Effects of the CFA Devaluation on Cattle Trade, Beef Consumption, and Welfare in the Central Corridor of West Africa.

by

Samuel Asuming-Brempong and John M. Staatz[1]

Abstract

Constrained social surplus maximization was applied as a tool that allowed us to use mathematical programming methods to analyze the market for cattle and beef within a competitive market framework. The January 1994 devaluation of the CFA franc by 50% relative to the French Franc affected cattle trade flows and beef consumption in the West African 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. However, 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.

Introduction

Inter-regional trade within the West African Central Corridor [2] and the sub-region as a whole 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, substantial tariff and non-tariff trade barriers still exist that have prevented free movements of goods and services throughout the region (Egg *et al.*, 1991).

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, but cost structures differ across these countries, 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

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[1]*The authors are a Senior Lecturer, Department of Agricultural Economics, University of Ghana, Legon, Accra, Ghana, and a Professor, Department of Agricultural Economics, Michigan State University, East Lansing, Michigan, USA, respectively.*

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

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 CFA Franc Zone, 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.

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 (1997) 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 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, 1993). 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.

The main objective of this paper is to estimate the magnitude and direction of trade flows in cattle and beef consumption, as well as their associated welfare implications in the West African Central Corridor, following the one-time devaluation of the CFA Franc. More specifically, the study seeks to (a) determine how the CFA Franc devaluation has affected cattle production and beef consumption in the countries of the Central Corridor; (b) estimate changes in the producer and consumer surpluses for the beef sub-sector in these countries; and (c) determine what effects the CFA Franc devaluation has had on beef imports into the sub-region.

The paper is organized into five sections. Following the introduction, the method of analysis is discussed. The mathematical model analyzed is then presented, after which the effects of devaluation on cattle trade and beef consumption, as well as their welfare implications are discussed. The last section gives the conclusions and policy implications of the paper.

Method of Analysis

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 (Varian, 1993). The constrained social surplus maximization is thus a tool that allows us to use mathematical programming methods to simulate 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.

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 base year (1993) scenario, and for the period subsequent to the CFA Franc devaluation. The analysis was

accomplished using a quadratic programming model and comparing a base year analysis with results obtained from the period following the devaluation. We 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 (1980) provide a more formal discussion on how maximizing net social benefits in the aggregate is analogous to maximizing profits and utility of individuals.

Mathematical Programming

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 analyses based on mathematical programming have 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 the Central Corridor of 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.

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. 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 both the objective function and constraints (*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 CFA Zone 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.

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 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 number of cattle a hectare of pastoral land can support, and other accounting rows constitute the constraints.

The maximization problem is specified as:

$$\max NSB = \sum_j \int_0^{Q_j^D} P_j^D \, \delta \, Q_j^D \quad \sum_s Q_s^s * F_s^C * C_s^P \quad \Phi(L - \Omega L)^{1/2}$$

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

$$- \sum_j \sum_s X_{sj} * MC_s * MC_j * C_s^F \qquad (1)$$

$$\sum_s X_{sj} * F_s^C = Q_j^D; \; j = 1, \ldots\ldots\ldots\ldots, J \qquad (2a)$$

$$\sum_j X_{sj} = Q_j^D; \; j = 1, \ldots\ldots\ldots\ldots, J \qquad (2b)$$

$$\sum_s \sum_t X_{sjt} = \sum_s X_{sj}; \; j = 1, \ldots\ldots\ldots\ldots, J \qquad (3a)$$

$$\sum_j \sum_t X_{sjt} = \sum_j X_{sj}; \; s = 1, \ldots\ldots\ldots\ldots, S \qquad (3b)$$

$$R_s^A * Q_s^S \leq A_s; \; s = 1, \ldots\ldots\ldots\ldots, S \qquad (4a)$$

$$R_s^L * Q_s^S \leq L_s; \; s = 1, \ldots\ldots\ldots\ldots, S \qquad (4b)$$

$$R_s^K * Q_s^S \leq K_s; \; s = 1, \ldots\ldots\ldots\ldots, S \qquad (4c)$$

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

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: $\mathbf{t}_1$ = truck; $\mathbf{t}_2$ = trek, $\mathbf{t}_3$ = train; $\mathbf{t}_4$ = 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 $\mathbf{P_j^D = a_j - b_jQ_j^D}$)

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**

F_s^c = conversion factor of each animal 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**

L_s = labor (man days) endowment for cattle production in supply/producing country **s**

K_s = 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

The objective function (Equation (1)) 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 the optimal solution.

Equations (2) to (4) represent the constraints which give form to the model. For example, Equations (2a) and (2b) 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 (3a) and (3b) ensure that shipments of cattle and beef by all modes of transport are equalized between production and demand or consuming centers. Equations (4a), (4b), and (4c) 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, 1986). 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.

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 equation (5), which is derived from the maximization of consumer and producer surpluses within a simple demand-supply framework. The price and quantity parameters are endogenously determined within the quadratic programming model (the model generates beef prices and quantity parameters within the objective function for each optimal solution).

$$\mathbf{ACS_j} = \Sigma_i \left(a_i - 1/2 b_i Q_i^* \right) Q_i^* - P_i^* Q_i^* \qquad (5)$$

where ACS_j is the aggregate consumer surplus for country/region **j** ; $\mathbf{P}^*$ and $\mathbf{Q}^*$ 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.

In order to ascertain how stable the model results were, sensitivity analysis was conducted 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.

CFA Franc Devaluation Effects on Cattle Trade and Beef Consumption

The trade model was applied to simulate what effects the CFA franc devaluation of January 1994 has had 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 1. 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

Table 1. Analysis of Regional Beef and Cattle Trade – Simulating the Effect of the January 1994 CFA Franc Devaluation in the Central Corridor of West Africa.

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 A.1.

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. (1998) 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 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. *ibid.*). 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, and

imports from the European Union3 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 the CFA franc devaluation of restoring the competitiveness of Sahelian cattle exports in the coastal markets seemed to have been achieved.

CFA Franc Devaluation Effects on Welfare in the Central Corridor

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 2.

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

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 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. Producer profits also increased in all four countries following the CFA franc devaluation in spite of sharp increases in input costs4. 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, Ghanaian livestock meat prices (in CFA terms) rose in response to the higher regional demand for Sahelian cattle.

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

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[4]Yade et al. (*ibid.*) report that in Mali, the price of cottonseed-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).

Table 2. 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						
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.
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						
PP FCFA	6256039230	5680080000	1159159740		1438087200	
PP US$	22 mil.	20 mil.	4 mil.		5 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 1 and Appendix A.1.

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.

Conclusion and Policy Implications

The January 1994 devaluation of the CFA franc by 50% relative to the French Franc affected cattle trade flows and beef consumption in the West African 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. However, 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.

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 major policy implication of the analysis is that governments in the sub-region should recognize the differential effects that economy-wide policies such as devaluation could have on the various sectors of the economy, as well as the individual stake holders in each sector. Careful analysis for both the ex-ante and ex-post scenarios should therefore be done so as to develop mitigating programmes that will alleviate undue hardships that some sectors of the society might experience as fall-out from such policies. Also, in formulating and implementing economic policies, it is important for governments to coordinate macro adjustments and sectoral adjustments in order to create relevant complementaries that will enhance the welfare of the communities affected.

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Appendix A 1.

Optimal Solution Values for the Effect of the CFA Franc Devaluation on Cattle Trade and Beef Imports in the West African Central Corridor

	Mali	Burkina	Ghana		Cote d'Ivoire	
			South Zone	North Zone	Zone Foret	Zone Savane
Off-take (num)	363410	330000		108960		97500
Price(FCFA/hd)	89788	96603		64687		83604
Demand (Mt)	28672	22607	36136	6161	36646	13285
Price(FCFA/Mt)	807880	815700	804180	-	859880	-
WD Imports(Mt)	-	-	13520	-	10200	-

Cattle Shipments by Mode of Transport

	Trekking	Truck	Train
MZ.MZ	102400	102400	
MZ.GN	13500		
MZ.CN	13861		
MZ.GE		35748	
MZ.CC		95500	
BF.BF	79868	79868	1740
BF.GN	12343		
BF.CN	28500	19138	
BF.GE		58350	
BF.CC		35520	14671

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

GN.GN		23121		
GN.GE		85840		
CN.CN	21250	21250		
CN.CC		55000		