total Revenue	3.0521E+10	3.1879E+10	7096810770	6443360280
Profits FCFA	1.0173E+10	1.0626E+10	2365567020	2147786760
Profits US$	36 mil.	38 mil.	8 mil.	8 mil.
Profit as % of GDP	2%	2%	0.2%	0.1%
Δ in Pf FCFA	3917426450	4946250000	1206407280	709699560
Δ in Pf US$	14 mil.	18 mil.	4 mil.	3 mil.
% Δ in Profit	64%	90%	0	60%
More Open Trade Model assuming a Single Currency				
Total Cost	2.197E+10	2.1253E+10	4795931250	4605855832
Total Revenue	3.2955E+10	3.1879E+10	7193841270	6908783748
Profit FCFA	1.0985E+10	1.0626E+10	2397910020	2302927916
Profit US$	39 mil.	38 mil.	9 mil.	8 mil.
Profit as % of GDP	2%	2%	0.2%	0.1%
Δ in PF FCFA	4728801640	4946250000	1238750280	864840716
Δ in Pf US$	17 mil.	18 mil.	4 mil.	3 mil.
% Δ in Profit	77%	90%	0	60%

Source: Computed from Appendix Table A5.9.

Estimates of profits that would accrue to cattle producers in the Central Corridor indicate that farmers in all four countries would gain under all trade scenarios, though the levels of profitability would be different in each country. Farmer profits would be higher relative to the base model in the cattle exporting countries (between 63% and 87% increases) as well as in the cattle importing countries (profit increases range between 104% and 110% in Ghana and between 20% and 60% in Cote d'Ivoire). Cattle farmers in Burkina Faso would realize the highest increases in profits under the single currency and the single currency with a more open trade system in the Central Corridor (US$ 17.5 million) than the adoption of a more open trade system in the sub-region (US$ 17.1 million). Malian cattle farmers, on the other hand, will have more profit under the single currency with a more open trade scenario (US$16.7 million), and least profit under the single currency scenario (US$ 13.8 million).

The experience of cattle farmers in importing countries would be somewhat different from those of exporting countries. For example, profits for cattle farmers in Ghana would increase by 104% to 110%, highest under the more open trade scenario (US$ 4.5 million) and least under a single currency system (US$ 4.3 million). Farmers in Cote d'Ivoire would, on the other hand, realize their highest profit increase under a single currency with a more open trade scenario (US$ 3.1 million), and their smallest profit increase under a more open trade scenario (US$ 1 million). These profit increases may be attributed to the expansion of cattle trade in the Central

Corridor, which raises producer prices of cattle and thereby provides incentives for farmers in importing countries to increase cattle off-take. In the case of Cote d'Ivoire, the pattern of farmer profitability is expected since a single currency with a more open trade scenario substitutes more local slaughter with imports from the Sahelian countries than an open trade scenario. Also, higher demand for all cattle types translate somewhat into increased prices for the smaller local cattle and thereby increase producer gains.

Changes in Government Revenue and Other Transfers

Estimates of changes in government revenue in the different countries due to more open cattle trade in the Central Corridor are presented in Table 5.12. Also presented in Table 5.12 are estimates of tips/bribes that cattle traders would paid under the different trade scenarios.

Government revenues were higher in both Burkina Faso and Cote d'Ivoire (about US$ 0.5 million); than in Mali and Ghana (about US$ 0.2 million) under the base model analysis. Similarly, government potential revenue losses under the more open trade scenarios were higher in Burkina Faso and Cote d'Ivoire than in Mali and Ghana by about the same margins as the gains under the base model. Government revenues from cattle trade in these countries were driven by the level of taxes/tariffs and numbers of animals officially traded. Taxes, for example, have been higher in

Table 5.12. Estimated Changes in Government Revenue and Other Transfers Under Different Cattle Trade Scenarios in the Central Corridor .

	Mali	Burkina Faso	Ghana	Cote d'Ivoire
Base Model				
Total GRev FCFA	645,611,078	682,152,000	398,249,012	669,878,814
Total GRev US$	2 mil.	2 mil.	1 mil.	2 mil.
GRev as % of GDP	0.1%	0.1%	0.02%	0.03%
Bribes/Tips US $	1.6 mil.	1.6 mil.	0.5 mil.	2.2 mil.
More Open Trade Model				
Total GRev FCFA	702,807,600	872,416,250	436,084,011	931,984,296
Total GRev US$	3 mil.	3 mil.	2 mil.	3 mil.
GRev as % of GDP	0.2%	0.2%	0.04%	0.04%
Bribes/Tips US $	1.8 mil.	2 mil.	0.5 mil.	3 mil.
Single Currency Model				
Total GRev FCFA	631,296,072	900,360,875	365,453,389	806,201,515
Total GRev US$	2 mil.	3 mil.	1 mil.	3 mil.
GRev as % of GDP	0.1%	0.2%	0.02%	0.04%
Bribes/Tips US $	1.6 mil.	2.1 mil.	0.4 mil.	2.6 mil.
Single Currency & Open Trade Model				
Total GRev FCFA	770,714,736	895,953,375	444,087,039	840,005,492
Total GRev US$	3 mil.	3 mil.	2 mil.	3 mil.
GRev as % of GDP	0.2%	0.2%	0.04%	0.04%
Bribes/Tips US $	2 mil.	2.1 mil.	0.5 mil.	2.7 mil.

GRev means Government Revenue.

Source: Computed from Appendix Table A5.10.

both Burkina Faso and Cote d'Ivoire than in Mali and Ghana. Except for Burkina Faso where government revenue was higher relative to the base model, the single currency model generated lower government revenue for Cote d'Ivoire, and government revenue losses for both Mali and Ghana, howbeit, negligible. However, compared to the base model, government potential revenue losses would be higher for all four countries under the single currency and more open trade scenario since more animals would be traded.

Other transfers, mainly bribes and tips, that traders pay to officials in government offices and custom officers along the trade routes were estimated to be about two-thirds of the revenue that went to government coffers in each case. Such gains that went into private pockets would be higher under the single currency scenario than all other scenarios; while the losses to these officials would be highest in the case of a single currency with open trade. This suggests that while some of these government officials are more likely to support a single currency regime in the Central Corridor, they might oppose it if combined with a more open trade.

Considering both the consumer surplus and producer profits, as well as changes in government revenue and other transfers together, one could conclude that there would be an overall gain with trade and currency reform for all four countries in the Central Corridor, even though cattle exporting countries would enjoy higher gains that cattle importing countries. These net gains for all four countries might be the result of trade diversion of extra-Africa beef imports as the Central Corridor

adopts a more open trade regime for cattle. Moreover, even in the case of Ghana and Cote d'Ivoire, where there would be loses in consumer surpluses under some of the trade scenarios, producer profits are likely to outweigh consumer loses.

The gains in welfare under a single currency scenario in the sub-region is not completely certain. Whereas Mali and Burkina Faso, and to a large extent Cote d'Ivoire, have definite gains in welfare if a single currency is adopted, the gains that would accrue to Ghana are not substantial enough (producer profits exceed losses in consumer surpluses by only a small margin); so that further analysis as well as more political persuasion would be needed to get Ghana on board a single currency system in the sub-region.

5.6. Effects of the CFA Franc Devaluation on Cattle Trade and Welfare in the Central Corridor

The trade model was applied to simulate what effects the CFA franc devaluation of January 1994 would have on the cattle sub-sector in the sub-region (the CFA franc was devalued by 50% relative to the French franc). We should note that a long-run perspective is the underlying assumption of the trade model, and therefore the simulation results reflect the long-run period when economic agents have had time to adjust to the devaluation. The results of the trade model with a CFA franc devaluation (assuming trade conditions in 1993) are presented in Table 5.13.

Effects of the CFA Franc Devaluation on Trade

As expected, the model indicated that there was de-stocking in both Mali and Burkina Faso by cattle producers to take advantage of the improved competitiveness of cattle in the coastal markets as a result of the CFA franc devaluation. Similarly, cattle farmers in Ghana and Cote d'Ivoire made substantial de-stocking as well. As a result, cattle off-take numbers increased in all four countries. Off-take increased by 4% in Mali, 7% in Ghana, 12% in Burkina Faso, and 13% in Cote d'Ivoire; but slaughter numbers declined in Mali (5%) and Burkina Faso (3%), while they increased in Ghana (11%) and in Cote d'Ivoire (2%).

These changes that resulted from the devaluation are consistent with the actual observed changes in these countries after the CFA franc devaluation, even though the magnitude of change differ in some respects. For example, Yade et al. (*ibid.*) report that the post-devaluation off-take increases stabilized, on the average, at about 17% in Burkina Faso, but only modestly in Mali (after initial large increases of 58% in Mali and 30% in Burkina Faso); and there was noticeable reduction in cattle slaughter in the two cattle exporting countries (i.e., Mali and Burkina Faso).

The model indicated that cattle prices at the production centers, as well as beef prices also increased in all four countries. The increase in cattle prices were in the range of 15% to 18%; but beef price increases were higher in all four countries.

The beef price increase was highest in Ghana (77%), while in the other three countries the increase was about 48% in Mali and Burkina Faso, and 49% in

Table 5.13. Analysis of Regional Beef and Cattle Trade – Simulating the Effect of the January 1994 CFA Franc Devaluation.

Production Center

Country or Region	Off-take (numbers)		Slaughter (numbers)		Price (FCFA/head)	
	Base[a]	FCFA Dev[b]	Base	FCFA Dev	Base	FCFA Dev
Mali	348,390	363,410 (4% ↑)	216,204	204,800 (5% ↓)	77,816	89,788 (15%↑)
Burkina Faso	294,000	330,000 (12%↑)	167,090	161,476 (3% ↓)	83,722	96,603 (15%↑)
Ghana	101,940	108,960 (7% ↑)	187,129	228,902 (22%↑)	54,496	64,687 (19%↑)
Cote d'Ivoire	86,010	97,500 (13% ↑)	259,922	304,690 (17%↑)	72,456	83,604 (15%↑)

(Continued on next page)

Consuming/Demand Center

	Exports/Imports (numbers)		Demand (Mt)		Price (FCFA/Kg)	
	Base	FCFA Dev	Base	FCFA Dev	Base	FCFA Dev
	Exports					
Mali	132,189	158,609 (20% ↑)	30,268	28,672 (5% ↓)	545	808 (48% ↑)
Burkina Faso	126,912	168,522 (33% ↑)	23,392	22,606 (3% ↓)	550	816 (48% ↑)
	Imports					
Ghana						
World Meat Imports	19,123 mt	13,520 mt (71% ↓)				
- Southern Zone	52,891	94,098 (78% ↑)	36,136	36,136	455	804 (77% ↑)
- Northern Zone	32,298	25,843 (20% ↓)	6,853	6,161 (10% ↓)	-	-
Cote d'Ivoire						
World Meat Imports	16,768 mt	10,200 mt (39% ↓)				
- Zone Foret (Sud)	105,412	145,691 (38% ↑)	36,646	36,646	576	860 (49% ↑)
-Zone Savane (Nord)	68,500	61,499 (10% ↓)	14,012	13,285 (5% ↓)	-	-

[a] Base refers to the optimal solution values of the base model.
[b] FCFA Dev refers to the optimal solution values of the trade model that simulates the effects of the CFA Franc devaluation of January 1994. Percentages in parentheses indicate differences in the Devaluation model figures relative to the base model figures.

Source: Model values were computed from Appendix A5.10.

Cote d'Ivoire. Subsequently, except Southern Ghana and Southern Cote d'Ivoire, which maintained their pre-devaluation beef consumption levels, beef demand decreased in both Mali and Burkina Faso (about 3% to 5%), as well as in Northern Ghana and Northern Cote d'Ivoire (about 5% to 10%).

Again, these figures are consistent with actual observations in all four countries in the post-devaluation period (Yade et al.). Reardon et al. report that as beef prices increased after the CFA devaluation, low-income households reduced beef consumption in favor of processed fish (smoked and dried), while high income households tried to maintain their pre-devaluation beef consumption levels.

Following the CFA franc devaluation, the model shows that cattle exports increased in Mali by 20% and in Burkina Faso by 33%. In response, even though cattle imports to Northern Ghana and Northern Cote d'Ivoire declined by 20% and 10%, respectively, imports to Southern Ghana and Southern Cote d'Ivoire increased by 78% and 38%, respectively. As a result, beef imports from the European Union[5] to Ghana and Cote d'Ivoire declined by 30% and 40%, respectively. It is evident therefore that Sahelian cattle effectively replaced beef imports in the coastal countries as their competitiveness improved following the devaluation. Hence, an objective of

[5]In 1994 the EU cut its export subsidies on beef, which also affected its beef exports to the West African coast.

the CFA franc devaluation of restoring the competitiveness of Sahelian cattle exports in the coastal markets seemed to have been achieved.

Effects of the CFA Franc Devaluation on Welfare

Welfare, as measured by changes in consumer surplus, producer profits, and changes in government revenue and other transfers relative to the base model, declined on the average in the Central Corridor as a result of the CFA franc devaluation. Estimates of consumer surplus and producer profits based on the simulation results, as well as changes in government revenue and other transfers, are presented in Table 5.14.

There was a general decline in consumer surplus in all four countries as a result of the CFA franc devaluation. In absolute terms, the decline in consumer surplus was higher in the cattle importing countries relative to cattle exporting countries, mainly because the sharp decline in cheap European beef imports (also due to the reduction of EU subsidies on beef exports) was not fully compensated for by imports of cattle from the Sahelian countries. Ghana had the highest decline, in excess of 40%, followed by Cote d'Ivoire (33% to 38%); while Burkina Faso and Mali experienced decline in consumer surplus of 36% and 38%, respectively. In percentage terms, prices rose more in importing countries than in exporting countries following the devaluation. Total higher decline in consumer surplus in coastal countries than in

Table 5.14. Consumer Surplus (CS), Producer Profit (PP), and Government Revenue/Other Transfers Changes Resulting from the January 1994 CFA Franc Devaluation.

Consumer Surplus	Mali	Burkina Faso	Ghana		Cote d'Ivoire	
			South GH	North GH	South CI	North CI
Base Model						
CS	3.9099E+10	2.531E+10	3.693E+10	8.381E+09	5.095E+10	2.442E+10
CS FCFA	138 mil.	89 mil.	131 mil.	30 mil.	180 mil.	86 mil.
CS US$						
Devaluation CS US$	86 mil.	57 mil	75 mil.	15 mil.	121 mil.	54 mil.
Δ CS US$	-52 mil.	-32 mil.	-56 mil.	-15 mil.	-59 mil.	-33 mil.
Producer Profits (PP)*						
Base Model						
PP	6256039230	568008000	1159159740		1438087200	
PP FCFA	22 mil.	0	4 mil.		5 mil.	
PP US$		20 mil.				
Devaluation PP US$	39 mil.	40 mil.	5 mil.		13 mil.	
Δ PP US$	17 mil.	20 mil.	0.8 mil.		8 mil.	
Changes in Government Revenue and Other Transfers						
Base Model						
GRev. FCFA	645611076	682152000	398249012		669878814	
GRev. US$	2 mil.	2 mil.	1 mil.		2 mil.	
Devaluation GRev. US$	3 mil.	3 mil.	2 mil.		3 mil.	
GRev as % of GDP	0.2%	0.2%	0.04%		0.04%	
Bribes/Tips	2 mil.	2.1 mil.	0.6 mil.		2.6 mil.	

*PP assumes a 100% increase in the prices of tradeable inputs, and a 20% increase in labor cost after devaluation.. GRev. refers to Government Revenue. Both pre and post devaluation figures were converted to US$ using the same exchange rate.

Source: Estimates based on Table 5.13 and Appendix Table A5.10.

the Sahelian countries was due also, in part, to higher incomes in coastal countries.

This is consistent with what was expected since there were increases in the general price levels in all four countries, while quantities of beef consumed either declined or were maintained at previous levels. The case of Ghana is not really different from the experience of the other three countries because, even though it is not part of the CFA franc zone, Ghana has experienced a continual depreciation of the Cedi since structural adjustment started in the country in the early 1980s.

Producer profits increased in all four countries following the CFA franc devaluation. This was based on the assumption that the prices of tradeable inputs used in cattle production and marketing increased by 100% while labor cost increased by 20% following the devaluation. Yade et al. (*ibid.*) report that in Mali, the price of cotton seed based livestock feed increased by 43% between 1993 and 1996; and the prices of agro-industrial by products used in cattle production in Burkina Faso also increased by about 40% to 50% in the 1994/95 marketing year (which followed directly after the devaluation). Producer profits in Mali increased by 75%, while those in Burkina Faso doubled (101%). Similarly, in Ghana and Cote d'Ivoire, producer profits increased by 19% and 153%, respectively, indicating that as expected, cattle farmers in Ghana did not benefit from the CFA franc devaluation as much as their counterparts in the CFA franc zone countries.

Considering both the consumer surplus and producer profit changes together, and also looking at government revenue changes and changes in other transfers (i.e., bribes/tips), we conclude that even though the CFA franc devaluation resulted in losses in consumer welfare for beef consumers in all four countries of the Central Corridor (which may be attributed to the decline in beef consumption, coupled with the general increase in beef prices across all four countries), cattle producers in general enjoyed higher profits, and therefore experienced welfare increases following the CFA franc devaluation, even though their experiences differed from one country to another. The overall effect therefore was mixed for the Central Corridor. Both cattle exporting and importing countries experienced decrease in welfare following the CFA Franc devaluation as consumer losses outweighed producer gains, but the welfare loss was higher for cattle importing countries than for exporting countries.

By comparing the model results for the more open trade (pre-devaluation period) with that of the CFA franc devaluation, it is seen that both off-take and slaughter figures were higher for all countries (except off-take in Ghana) with the devaluation than under the more open trade scenario. Cattle trade in the sub-region also expanded more following the devaluation (7% more animals traded) than would occur under a single currency scenario prior to devaluation. Also, changes in consumer surplus and producer profits, as well as government revenue relative to the base model, were higher in the case of the CFA franc devaluation than under the more

open trade scenario. These differences in the effect of the two scenarios suggest that devaluation would have a greater effect on the cattle sector compared to a more open trade policy for the sub-region, emphasizing the importance of macro adjustments compared to sectoral adjustments in the formulation and implementation of economic policies.

CHAPTER VI

Summary and Policy Implications

6.1. Summary

The focus of this study was to estimate the magnitude and direction of trade flows in cattle and their associated welfare implications in the event that more open trade is instituted in the Central Corridor of the West African sub-region. This will inform the ongoing debate on economic integration in West Africa (a goal that has eluded the ECOWAS countries since the mid 1970s).

The choice of cattle for this analysis is borne out of two related issues. First, animal production is a major economic activity in the two Sahelian countries, representing about 16% and 10% of Gross Domestic Product (GDP) in Mali and Burkina Faso, respectively. The World Bank, for example, estimates that about 30% of exports from Mali and 26% from Burkina Faso are trade in animals. At the same time, coastal countries in the region, such as Ghana and Cote d'Ivoire, are net importers of beef and cattle; and this has traditionally created a potentially viable trade in animals between the sahelian and coastal countries.

Second, the European Union (EU) in the 1980s and early 1990s followed a policy of dumping beef in West Africa (at prices about 30% to 50% lower than beef from the West African sub-region) as a way of containing problems with European

surpluses (Madden, *ibid.*). The exports of beef from the EU to West Africa increased about 700% in the 1980s, which greatly affected the traditional cattle trade in the region. GATT (1993), for example, reports that in 1992/93 about 99% of all non-African beef imports to West Africa came from the EU countries. There is need for assessing how cattle trade in the sub-region has been affected as a result of the EU beef dumping, as well as the overvaluation of West African currencies, which also contributed to making imports of beef from Europe artificially cheap.

It is evident from the existing literature on regional economic integration (and therefore more open trade in Sub-Saharan Africa) that there exists a wide gap between recognizing what the potential benefits of integration are, and actually quantifying such benefits. In part, the reluctance of government to commit to full implementation of the numerous protocols on integration and liberalization of trade in the West African sub-region could be attributed to the uncertainties that surround these expected benefits. This study is therefore an attempt to quantify the magnitudes of such gains (or losses as the case may be) to specific countries and economic agents.

The study is limited to the four countries (Ghana, Cote d'Ivoire, Mali and Burkina Faso) due to time and financial constraints. Also, Ghana and Cote d'Ivoire provide a comparison between coastal countries in the region, while inclusion of Mali and Burkina Faso allows comparison between both coastal and interior countries, and between two interior countries.

This study applies a competitive market framework to determine the magnitudes of gains from trade and how such gains are distributed among economic agents. The approach was to consider the central corridor of West Africa as a trading area which satisfies the competitive market assumption (homogenous product, large number of sellers and buyers, etc.) in respect to cattle trade. In order to simulate the effects of a competitive market, the net social welfare that was generated from demand for beef at the country or regional level was maximized for the case where no trade barriers exist, the common regional currency scenario, etc. The analysis of this situation was accomplished using a quadratic programming model and comparing a base year analysis with results obtained from other different scenarios.

For the maximization of the net social surplus for beef consumption in the West African Central Corridor, we apply the principles of welfare economics based on the argument that the competitive equilibrium that results will yield Pareto efficient allocation in the beef sub-sector. When the objective function is maximized, the model generates optimal values for all prices and factors of production and outputs of commodities included in the model at the point where the market is in equilibrium. These values represent the production and consumption levels of the economy modeled, and allow us to compute the consumer and producer surpluses as welfare indicators. Hence, the model provides a convenient way for conducting simulation analysis for a sector of an economy at the country or regional level when

a competitive market framework is an appropriate representation as in the case of beef and cattle trade in the central corridor of West Africa.

Since agricultural production, particularly in developing countries, has been recognized as risky due to the mostly uncontrollable nature of the environment in which production and distribution take place, cattle farmers' risk- averse behavior was accounted for in the model. Farmers generally confront numerous natural hazards such as drought, fire, or floods, which may destroy both crops and livestock; as well as variability in outputs, inputs, and prices that affect their incomes, and they therefore show risk-averse behavior in most farm decision making processes.

This study applies the more commonly used mean-variance (E, V) method to account for the risk-averse behavior of economic agents in the cattle sub-sector of the Central Corridor of West Africa. The basic assumption here is that the coefficient for aggregate risk aversion for a region or country should be equal to the sum of the individual risk aversion coefficients (Hazell and Scandizzo, *ibid.*). For this analysis the risk-aversion coefficient, Φ, was 1.5 (derived through sensitivity analysis). Also accounted for in the trade model is the effect of exchange rate changes on the flow of cattle in the Central Corridor.

The quadratic programming applied in this analysis maximizes a non-linear objective function (a polynomial of the second degree) subject to a set of linear constraints, with all the variables defined for non-negative values. The optimal

solution of the model gives estimates of beef quantities and cattle numbers per country/region; and also provides information on the transportation network among supply and demand centers. The analysis is based on a long run-scenario, allowing time for changes in government policies to take effect.

After providing an overview of trade in general, and production and marketing of cattle and beef in the Central Corridor in particular, an initial base model was calibrated to simulate 1993 (base year for the analysis) beef and cattle trade in the Central Corridor under the existing trading conditions (where Ghana's currency is the Cedi and the other three countries use the CFA Franc). The base model was then run under three scenarios: (a) all four countries had more open trade in cattle (i.e., all existing cattle trade barriers removed); (b) all four countries adopted the same currency (CFA Franc in this case); and (c) all four countries had more open trade and also adopted a single currency (a combination of scenarios (a) and (b) above). This was accomplished by changing the initial parameters and model constraints to reflect the intended scenario.

In order to ascertain how stable the model results were, sensitivity analysis was done by changing the price elasticity of demand for each consuming country/region by 10% up and down (i.e. 10% increase in one case, and 10% decrease in another). In general, the price and quantity values endogenously determined by the model

compared well with the reported 1993 data for each country in the Central Corridor, thereby validating the model.

Analysis of a more open trade in the Central Corridor indicates that there will be increased cattle trade and beef consumption in the sub-region; while beef imports from outside the region would decline, provided the present tariffs and other restrictions on beef imports into the region remain. Cattle farmers gain through higher prices of local cattle, but beef consumers, particularly in the exporting countries, lose as a result of lower local slaughter and higher beef prices.

Under the single currency scenario, the total volume of trade in live cattle within the Central Corridor would increase even though both exporting and importing countries might have different experiences. The figures generated by the model suggest that the adoption of a single currency by all countries in the Central Corridor will benefit them all, particularly because total trade will expand. Burkina Faso, for example, will unambiguously benefit as a result of increased cattle exports, while the case of Mali is inconclusive because exports will decline slightly. In the presence of substantial trade barriers, adopting a single currency for the sub-region will not automatically lead to expansion in cattle production in the sub-region (e.g., Mali's off-take declined).

In the case of the single currency and a more open trade scenario, the off-take values relative to the base model increased for all countries except Cote d'Ivoire. This

suggests that under this scenario, there would be expansion in the cattle sector (total off-take increases), as well as increase in the overall trade flow in cattle, and the consumption of beef in the Central Corridor.

Welfare analysis using consumer surplus and producer profits, and also net transfers, indicates that there would be an overall gain for all four countries in the Central Corridor, even though cattle exporting countries would enjoy higher gains than cattle importing countries. Moreover, even in the case of Ghana and Cote d'Ivoire, where there would be loses in consumer surpluses under some of the trade scenarios, gains in producer profits are likely to outweigh consumer loses. Also, changes in net transfers (including government revenue and bribes/tips) under different trade scenarios range from US$ 1 million to US$ 3 million for all four countries; and do not significantly alter the effects of consumer surplus and producer profit changes.

The January 1994 devaluation of the CFA franc by 50% relative to the French franc also affected cattle trade flows and beef consumption in the Central corridor. Following the devaluation, there was de-stocking in both Mali and Burkina Faso by cattle producers to take advantage of the improved competitiveness of cattle in the coastal markets, thereby expanding cattle trade in the sub-region. Also, the CFA franc devaluation resulted in losses in consumer welfare for beef consumers in all four countries of the Central Corridor. On the other hand, cattle producers in general

enjoyed higher profits, and therefore experienced welfare increases following the CFA franc devaluation.

Comparing the CFA franc devaluation and the more open trade models, it is evident that the effect of the devaluation was greater on the cattle sector than the more open trade scenario. This comparison highlights the importance of macro adjustments relative to sectoral adjustments in the context of formulating and implementing economic policies.

Even though many studies have been conducted on the livestock sector and on cattle and small ruminants in particular in West Africa, few have attempted to quantify the gains and losses to the various actors or economic agents involved in the sub-sector. The major contribution of this study, therefore, is the simulation analysis that has shown the trends and directions of cattle trade flows as well as beef imports and consumption in the Central Corridor under various policy options. The magnitudes of these variables are also provided, but due to the general weakness of the data in the region, considerable caution is needed when interpreting these figures.

6.2 Policy Implications

This study that has analyzed cattle trade flows in the Central Corridor, as well as beef imports and consumption, has shed considerable light on the existing potential in cattle trade and some of their implications to the sub-region. As a result of

structural adjustment and economic reforms, the governments of all four countries in the Central Corridor have sought to liberalize both the input and product markets of their respective livestock sectors, encouraging the private sector to play a more pivotal role in these markets. Government policy options in the livestock sector, particularly for cattle and beef, thus relate more to incentive creation and the provision of enabling environment that promote private sector initiative, and ensure gains for economic agents involved in the sector.

The results of the study have implications for government policies in all four countries. First, the study shows that under the more open trade scenario there will be increased cattle trade and beef consumption in the sub-region, while beef imports from outside the region would decline. Encouraging more open trade will therefore be a way the governments of all four countries in the Central Corridor can promote the welfare of their people, as well as move towards closer cooperation and integration. The caveat, though, is that promoting more open trade in cattle will be at the expense of consumers in the exporting countries. However, a dwindling cattle trade in the sub-region, on the other hand, could lead to a decline in welfare for producers, and an increase in beef import bills for coastal countries.

One issue of interest besides how to compensate for losses in government revenue under a more open trade system, particularly for cattle exporting countries, will be how to address the decline in beef consumption in the Sahelian countries

(exporters), which could threaten the quality of life in those countries. Considering that there is no easy answer to these problems, one way to address them will be for more vigorous government action to boost productivity in the cattle sector, such as more extension to cattle producers and making relevant inputs available on a timely basis. A more productive cattle sector will be capable of satisfying both domestic demands and exports, as well as spread gains that could compensate for any losses in government revenue.

Second, even though under a single currency scenario there is increase in cattle trade in the sub-region, there are also losses to some countries, particularly Ghana and Mali. On the other hand, the single currency with more open trade scenario leads to a relatively greater expansion of the cattle sector, and could increase the overall net gains to individual countries. A regional approach to promoting the cattle sector in the sub-region could therefore bring greater benefits to all economic agents and countries involved. We should note that all the countries in the Central Corridor except Ghana already belong to a single currency zone (CFA Franc Zone), and that the single currency with more open trade seem to generate more benefits for these countries. Another important consideration is that the model estimates the minimum level of benefits for the single currency or single currency with open trade scenarios as it doesn't take into account costs associated with currency transfer across countries by individuals (e.g. traders that carry CFA francs or Cedis across the borders)..

Third, the welfare analysis indicates that there will be net welfare gains for both consumers and producers in the Central Corridor under a trade regime that has a single currency with more open trade, in spite of the consumer welfare losses in Ghana and Mali. Governments of the countries in the Central Corridor could therefore take advantage of such welfare gains by more cooperation in their policy formulations regarding both cattle and other goods and services that will also seek to compensate the losers (such as Ghana). For example, the Sahelian countries which are landlocked could channel some of their exports and imports through Ghana to help generate "compensatory" revenue for that country. This is particularly important as these governments face prospects of increasing populations and therefore new challenges as to how to adequately cater for these populations.

6.3 Limitations of the Study

This study has been done with mainly secondary data, with only limited primary data content. The quality of the available data therefore has a bearing on the analysis and conclusions of the study. Even though there existed good sources for production cost and marketing and transformation cost data, some of the aggregate data such as trade figures and prices collected at the official level could have shortcomings inherent in such official data in most of West Africa. One should

therefore exercise some caution in the interpretation and use of the results of this study.

Also, an important consideration is that the implementation of these trade and currency reforms, especially the more open trade, and single currency with more open trade scenarios. These could meet with considerable political opposition from politically powerful groups who might lose their rents in the form of transfers under existing conditions. For example, losses in tips and bribes range between US$0.5 million in Ghana to US$2.7 million in Cote d'Ivoire under the single currency with more open trade scenario (see Table 5.12). Implementing these reforms should therefore take into account how these groups might be affected.

6.4 Future Research

The challenge of useful quantitative analysis becomes a more daunting task in the absence of very reliable data base. In pursuing the objectives of this study, the availability of good data became a major determining factor in deciding on what could and could not be done. For example, a more dis-aggregated analysis for each country in the Central Corridor that would look at the provincial level would have been pursued if the relevant data were available. Considering that good data is indispensable for policy formulation, planning, and implementation, as well as for research, governments in the Central Corridor should invest more resources to

generate reliable data for the beef and cattle sector, as well as all other sectors of the economy.

Also, due to time and financial constraints, this study was limited to beef and cattle, which is a subset of the livestock sector. Future research should pursue a more extensive analysis that will incorporate other livestock and livestock products, such as small ruminants. An area of considerable interest is to what extent trans-shipment of livestock is made through Burkina Faso due to its strategic geographic position in the Central Corridor, particularly from Mali and Niger; and whether the seasonality of livestock sales and shipments has any significant effect on beef consumption in the sub-region. Moreover, considering the expected population increases in the sub-region in the near future, it will be useful to do projections on cattle production and beef consumption in the sub region based on the simulation analysis used for this study.

This analysis was conducted with a pre-devaluation (1993) data base. It will be interesting to do a similar analysis with a post-devaluation data base, say for 1998 data, to see whether there have been any significant structural changes in cattle trade in the sub-region.

APPENDICES

Appendix A4.1

Cattle Production Cost Estimates for the Central Corridor (1993 Prices)

Production Cost - Mali Cattle (FCFA/head)

Sikasso - sed	Yr 1	Yr 2	Yr 3	Yr 4	Total NPV*
Rep Stock	16019	0	0	0	
Fixed Inputs	71	26	26	26	*133.45 F*
Labor	5516	5516	5516	5516	*18,764.50 F*
Comm. Feeds/Inputs	1539	1539	1539	1539	*5,235.42 F*
Misc.(eg. vert.)	1846	1846	1846	1846	*6,279.78 F*
TOTAL	24991	8927	8927	8927	
NPV COST	*46,432.15 F*				

Production Cost - Burkina Faso Cattle (FCFA/head)

Yako - sed.	Yr 1	Yr 2	Yr 3	Yr 4	Total NPV*
Rep Stock	15584	0	0	0	
Fixed Inputs	121	60	60	60	*265.11 F*
Labor	9026	9026	9026	9026	*30,704.93 F*
Comm. Feeds/Inputs	429	429	429	429	*1,459.39 F*
Misc.(eg. vert.)	367	367	367	367	*1,248.47 F*
TOTAL	25527	9882	9882	9882	
NPV COST	*49,261.90 F*				

Production Cost - Ghana Cattle (Cedis/head)

K.Tamale - sed.	Yr 1	Yr 2	Yr 3	Yr 4	Total NPV*
Rep Stock	19724	0	0	0	
Fixed Inputs	3500	1750	1750	1750	*C7,703.20*
Labor	5922	5922	5922	5922	*C20,145.64*
Comm. Feeds/Inputs	4500	4500	4500	4500	*C15,308.24*
Misc.(eg. vert.)	2726	2726	2726	2726	*C9,273.39*
TOTAL	36372	14898	14898	14898	
NPV COST	*C72,154.48*				
	(or FCFA 35,502)				

Production Cost - Cote d'Ivoire Cattle (FCFA/head)

Korho - sed.	Yr 1	Yr 2	Yr 3	Yr 4	Total NPV*
Rep Stock	12330	0	0	0	
Fixed Inputs	218	110	110	110	*482.20 F*
Labor	7231	7231	7231	7231	*24,598.64 F*
Comm. Feeds/Inputs	588	588	588	588	*2,000.28 F*
Misc.(eg. vert.)	989	989	989	989	*3,364.41 F*
TOTAL	21356	8918	8918	8918	
NPV COST	*42,775.53 F*				

SOURCE: Production cost figures were computed based on Metzel et al., 1993.

* Discount Rate used was 12%

Note: This appendix table presents the discounted values of inputs used in the model. The column at the extreme right (bold) presents the discounted value of individual inputs used to construct the a_{ij}s of the model; while the NPV Cost gives the discounted total cost.

Appendix A5.1.

Nominal Exchange Rates of the Ghana Cedi and CFA Franc Relative to the US Dollar, and of the Cedi relative to the CFA Franc — 1985 to 1997.

Year	Cedis/US$1	FCFA/US$1	Cedis/1000 FCFA
1985	**54.37**	**449.26**	**121.13**
Qt. I	50.00	498.01	100.60
II	52.36	470.36	110.60
III	55.25	434.34	126.13
IV	59.88	394.34	147.93
1986	**89.20**	**346.30**	**302.39**
Qt. I	89.96	360.38	234.90
II	90.09	357.34	252.78
III	90.09	338.89	272.33
IV	90.09	328.61	449.54
1987	**153.73**	**300.54**	**536.53**
Qt. I	130.00	306.39	490.11
II	150.00	301.27	524.53
III	160.51	306.76	533.43
IV	174.43	287.72	598.05
1988	**202.35**	**297.85**	**673.74**
Qt. I	180.02	283.44	635.92
II	185.77	288.93	644.98
III	213.73	315.95	656.94
IV	229.86	303.07	757.11
1989	**270.00**	**319.01**	**817.16**
Qt. I	245.35	314.71	778.67

	II	266.35	327.71	822.85
	III	275.59	325.31	833.09
	IV	292.72	308.31	934.04
1990		**326.33**	**272.26**	**1180.44**
Qt.	I	307.42	286.79	1045.31
	II	321.38	282.21	1118.49
	III	334.04	267.19	1225.81
	IV	342.49	252.87	1332.16
1991		**367.83**	**282.11**	**1293.97**
Qt.	I	351.42	260.50	1357.45
	II	365.09	293.95	1253.00
	III	371.82	296.37	1215.43
	IV	383.00	277.60	1350.00
1992		**437.09**	**264.69**	**1576.09**
Qt.	I	393.22	275.52	1428.44
	II	409.70	272.03	1340.31
	III	445.16	248.00	1677.48
	IV	500.26	263.22	1858.13
1993		**649.06**	**283.16**	**2224.03**
Qt.	I	571.62	277.33	200.37
	II	601.00	272.91	2237.50
	III	672.82	290.61	2216.69
	IV	750.81	291.79	2441.56
1994		**956.71**	**555.20**	**1779.35**
Qt.	I	906.18	586.20	1789.29
	II	933.33	568.75	1631.07

	III	965.81	535.36	1761.10
	IV	1021.53	530.51	1935.95
1995		**1200.43**	**499.15**	**2364.09**
Qt.	I	1069.03	516.88	2019.36
	II	1141.20	491.77	2244.21
	III	1210.68	494.90	2434.31
	IV	1380.80	493.04	2758.46
1996		**1637.23**	**511.15**	**3188.89**
Qt.	I	1516.42	503.51	2990.56
	II	1618.70	515.81	3131.87
	III	1686.62	509.39	3285.67
	IV	1727.18	517.50	3347.47
1997		**2037.16**	**582.85**	**3508.77**
Qt.	I	1793.79	559.71	3269.47
	II	1976.00	577.82	3449.33
	III	2161.67	604.02	3560.00
	IV	2217.17	589.85	3756.27

Source: Cedis/US$ and FCFA/US$ were obtained from the International Financial Statictics, IMF. Washington DC. Various Issues. Cedis/FCFA were obtained from Fosu, 1997.

Appendix A5.2.

Optimal Solution Values for the Base Model (initial existing conditions as in 1993).

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take (num)	348,390	294,000		101,940		86,010
Price(FCFA/hd)	77,816	83,722		54,495		72,456
Demand (Mt)	30,268	23,392	36,136	6,853	36,646	14,012
Price(FCFA/Mt)	545,620	550,430	455,045	-	575,800	-
WD Imports(Mt)	-	-	19,850	-	16,850	

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	108,102	108,102	
MZ.GN	8,500	3,798	
MZ.CN	20,000	20,000	
MZ.GE		14,891	
MZ.CC		65,000	
BF.BF	83,545	83,545	
BF.GN	10,000	10,000	
BF.CN	9,500	9,500	9,500
BF.GE		38,000	
BF.CC		20,206	20,206
GN.GN		21,200	
GN.GE		80,740	
CN.CN	20,100	20,100	
CN.CC		45,810	

Note:
WD Imports implies World Imports

MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

Appendix A5.3.

Optimal Solution Values for the Open Trade Model (based on existing conditions as in 1993).

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take (num)	356,200	327,010		112,820		61,922
Price(FCFA/hd)	89,788	96,603		64,687		83,604
Demand (Mt)	39,722	23,058	36,136	7,695	36,646	13,564
Price(FCFA/Mt)	545,920	550,640	455,045	-	575,800	-
WDImports(Mt)	-	-	16,820	-	15,132	-

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	106,150	106,150	
MZ.GN	12,500		
MZ.CN	15,400	15,400	
MZ.GE		28,400	
MZ.CC		72,200	
BF.BF	82,350	82,350	
BF.GN	10,950	10,950	
BF.CN	11,500	11,500	11,500
BF.GE		41,500	
BF.CC		32,205	32,205
GN.GN		26,180	
GN.GE		86,638	
CN.CN	20,100	20,100	
CN.CC		21,722	

Note:

WD Imports implies World Imports

MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

Appendix A5.4.
Optimal Solution Values for the Base Model (based on existing conditions as in 1993) assuming all Countries used the Same Currency (i.e. FCFA).

	Mali	Burkina	Ghana		Cote d'Ivoire	
			Southern Zone	Northern Zone	Zone Foret	Zone Savane
Off-take (num)	339,920	330,000		109,710		77,070
Price(FCFA/hd)	89,788	96,603		64,687		83,604
Demand (Mt)	29,493	22,749	36,136	6,876	36,646	14,202
Price(FCFA/Mt)	546,050	550,830	467,980	-	575,800	-
WD Imports(Mt)	-	-	18,718	-	13,050	-

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	105,332	105,332	
MZ.GN	9,500		
MZ.CN	15,000	15,000	
MZ.GE		11,758	
MZ.CC		78,000	
BF.BF	81,245	81,245	
BF.GN	11,500	8,923	
BF.CN	12,500	12,500	11085
BF.GE		45,650	
BF.CC		35,520	29,830
GN.GN		24,425	
GN.GE		85,282	
CN.CN	22,500	22,500	
CN.CC		32,070	

Note:

WD Imports implies World Imports

MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

Appendix A5.5.
Optimal Solution Values for Open Trade Model (based on existing conditions as in 1993) assuming all Countries used the Same Currency (i.e. FCFA).

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take (num)	367,030	330,000		111,210		82,637
Price(FCFA/hd)	89,788	96,603		64,687		83,604
Demand (Mt)	29,291	22,863	36,136	6,949	36,646	14,239
Price(FCFA/Mt)	546,160	550,760	467,980	-	575,800	-
WD Imports(Mt)	-	-	15,980	-	11,240	-

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	104,612	104,612	
MZ.GN	13,000		
MZ.CN	15,250	15,250	
MZ.GE		33,662	
MZ.CC		80,642	
BF.BF	81,655	81,655	
BF.GN	11,000	5,661	
BF.CN	15,050	15,050	7,248
BF.GE		42,910	
BF.CC		40,270	29,500
GN.GN		25,425	
GN.GE		85,782	
CN.CN	21,550	21,550	
CN.CC		39,537	

Note:

WD Imports implies World Imports
MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

Appendix A5.6.

Sensitivity Analysis: Optimal Solution Values for the Base Model assuming a 10% increase in the Price Elasticities of Demand for each Consuming Region/Country

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take(num)	351,290	294,000		101,940		86,010
Price(FCFA/ hd)	77,816	83,722		54,495		72,456
Demand (Mt)	30,268	23,392	36,136	7,259	36,646	14,012
Price(FCFA/ Mt)	575,010	582,860	493,198	-	622,850	-
WD Imports(Mt)	-	-	19,850	-	16,850	-

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	108,102	108,102	
MZ.GN	8,500	6,693	
MZ.CN	20,000	20,000	
MZ.GE		14,891	
MZ.CC		65,000	
BF.BF	83,545	83,545	
BF.GN	10,000	10,000	
BF.CN	9,500	9,500	9,500
BF.GE		38,000	
BF.CC		20,206	20,206
GN.GN		21,200	
GN.GE		80,740	
CN.CN	20,100	20,100	
CN.CC		45,810	

Note:

WD Imports implies World Imports

MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

Appendix A5.7.

Sensitivity Analysis: Optimal Solution Values for the Base Model assuming a 10% decrease in the Price Elasticities of Demand for each Consuming Region/Country

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take (num)	340,340	294,000		101,9450		86,010
Price(FCFA/hd)	77,816	83,722		54,495		72,456
Demand (Mt)	30,268	23,392	36,136	6,448	36,646	13,289
Price(FCFA/Mt)	516,240	517,990	416,896	-	528,750	-
WD Imports(Mt)	-	-	19,850	-	16,850	-

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	108,102	108,102	
MZ.GN	8,500	902	
MZ.CN	20,000	14,841	
MZ.GE		14,891	
MZ.CC		65,000	
BF.BF	83,545	83,545	
BF.GN	10,000	10,000	
BF.CN	9,500	9,500	9,500
BF.GE		38,000	
BF.CC		20,206	20,206
GN.GN		21,200	
GN.GE		80,740	
CN.CN	20,100	20,100	
CN.CC		45,810	

Note:

WD Imports implies World Imports

MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

Appendix A5.8.
Consumer Surplus changes under different Trade Scenarios in the Central Corridor - Estimates based on 1993 figures

	Mali	Burkina Faso	Ghana		Cote d'Ivoire	
Base Model			*South GH*	*North GH*	*South CI*	*North CI*
a - intercept	1018194	896900	747764	884153	1063972	1220004
b - slope	-18.11	-15.87	-15.2	-98.98	-17.84	-74.73
Q - Qty DD	30269	23393	36136	6853	36647	14012
P - price	546	550	455	455	576	576
CS - FCFA	3.9099E+10	2.531E+10	3.693E+10	8.381E+09	5.095E+10	2.442E+10
CS - US $	**138,158,317**	**89,434,942**	**130,491,699**	**29,616,244**	**180,028,738**	**86,299,385**
Open Trade Model						
a - intercept	1018194	896900	747764	884153	1063972	1220004
b - slope	-18.11	-15.87	-15.2	-98.98	-17.84	-74.73
Q - Qty DD	29722	23058	36136	7651	36647	13564
P - price	546	551	455	455	576	567
Δ CS - FCFA	-8.531E+08	- 4.232E+08	- 3,614	+1.349E+09	1.44E+06	-1.008E+09
Δ CS - US $	**-3,014,537**	**-1,495,590**	**- 13**	**+4,767,170**	**5,097**	**-3,561,529**
Base Model assuming a Single Currency (FCFA)						
a - intercept	1018194	973333	727218	858972	1063972	1220004
b - slope	-18.11	-15.87	-14.77	-96.15	-17.84	-74.73
Q - Qty DD	29493	22749	36136	6876	36647	14202
P - price	546	551	468	468	576	576
Δ CS - FCFA	-1.209E+09	-813E+08	-1.024E+09	-2.053E+08	+1.435E+06	+4.319E+08
Δ CS - US $	**-4,272,124**	**-2,872,971**	**-3,617,292**	**-725,466**	**+5,071**	**+1,526,465**

Open Trade Model assuming a Single Currency (FCFA)

a - intercept	1018194	896900	727218	858972	1063972	1220004
b - slope	-18.11	-15.87	-14.77	-96.15	-17.84	-74.73
Q - Qty DD	29291	22863	36136	6949	36647	14239
P - price	546	551	468	468	576	576
Δ CS - FCFA	-1.521E+09	-6.686E+08	- 1.024E+09	-9.368E+07	+1.435E+06	+5.181E+08
Δ CS - US $	-5,376,261	-2,362,545	-3,617,292	-331,060	+5,071	+1,830,886

Appendix A5.9.

Changes in Producer Profits under different Trade Scenarios in the Central Corridor -- Estimates based on 1993 figures

	Mali	B Faso	Ghana	Cd'Ivoire
Base Model				
Prd Cost	46432	49261	32505	42774
Loc Mkt Cost	13427	15141	10620	12962
Unit Cost	59859	64402	43125	55736
Total Cost	2.0854E+10	1.8934E+10	4396162500	4793853360
Off-take	348390	294000	101940	86010
Price/head	77816	83722	54496	72456
Total Revenue	2.711E+10	2.4614E+10	5555322240	6231940560
Profit FCFA	6256039230	5680080000	1159159740	1438087200
Profit US$	22106145.7	20070954.1	4095970.81	5081580.21
Open Trade Model				
Prd Cost	46432	49261	32505	42774
Loc Mkt Cost	13427	15141	10620	12962
Unit Cost	59859	64402	43125	55736
Total Cost	2.1322E+10	2.106E+10	4865362500	3451284592
Off-take	356200	327010	112820	61922
Price/head	89788	96603	64687	83604
Total Revenue	3.1982E+10	3.159E+10	7297987340	5176926888
Profit FCFA	1.0661E+10	1.053E+10	2432624840	1725642296
Profit US$	37670352.7	37208653.7	8595847.49	6097675.96
Ch in Pf FCFA	4404670570	4849969010	1273465100	287555096
Ch in Pf US$	15564207	17137699.7	4499876.68	1016095.75
Base Model assuming a Single Currency				
Prd Cost	46432	49261	32505	42774
Loc Mkt Cost	13427	15141	10620	12962
Unit Cost	59859	64402	43125	55736
Total Cost	2.0347E+10	2.1253E+10	4731243750	4295573520
Off-take	339920	330000	109710	77070
Price/head	89788	96603	64687	83604
Total Revenue	3.0521E+10	3.1879E+10	7096810770	6443360280
Profit FCFA	1.0173E+10	1.0626E+10	2365567020	2147786760
Profit US$	35948642	37548869.3	8358894.06	7589352.51
Ch in Pf FCFA	3917426450	4946250000	1206407280	709699560
Ch in Pf US$	13842496.3	17477915.2	4262923.25	2507772.3

More Open Trade Model assuming a Single Currency

Prd Cost	46432	49261	32505	42774
Loc Mkt Cost	13427	15141	10620	12962
Unit Cost	59859	64402	43125	55736
Total Cost	2.197E+10	2.1253E+10	4795931250	4605855832
Off-take	367030	330000	111210	82637
Price/head	89788	96603	64687	83604
Total Revenue	3.2955E+10	3.1879E+10	7193841270	6908783748
Profit FCFA	1.0985E+10	1.0626E+10	2397910020	2302927916
Profit US$	38815692.1	37548869.3	8473180.28	8137554.47
Ch in Pf FCFA	4728801640	4946250000	1238750280	864840716
Ch in Pf US$	16709546.4	17477915.2	4377209.47	3055974.26

CFA Franc Devaluation effect (assumes 100% increase in tradeable input prices, and 20% increase in labor cost)

Prd Cost	55420	56861	49694	41216
Loc Mkt Cost	4220	5142	2361	5142
Unit Cost	59640	62003	52055	46358
Total Cost	2.1674E+10	2.0461E+10	5671912800	4519905000
Off-take	363410	330000	108960	97500
Price/head	89788	96603	64687	83604
Total Revenue	3.263E+10	3.1879E+10	7048295520	8151390000
Profit FCFA	1.0956E+10	1.1418E+10	1376382720	3631485000
Profit US$	38714080.1	40346289.8	4863543.18	12832102.5
Ch in Pf FCFA	4700045450	5737920000	217222980	2193397800
Ch in Pf US$	16607934.5	20275335.7	767572.367	7750522.26

Appendix A5.10

Changes in Government Revenues under different Cattle Trade Scenarios in the Central Corridor

	Mali	Burkina Faso	Ghana	Cote d'Ivoire
Base Model				
No. of Cattle	132,189	126,912	95,189	173,912
Tax/animal	4,884	5,375	4,170	3,845
Imp Beef (Mt)	0	0	19,123	16,768
Tariff FCFA	0	0	1,310,882	1,187,174
Total FCFA	645,611,076	682,152,000	398,249,012	669,878,814
Total US$	2,281,311	2,410,431	1,407,240	2,367,063
More Open Trade Model				
No. of Cattle	143,900	162,310	104,300	242,110
Tax/animal	4,884	5,375	4,170	3,845
Imp Beef (Mt)	0	0	16,820	15,132
Tariff FCFA	0	0	1,153,011	1,071,346
Total FCFA	702,807,600	872,416,250	436,084,011	931,984,296
Total US$	2,483,419	3,082,743	1,540,933	3,293,231
Single Currency Model				
No. of Cattle	129,258	167,509	87,331	209,435
Tax/animal	4,884	5,375	4,170	3,845
Imp Beef (Mt)	0	0	18,718	13,050
Tariff FCFA	0	0	1,283,119	923,940
Total FCFA	631,296,072	900,360,875	365,453,389	806,201,515
Total US$	2,230,728	3,181,487	1,291,355	2,848,769
Rev Chg FCFA	-14,315,004	218,208,875	-32,795,623	136,322,701
Rev Chg US$	-50,583	771,056	-115,886	481,706
Single Currency plus More Open Trade Model				
No. of Cattle	157,804	166,689	106,233	218,260
Tax/animal	4,884	5,375	4,170	3,845
Imp Beef (Mt)	0	0	15,980	11,240
Tariff FCFA	0	0	1,095,429	795,792
Total FCFA	770,714,736	895,953,375	444,087,039	840,005,492
Total US$	2,723,374	3,165,913	1,569,212	2,968,217
Devaluation Model				
No. of Cattle	158,609	168,522	111,941	207,191
Tax/animal	4,884	5,375	4,170	3,845
Imp Beef (Mt)	0	0	13,520	10,200
Tariff FCFA	0	0	926,796	722,160
Total FCFA	774,646,356	905,805,750	467,720,766	797,371,555
Total US$	2,737,266	3,200,727	1,652,724	2,817,567
Rev Chg FCFA	129,035,280	223,653,750	69,471,754	127,492,741
Rev Chg US$	455,955	790,296	245,483	450,504

Appendix A5.11.

Optimal Solution Values for the Effect of the CFA Franc Devaluation (based on existing conditions as in 1993).

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take (num)	363,410	330,000		108,960		97,500
Price(FCFA/hd)	89,788	96,603		64,687		83,604
Demand (Mt)	28,672	22,607	36,136	6,161	36,646	13,285
Price(FCFA/Mt)	807,880	815,700	804,180	-	859,880	-
WD Imports(Mt)	-	-	13,520	-	10,200	-

Cattle Shipments by Mode of Transport			
	Trekking	Truck	Train
MZ.MZ	102,400	102,400	
MZ.GN	13,500		
MZ.CN	13,861		
MZ.GE		35,748	
MZ.CC		95,500	
BF.BF	79,868	79,868	1740
BF.GN	12,343		
BF.CN	28,500	19,138	
BF.GE		58,350	
BF.CC		35,520	14,671
GN.GN		23,121	
GN.GE		85,840	
CN.CN	21,250	21,250	
CN.CC		55,000	

Note:

WD Imports implies World Imports

MZ.MZ is shipments within Mali
MZ.GN is Mali to North Ghana
MZ.CN is Mali to North Cote d'Ivoire
MZ.GE is Mali to South Ghana
MZ.CC is Mali to South Cote d'Ivoire
BF.BF is shipments within Burkina
BF.GN is Burkina to North Ghana
BF.CN is Burkina to N. Cote d'Ivoire BF.GE is Burkina to South Ghana
BF.CC is Burkina to S. Cote d'Ivoire
GN.GN is shipments within N.Ghana
GN.GE is N. Ghana to S. Ghana
CN.CN is shipments within North Cote d'Ivoire
CN.CC is North Cote d'Ivoire to South Cote d'Ivoire

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