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AN ANALYSIS OF RICE SUPPLY AND DEMAND IN THE IVORY COAST

By

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To
my wife Mariam Ouattara,
my parents,
my son,
for their love and spiritual support.

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CHAPTER I

INTRODUCTION: A HISTORY OF RICE GROWING IN THE IVORY COAST[1]

Ivorian economic growth, as in most developing countries, springs from its agriculture. During the 15-year period 1950-1965, the annual growth rate averaged 9 percent,[2] but in fact was even more pronounced after 1960 (11 to 12 percent).

Since colonial times, agriculture has been carefully promoted through planning, research, and high investment, aided by significant inflows of foreign labor and capital and by high world prices for export crops. A balance of payment constraint never created serious problems and balanced budgets have generally helped to avoid inflation, despite high government expenditures.

Of the estimated total area of 322,500 square kilometers, about one-half is arable. The country is divided into two main ecological zones, which correspond roughly with the forest and the savannah. The forest

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[1]Throughout this paper, "rice" means processed rice as opposed to paddy rice. This definition is maintained except when otherwise stated.

[2]Samir Amin, Le Developpement du Capitalisme en Cote d'Ivoire (Paris: Les Editions de Minuit, 1967), p. 48.

zone consists of two parts extending approximately over the Southern half of the country, called V Baoulé." There is a narrow coastal belt with high rainfall and acidic soils which produces industrial crops such as palm oil, pineapples, and rubber. The forest north of this coastal belt benefits from the most fertile soil in the country and produces the major cash crops (cocoa and coffee) and the most food crops (particularly rice), with 1,500 to 1,600 millimeters of rainfall per annum.

The northern savannah also comprises two parts. The center, around Bouake, is a transition zone of highly variable rainfall. It produces cotton, some coffee, and cocoa and food crops--especially yams. The second area in the savannah covers the northern third of the country and is the driest and least-fertile region.

The cultivated area in the Ivory Coast was 970,000 hectares in 1960, around 1,070,000 ha in 1970, and 1,100,000 ha in 1975. Agricultural land use is divided between industrial and food crops, the latter comprising about 45 percent--a share which has changed little since 1965 (Table 1). Rice represents a relatively small part of this amount, produced on roughly one-fifth of the food-crop land. The production of rice was 160,000 MT in 1960 and 425,000 MT in 1976 (Table 2). The average annual increase was 10.6 percent in 1960-1961, 5.6 percent in

TABLE I

LAND UTILIZED FOR CROP PRODUCTION

Crop	1965		1974	
	Physical Hectares (000)	Percent	Physical Hectares (000)	Percent
Coffee	680	32.4	1,121	30.6
Cocoa	624	20.2	745	20.3
Corn	186	8.9	167	6.6
Banana plantain	120	5.7	480	13.1
Rice	209	10.0	258	7.0
Yams	162	6.8	149	4.1
Cassava	56	2.7	169	4.6
Taro (coco yam)	62	2.0	306	8.4
Millet, sorghum	63	3.0	94	2.6
Oil palm	19	0.9	22	0.6
Cotton	62	3.0	34	0.9
Peanuts	37	1.8	34	0.9
Coconut	11	0.5	26	0.7
Rubber	10	0.5	16	0.4
Sugar	0	0.0	9	0.2
Others	36	1.7	34	0.9
Total:	2,097	100.0	3,664	99.9

SOURCE: Charles P. Humphrey and Patricia L. Rader, Rice Policy of the Ivory Coast (Stanford: Food Research Institute, Stanford University, August 1978).

TABLE 2

TOTAL CULTIVATED AREA UNDER RICE

Year	Cultivated Land Total (1,000 ha)	Rice Area (1,000 ha)	Yield kg/ha	Production (1,000 MT)	Milled Equivalent
1960		218	734	160	101
1961		206	757	156	98
1962		260	881	223	166
1963		265	894	219	138
1964		271	915	248	156
1965		261	958	250	158
1966		258	1,070	275	173
1967		301	1,146	345	213
1968		300	1,217	365	230
1969		288	1,052	303	191
1970	2,830	289.0	1,093	316.0	209.0
1971		282.0	1,365	385.0	254.0
1972		285.0	1,123	320.0	211.0
1973		290.0	1,155	335.0	221.0
1974		317.0	1,281	406.0	268.0
1975		361.0	1,277	461.0	306.0
1976		364.0	1,168	425.0	277.0

SOURCE: WARDA, Rice Statistics Yearbook, First ed. (Monrovia: WARDA, July 1978).

1965-1970, and 8.3 percent in 1970-1975. The yield per ha was 736 kg in 1960 and 1,168 kg in 1976.

Virtually 100 percent of the total rice production is for domestic consumption rather than exportation. Rather, the Ivory Coast has been a net importer of rice since colonial times. In 1975, the country had a total population of nearly 7 million, with one-third living in urban areas and two-thirds living in rural areas. Of this two-thirds, 35 percent are involved in rice production, two-thirds of which is in the forest zone. Although the overall population growth rate is high (4.1 percent in 1975), over one-third of the population increase is due to significant in-migration from neighboring countries. Internal migration patterns are also observed: rural-urban and urban-rural.

The analysis of Ivorian rice consumption presents a paradox. While aggregate rice consumption has increased with population growth, there has been no growth in per capita consumption figures since 1965, in spite of large increases in real per capita income and high rates of urbanization. Per capita rice consumption has averaged slightly more than 40 kg during this period.[3] Unfortunately, little is known about the difference in consumption

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[3]Charles P. Humphrey and Patricia L. Rader, Rice Policy of the Ivory Coast (Stanford: Food Research Institute, Standord University, August 1978), p. 2.

between rural and urban areas except that rice constitutes 75 percent and 14 percent of urban and rural diets, respectively.[4]

Historically, Ivorian rice policy has followed a gradual pattern of change from the colonial period until 1974. The various planning statements were ambitious, even if, before 1976, self-sufficiency in rice was not viewed as an urgent goal. Both the drastic increase in world price in 1973-1976 and the doubling of imports, however, compelled the government to reconsider its rice policy. In the rice sector two main objectives were thus established:

1. to increase the income of farmers, particularly in the north; and

2. to help maintain a positive trade balance by reducing food imports and rice--the only domestically produced staple food which was also imported.

To reach these goals, four types of policies were emphasized: research, institutional, investment and pricing.

Research policies sought ways to make Ivorian rice competitive through technological change, and to increase production, availability of labor and land for export usage.

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[4] Ibid.

Management was carried out by SATMACI[5] in 1963 and was consigned to SODERIZ[6] in 1970. Its main role was to insure inputs supplies and to improve paddy marketing.

Domestic price policy was emphasized in 1977 by the reorganization of the "Caise de Perequation." This organization fixed retail prices and defended them through imports, thereby compensating for any fluctuation in import prices. The official paddy support price was linked to the retail rice price, which required a modest subsidy paid to government rice mills. The subsidy was financed by the Caisse de Perequation out of the revenue earned from the difference between imports and higher retail prices.

Other crops compete with rice in the Ivory Coast. Coffee, cocoa, yams, corn, and cassava are vying for the production factors of land and labor--the extent of competition depending on the comparative profitability in the previous growing period of each commodity. Until the colonial period, rice was very insignificant in Ivorian diets. Originally introduced by the French to nourish their cash crop farm workers, its production evolution was very slow. But increasing rice consumption eventually compelled the colonial administration to import rice to meet domestic needs. With the monetarization

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[5]Societé d'Assistance Technique et de Mecanisation Agricole.

[6]Societé de Developpement du Riz.

of the economy, the consumption pattern started changing and rice became much more important. Today, rice constitutes 75 percent of Ivorians' diet in urban areas and 14 percent in rural areas; rice-producing farmers, however, consume as much as, if not more than, the urban population.

Statement of the Problem

Despite the importance of rice in Ivorians' diet, and thus in the economy of the Ivory Coast, self-sufficiency in rice production, until recently, has received little attention from economists and statisticians. Agronomists, sociologists and anthropologists have examined in some detail the cultural practices, soils, land barriers, tools and basic techniques used by the Ivorian farmers. But they have failed to produce much needed basic information related to crop acreages, yields, prices and other areas which are most relevant for policy formulation. And even the information that was available was not used properly. In effect, while certain efforts to collect such information are noticeable in recent literature, they are most often unreliable, and the policies which result appear inappropriate upon preliminary evaluation.

Furthermore, the agricultural literature of the Ivory Coast provides different impressions of primary producer and consumer responsiveness to price changes in

agricultural products. No explicit study is available, however.

Obviously, the accelerated growth in the Ivory Coast brought about by the different development processes since 1960 has important implications for rice consumption requirements. Rice is being consumed in greater quantities as population and income increase. This in turn produces an increased demand for inputs required in rice production. Reliable forecasts of rice consumption requirements are therefore crucial and an indispensable tool to planners. They can help to reduce the margin of error in setting rice production goals and thus minimize misallocation of resources which results in overproduction or underproduction and famine.

Furthermore, estimates of elasticities are necessary to determine the effects of alternative policies, such as supply-control programs.

Objectives of the Study

This paper, then, analyzes the rice demand and supply in the Ivory Coast, and attempts to estimate both price and income elasticities of demand, and price elasticity of supply. Great emphasis will not be placed on evaluating existing rice policies or programs; rather, equilibrium demand and supply relations will be analyzed

according to economic theory, and prices will be predicted from equations specified to define these relations.

The specific objectives are as follows:

1. To develop an economic model based on theory and knowledge of economic relationships of the Ivory Coast rice industry

2. To formulate, estimate and test the statistical model of the specified supply and demand relationships consistent with the economic model

3. To interpret and apply the model to current conditions

4. To use the model in forecasting demand and supply for rice in the Ivory Coast

5. To state some implications for the impact of government policy on the Ivory Coast rice policy

It is hoped that the analysis of this nature will serve as a guide to policy-makers in estimating demand and supply of rice and in implementing strategies for self-sufficiency in rice in the Ivory Coast.

Methodology and Data Collection

Methodology

This study attempts to isolate some of the empirically relevant demand and supply shifters for rice in

the Ivory Coast in order to better understand the forces operative in the determination of Ivorian rice supply and demand. The procedure is to fit demand and supply equations by ordinary least squares, then to use these equations for projections and analysis, both statistically and economically.

Data Collection

The 1960-1976 time series data used in this analysis are obtained from the West African Rice Development's Rice Statistics Yearbook of 1975 and 1978 and the study done by Charles P. Humphreys from the Food Research Institute at Stanford University ("Rice Policy of the Ivory Coast," August 1978).

The 1960 starting point for the data series corresponds to the beginning of Ivory Coast independence, or the birth of the Republic of the Ivory Coast. The data attempt to include the necessary information concerning the factors that influence both consumption and production of rice.

CHAPTER II

THE GOVERNMENT AND RICE IN THE IVORY COAST

Rice is a storable and widely traded product. Strong import demand and limited export supplies of rice, coupled with tight supplies and high prices of other cereals, as well as inflationary pressures, led to a sharp rise in rice prices in the world market in 1974. These events made rice much more expensive in relation to other cereals. Security stock establishment by some importing countries and the continuation of export restrictions by some exporting countries also contributed to the rise in world prices.

In response to this rice crisis a number of countries made important policy changes affecting rice production, consumption and trade. In the Ivory Coast these changes were made as follows:

1. Substitution of rice imports with domestic production suddenly gained a much higher priority than ever before. As a result, the SODERIZ activities were reinforced by the numerous subsidies and credits allowed to farmers.

2. Despite the availability of incentive policies, production remained short of consumption (due to underestimation of population growth and low real price). The solution for meeting high consumption demand and offsetting insufficient domestic production was to allow consumer prices to rise with the higher import price, thereby reducing consumption and making domestic rice more competitive without excessive government subsidies.

This price movement happened within the two marketing systems existing in the Ivory Coast's government sector and private sector.

Demand

Rice and bread are the only two starchy staples for which the government set official consumer prices, seemingly well-controlled through an extensive system of small retail outlets.[1] Furthermore, the gradual increase in the price of other foods (yams, cassava, plantains) since 1974 caused the government to make rice the cheapest staple in terms of calories per kg. But in terms of rice per se, retail prices have been allowed to rise. This policy led to a reduction of per capita rice consumption. Hence, a surplus on the supply side was noticed.

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[1] Humphrey and Rader, p. 9.

Supply

Most agricultural production in the Ivory Coast comes from small family farming. It is generally land extensive, based on shifting cultivation. Although the agricultural sector in the Ivory Coast has been very successful recently, rice production is the exception. Its lack of success scarcely shows, for production has greatly increased. But increased production has been extracted at high costs to the economy and to the government budget.

Although rice is the only Ivorian diet staple grown in the country, and despite ambitious planning statements, self-sufficiency in rice was not viewed as an urgent goal from colonial times until 1974. In fact, government policy makers planned to increase rice production through a gradual process of technological change, since world prices were considerably lower and Ivorian production was not competitive. But in 1973-1974 the quadrupling of world rice prices and a doubling of imports forced the government into a new policy of price support which radically increased the scope and level of its intervention.[2]

Despite great improvements in rice production, the feasibility of meeting the objectives in the near future

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[2]Ibid., p. 3.

has been called into question.

Rice is grown throughout the Ivory Coast during the rainy season. Humphreys cites three major types of rice culture, two traditional and one modern: upland rice; flooded rice; and irrigated rice. Virtually all traditional rice culture, however, is rainfed, and primarily upland. The small amount of flooded rice in the northwest is relatively unimportant and no indigenous water control systems exist. Recently, the government subsidy and mechanization policy on rainfed rice has led to a greater increase in the use of modern inputs and machinery. Despite the overwhelming predominance of rainfed rice, government efforts to introduce modern rice cultivation have been focused on irrigated rice.

One could say that the government stands in the middle: it is a supplier for servicemen, officials and other non-farmers; but for farmers, it monitors rice production.

Marketing

The processing of rice can be placed into three categories: traditional; privately owned small mills; and government owned large-capacity mills. Traditional processing entails parboiling, hand pounding and winnowing. It is the least expensive technique, is highly labor

intensive and probably has a high extraction rate. Because it is almost exclusively the work of women and children, it seems an attractive form of processing, but the capacity for expansion is limited.

Since the mid-1960s, the government has increased its industrial scale milling capacity two and one-half times to over 15,000 t net paddy in 1976. The mills' productivity has also improved from an estimated 45-50 percent to an estimated 66 percent in 1975-1976. In addition, some 1,700 to 3,000 private small steel cylinder mills have been installed by private operators--mostly in the forest zones. Although total capacity probably exceeds 500,000 MT, net current utilization may be as low as 10-15 percent. Outturns are slightly lower than those of government mills, but the rice produced is often fresher and sells at a premium of as much as 10 percent above the official price.[3]

Two parallel marketing systems exist in the Ivory Coast: the government sector with industrial-scale mills, and private transporters, merchants and small-scale millers. Before the 1973-1974 price increases, government buying programs failed to compete with home consumption or private merchants and millers who handled virtually all marketed rice over both short and long distances. The domestic

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[3]Ibid., p. 8.

price policy established in 1974-1975, which fully subsidized SODERIZ (a state company) for its collection, milling, and distribution, gave the government control of the paddy market and permitted it to purchase "a quarter of national production, and perhaps half to three-quarters of all paddy sold."[4] In effect, government policy has forced much of the traditional milling sector into dormancy, but private buyers and transporters remain important, as do private rice wholesalers.

Before 1974 the government market channel handled mostly imported rice, which was purchased and distributed by a cartel of import houses working with the government. It is estimated that as much as 50 percent of these imports have been consumed outside Abidjan (the capital city). Any domestic rice which did flow to Abidjan was handled through the traditional private sector.[5] Since 1975 this situation has been reversed, however, with decreasing imports resulting from the price policy. Government mills in the interior have supplied Abidjan with rice and domestic rice has replaced imports. Nevertheless, a market in privately-milled sectors continues to exist, but it operates over shorter distances and serves areas near producing centers.

The resumption of imports in 1977 has had no

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[4] Ibid. [5] Ibid.

effect on the price structure thus far, although the pressure to ship rice should be eased.

To these figures should be added the direct farmers-consumers channel, since large quantities of rice are generally sold directly to consumers by farmers. Also, about 60 percent of the rice produced by farmers is used for their home consumption and, consequently, never enters the marketplace.

CHAPTER III

THEORETICAL FRAMEWORK

The method used to study rice demand-supply relationships in the Ivory Coast involves combining economic theory, statistical technology and knowledge of the market. Several questions or problem areas are important to this process: what variables should be included; what form of the function will allow for a better-"fitted" relationship; and what data are available. The task of obtaining the estimates of the relevant variables and conducting the appropriate statistical tests is also necessary. Ultimately, the variables which will be used depend on the purpose of the study and the cost of gathering information which, in turn, is closely tied to the data available.

In this chapter the theoretical relationships among the numerous variables affecting rice supply and demand in the Ivorian economy will be briefly discussed. Next, the variables to be used in the model will be discussed. Finally, a graphical representation of the rice economy will be presented and followed by a discussion of some of the problems which occur in obtaining adequate data in LDCs.

Supply of Rice

Factors of Rice Supply

Major changes have occurred in the world of rice production due to a variety of factors such as weather, fertilizer, technical change, etc. Furthermore, because of the specific characteristics of the agricultural product in terms of seasonality and the time requirement for growth, dependency on time and weather (and in the Ivorian case on the "necessity nature" of rice) makes the quantity supplied in the short-run more responsive to price than to quantity demanded.

Tomek and Robinson state that six principal factors affect the supply relations. These are:

1. changes in factor price
2. changes in the profitability of substitute commodities
3. changes in technology which influences both yields and costs of production or efficiency
4. changes in the prices of joint products
5. institutional constraints (government acreage programs)
6. changes in production due to weather, diseases and insects.

In the Ivorian case, the above factors can be specified as follows:

1. Area: As noted earlier, most agricultural production in the Ivory Coast comes from small family farms which are generally land extensive and based on shifting cultivation with bush fallows. This practice encounters many constraints where rice production is situated in densely-settled areas. Land is scarce and its availability is very important in rice production. Recent government policies have encouraged investment and expansion. This influence will be expanded upon later in the section "Government Policies."

2. The price of rice: Throughout the literature it is mentioned that even though farmers tend to do things as they have in the past, major changes have occurred. If farmers were questioned as to why they have changed both in the level and manner of production of a given crop or product most would likely respond that such changes have increased their profits. Most farmers are profit maximizers and price is used as a good indicator of profits within a perfectly competitive market: the higher the price, the higher the possibility of increasing profits, ceteris paribus. However, because most agricultural products are characterized by some seasonality in production and marketing patterns, climatic factors, biological growth of the plants (five months for rice), and time requirement for growth, current price alone may not be a good indicator. Producers are likely to base

production plans on both current and recent past prices. In other words, current production is a function of lagged prices.

3. Production costs: The concept of cost is very important in the production process. It enables one to estimate the actual added costs that go along with a proposed operation or to better diagnose past results. Two categories are involved in the production process: fixed costs, and variable costs.

Fixed costs, sometimes called overhead costs, are those costs that do not change when production changes. In fact, they remain the same whether one produces anything or not. Some examples include: depreciation, repair costs for buildings, machinery, interest and taxes.

Examples of variable or operating cost items are: fertilizer, fuel, seed, insecticides, herbicides and hired labor. In the Ivory Coast the retained costs are the expenses of fertilizer, hired labor and cost of land, equipment, irrigation, leveling, etc.

4. Government policies: The effects of government policies on agricultural production patterns are fairly straightforward. Depending on the importance of the crop in the economy as a whole, the government often intervenes as a regulator by several means, such as: input subsidies, farm-price supports, subsidized credit and interest rates.

In the Ivory Coast, through SATMACI and later SODERIZ, the government undertook a vast development program in the rice sector. The major goal was to increase rice production through the following policy: price supports, large loans with a special repayment schedule and expanded extension programs. The production figures showed important effects; i.e., the results of these efforts were successful in physical terms, but at prohibitive costs. In fact, in terms of efficiency and welfare gain, there are many doubts. This issue is discussed in Chapter VI.

5. Technology: Technological changes are embodied in new resource combinations or improved resources that decrease total resource needs (and costs) for producing a given level of output. The result is a shift in the entire production function with a corresponding increase in production efficiency. Among the recent technological changes in Ivorian rice production are improved varieties from Taiwan, increased fertilizer use, and improved machinery and irrigation.

6. Weather conditions, crop diseases and others: Weather influences the production of most agricultural commodities. Until now, however, adequate rainfall has not been an important production inhibitor in the Ivorian rice-producing areas. Yet weather remains a relevant determinant of production patterns. And because the Ivory Coast, since 1960, has removed large areas of forest cover

which have not been improved by sound reforestation or agricultural practices; rapid runoff, soil erosion, silting and flooding in rainy seasons may result, only to be followed by reduced downstream stream flows in dry weather and a subsequent disruption of agriculture.

Disease control influences both quantity and quality of production. Other factors such as storage, transportation conditions and processing procedures may also affect the ultimate quantities supplied.

Supply Equation

1. Selection of variables: Given the great importance of the variables stated above, an attempt could be made to include all of them in the model. In practice, however, this is difficult. Many of the factors cannot be statistically measured because they are not quantifiable; a very high degree of correlation may exist among the explanatory variables; or there is a complete lack of data.

In specifying the supply relation, two basic relationships are developed. Indeed, since the Ivory Coast has been an importer of rice over the entire period analyzed except 1976 (30,000 MT were exported), the supply can be said to equal the sum of domestic production and imports. Hypothetical specifications are made as follows:

(1) QXT = F (PT_1, T, DV)

(2) QIT = F (P, A, CIF)

(3) QST = QXT + QIT

In (1), the total milled rice produced domestically (QXT) is the dependent variable. However, due to the biological nature of agricultural production, there are certain lags in response to any stimulus, such as price, on production. So lagged producer price (PT_1) is used as an independent variable.[1] Other independent variables are the trend factors (T) standing for technological change and dummy variables (DV) equalling zero before 1973 and one thereafter. This dummy variable characterizes the effect of the government rice policy during the last ten years.

In the import-demand equation (2), the total quantity of imported rice (QIT) is the dependent variable. Area cultivation and the CIF price are independent variables. Both variables are likely to influence the importers' decisions.

In (3), the total supply of rice (QST) is the sum of QXT and QIT.

2. Methodology: A major problem in building econometric models is that many alternative specifications are more or less consistent with the theory underlying the model. Since we cannot expect a perfect explanation of the dependent variable by the independent variables

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[1] Consumer price has been used in the domestic production equation because of lack of reliable producer price that is most of the time either arbitrary or by guess.

within a multiple-regression framework, random variables called residuals or errors come into play to account for measurement errors in the dependent variables or imperfection in the specification of the function. It is assumed that the usual assumptions about the error term, the dependent and independent variables are met. They are:

a. linearity: the relationship between Y and X is linear (Y is the dependent variable and X the independent one)

b. nonstochastic X: $E(e_t X_t) = 0$ (e = error term)

c. zero mean: $E(e_t) = 0$

d. constant variance: $E(e_t^2) = \sigma^2$

e. nonautoregression: $E(e_t e_{t-m}) = 0$ where $m \neq 0$

f. normality: the error term is normally distributed.

Demand for Rice

Demand in this study means market demand, which is a generalization of the consumer demand concept. Tomek and Robinson define it as "the alternative quantities of a commodity which all consumers in a particular market are willing and able to buy as price varies and all other factors are held constant."[2] This definition embodies

[2] N. G. Tomek and K. L. Robinson, Agricultural Product Prices (Ithica, N.Y.: Cornell University Press, 1972), p. 11.

a static concept of demand which refers to only movement along a demand curve. This concept, while very useful, may seem somewhat artificial because with the passage of time the ceteris paribus assumption does not hold. Consquently, this study, using multiple regression analytical procedures, will stress the dynamic aspect of demand.

Determinants of Demand

Economists have always emphasized the fundamental difference between a change in quantity demanded and change in demand. Theoretically, there are many factors that may affect the level of demand. This study recognizes the appropriateness of these factors by examining the following ones appropriate for the Ivory Coast:

1. Population: Theoretically, increases in demand for food, both in the aggregate and for the individual products, are closely linked to the rate of population growth. In other words, demand and population size are positively related. The consumption pattern in the Ivory Coast confirms this relationship. In fact, the aggregate rice consumption has increased substantially with population growth, which has recently averaged about 3.5 percent annually. This pattern may remain unchanged as long as the price of close substitutes, if any, and

the consumer preferences are kept constant or fluctuate within a reasonable range.

Rice has two important characteristics in the Ivory Coast: it is the only starchy crop grown domestically; and it is increasingly important in Ivorians' diet. These factors, combined with the rapid increase in prices for yams, cassava, and plantain, have resulted in a government policy which has made rice (along with bread) the cheapest starchy staple in terms of calories per kilo.

2. Prices: In accordance with the theory of consumer behavior, it is hypothesized that quantity of rice demand varies inversely with the price of rice; that is, people would buy more rice at lower prices than they would at higher prices. Whenever this law does not hold, the product is called Giffen good. In the Ivorian case, this inverse relationship holds. Effectively, the doubled level of domestic rice production in 1974 could not offset an increasing trend of imports (due to population growth). Therefore, the solution for meeting high consumption and offsetting insufficient domestic production was to allow consumer prices to rise (an 80-percent increase occurred in 1974-1975). This policy met with expectation, for per-capita consumption has dropped from nearly 50 kg in 1973 to just under 30 kg in 1974-1975.

3. Prices of substitutes: Rice has been in the Ivorian diet since antiquity. At that time, however, only

a few tribes were rice consumers; the majority of the population consumed tubers. But during the colonial time, when the economy was moneterized, the French pushed rice production to feed their workers; rice became the wage-earner's food. Subsequently, rice consumption has continued to increase, with tubers remaining as rice substitutes, depending on price and consumers' preference. This fact is noticeable in government policies intended to keep the rice calories per kg cheaper than the tubers' prices. In accordance with economic theory, the quantity demanded of a good reacts positively to the price of its substitutes. The price fluctuations of the tubers do influence rice consumption and vice-versa to some extent.

4. Consumer income: For most agricultural products, income and demand are positively related. But for a few commodities the reverse is true. They are then called inferior goods. Rice in the Ivory Coast falls in the first category called normal goods. Actually, with the 80 percent increase in rice prices in 1974, the combined substitution and income effects resulted in a general decrease in per-capita consumption.

5. Consumer behavior and consumer preference: Like consumer income, consumer behavior and preference are dominant factors of agricultural product demand. According to Tomek and Robinson, "changes in tastes and preferences obviously contribute to shifts in demand for

agricultural commodities, although their effects are often difficult to isolate because they appear to be associated with changes in income or other variables."[3] As stated in the section "Price of Substitutes," rice was consumed by only a few tribes in the Ivory Coast. According to Samir Amin, its consumption over time has spread because of the monetarization of the economy during colonization. Rice became the wage earner's food throughout the country. That, with the possible decline in per-capita production, rules out the tendency to use long trends in per-capita consumption as an indicator of changes in preferences. In other respects, the per-capita consumption of rice in the Ivory Coast shows no big change since 1965. So the increased aggregate demand is most likely due to the population growth and increasing urbanization.

Demand Equation

1. Selection of variables: The statistical analysis of a demand function embodies a twofold process:

a. The first step should be to establish a theoretical model--that is, to list all factors that are believed to affect the demand of the commodity under study.

b. The second step should be to put the data in a form that can be fitted by statistical techniques

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[3]Tomek and Robinson, p. 18.

TABLE 3

RICE CONSUMPTION ESTIMATES, TOTAL AND PER CAPITA

Procedure			-	-	=	×.63(A)	-	+	=(B)	÷	= (A) ÷ (B)	
Units	1000 ha	1000 t	1000 t	1000 t	1000 t	1000 t	1000 t	1000 t	1000 t	1000		%
Years	Area harvested	Domestic paddy supply	Losses (10% p.a.)	Seed (70 kg/ha)	Available for consumption: paddy	Available for consumption: rice	Rice exports	Rice imports	Total consumption	Total population	Per capita consumption kg/head	Self sufficiency in rice
1960	218	143	14.3	15.3	113.4	71.4		36	107.4	3,735	28.8	66.5
1961	206	160	16.0	14.4	129.6	81.6		51	132.6	3,840	34.5	61.5
1962	260	156	15.6	18.2	122.2	77.0		48	125.0	3,945	31.7	61.6
1963	245	229	22.9	17.1	189.0	119.1		34	153.1	4,050	37.8	77.8
1964	271	219	21.9	19.0	178.1	112.2		63	175.2	4,165	42.1	64.0
1960-64		181.4				92.3		46.4	138.7		35.0	66.6
1965	261	248	24.8	18.3	204.9	129.1		69	198.1	4,302	46.1	65.2
1966	258	250	25.0	18.1	206.9	130.3		83	213.3	4,430	48.1	61.1
1967	301	275	27.5	21.1	226.4	142.6	0.19	24	166.4	4,560	36.4	85.7
1968	300	345	34.5	21.0	289.5	182.4		43	225.4	4,765	47.3	80.9
1969	288	365	36.5	20.2	308.3	194.2		56	250.2	4,940	50.7	77.6
1965-69		296.6				155.7		55.0	210.7		45.7	73.9
1970	289	303	30.3	20.2	252.5	159.1		99	258.1	5,115	50.5	61.6
1971	282	316	31.6	19.7	265.5	167.3	0.08	108	275.2	5,264	52.3	60.8
1972	285	385	28.5	20.0	326.5	205.7	0.07	88	293.6	5,423	54.1	70.1
1970-72		334.7				177.4		98.3	275.6		52.3	64.4
1973	290	320	32.0	20.3	267.7	168.7	0.65	147	315.1	5,609	56.2	53.5
1974	286	335	33.5	20.0	281.5	177.3	4.0	80	253.3	5,801	43.7	70.0
1973-74		331.8				175.6		104.4	279.1		51.4	63.2

SOURCE: WARDA estimates.

to determine if it is consistent with observed behavior. Chapter IV is concerned with fitting the demand model.

The factors which influence a consumer's decision with regard to the level of demand are many--five have been stated for rice in the Ivory Coast. Changes in tastes and preferences due to institutional and psychological factors cannot be statistically isolated. However, for practical purposes, a trend factor is often used as a proxy for tastes and preferences. Despite that, population, income, and relative prices of the commodity and its substitutes appear to be most important determinants of demand.

For this study, the following demand specifications have been hypothesized:

(a) $PCD = F(P, PCY, PB, PY, PCT, PM)$

(b) $D = F(P, YT, POP)$

(c) $D = F(P, YT, POP, B, Y, C, M)$

Where:

D = Total demand in t

P = Consumer price in t

C = Cassava consumption in t

B = Plantain consumption in t

M = Maize consumption in t

Y = Yam consumption in t

YT = Total income

PCD = Per capita demand for rice in t

PCT = Per capita cassava consumption in t

PY = Per capita yam consumption in t

PM = Per capita maize consumption in t

PB = Per capita plantain consumption in t

POP = Population in t

PCY = Per-capita income

2. Methodology: A time series regression model is also used to estimate the demand structure. The normal assumptions concerning the error term are also assumed to be met. Therefore, it is possible to estimate the parameters and their associated variances.

Graphical Analysis

From the preceding sections the price structure for rice in the Ivory Coast can be hypothesized as follows:

a. Total demand: $D = f(P|...)$

b. Import demand: $QIT = f(P|CIF|...)$

c. Domestic supply: $QXT = f(PT_1|...)$

d. Identity: $QST = QXT + QIT$

Using two-dimensional graphs, the economic model can be represented as shown in the figures following. These diagrams are based on economic theory and knowledge of the Ivory Coast rice industry. They give the price-quantity relationship, assuming that all other factors are held constant at a given point in time.

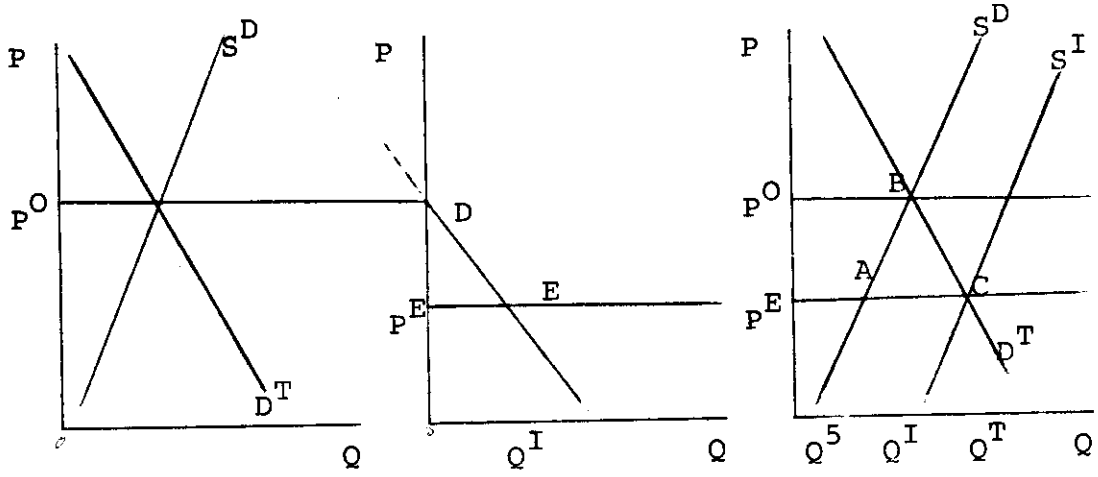

FIGURE 1A

Domestic Supply and Demand

FIGURE 1B

Import Demand

FIGURE 1C

Total

Figure 1A represents a market situation without imports. The equilibrium price would be P^O--much higher than if supply was increased with imports. This situation may represent the case where the government adopts an import-substitution policy. In the LDS this kind of policy means increased domestic production through subsidies and high domestic price supports, which generally lead to higher production costs and hence higher consumer prices.

Figure 1B shows the demand for imported rice. Imports equal zero at "D" which corresponds to P^O in Figure 1A. Its negative slope tells us that the lower the import price, the more government is willing to import.

Summing up Figures 1A and 1B, we get Figure 1C.

Total supply is thus derived from a quantity summation of domestic production and import demand. This results in a rightward shift of the supply curve. At P^E the equilibrium point is reached. Points E and C are these points in Figures 1B and iC, respectively.

Data and Methodological Problems

A number of problems arise in attempting to analyze the supply and demand relationships for a commodity produced in a developing country. Foremost among these are the lack of reliable time series data and the wide range of factors that must be considered when such a project is undertaken. National data are available, but they are often of suspect reliability, as evidenced in the following comparison of two government agencies' figures for total rice imports in the Ivory Coast from 1960 to 1976. (See Table 4.)

The discrepancies in recent years are particularly alarming. Another problem is that only a small percentage of rice produced actually reaches the marketplace. This does not mean that market price has no effect on rice production or demand, but rather, as Krishna points out,[4] that while output response may be positive to an increase

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[4]Ray Krishna, "Agricultural Price Policy and Economic Development," Agricultural Development and Economic Growth, H.M. Southworth and B. F. Johnson, eds. (Ithica, N.Y.: Cornell University Press, 1967), p. 509.

in producer price, quantity supplied response may well be negative. This occurs because of the typically high income elasticity of demand for staple food in low-income countries. An increase in the price of rice leads to an increase in the incomes of farmers (the largest group of consumers). With a high income elasticity of demand the increased farm level consumption, resulting from even a slight increase in income due to higher farm prices, can outweigh the output response induced by those same higher prices. This problem of output response versus market supply becomes even more complicated when we begin to ask what is the true level of farm income for subsistence farmers and what is the relevant consumer price of rice for this major segment of the population. Certainly the former is not a cash-income figure, and the latter is not the average consumer price--which is an urban price. Many scholars suggest that we use the opportunity costs in the calculation of income and consumer price, but this can be a difficult task.

Farm family income is derived from many sources: crop production, cottage industry production, off-farm labor, etc. Some of it is cash income, but much of it is income in kind. There are serious objections to the valuation of retained output and sold output at the same price, and to the valuation of all labor at wage rates which can be earned if and when off-farm work is available.

Presently, there are no right or reliable price-income and income-consumption relationships.

Finally, we are also faced with difficulties in quantifying inputs, primary family labor, and unpurchased land, and with the problem caused by the aggregation of a product originating from three or five distinct production technologies.

With these difficulties in mind, the results of the empirical analysis of rice supply and demand from 1960 to 1976 will be presented.

TABLE 4

GOVERNMENT FIGURES FOR TOTAL RICE IMPORTS

Year	WARDA	Planning Department
1960	30	35
1961	51	33
1962	48	43
1963	34	25
1964	63	58
1965	69	78
1966	83	82
1967	24	24
1968	43	47
1969	56	56
1970	99	79
1971	108	97
1972	88	77
1973	147	145
1974	80	65
1975	1.5	20
1976	-30.04	-30

NOTE: Figures are in 1000 metric tons.

CHAPTER IV

EMPIRICAL RESULTS

Both the demand and the supply equations were estimated using ordinary least squares (OLS). The assumptions for the error term are those for the classical regression model. That is, the equation errors are normally distributed with zero mean and constant variance. When the assumptions are met, the estimated parameters will be optimal in the sense that they are unbiased, efficient, consistent and will have approximately a normal distribution. This latter property makes it possible to use the t-test for approximate statistical inference. It is also assumed that supply and demand equations are independent so that any simultaneity bias will be avoided.

Interpretation of the Estimated Parameters

In this study, interpreting the results means assessing the validity of the estimators in relation to economic and statistical theory. Do the signs and the relative magnitudes of the estimators conform to

theoretical expectation? This question will be addressed in the following sections.

Supply

Selection of coefficients: As stated in Chapter III, a set of equtions has been tried. However, several alternative model specifications were estimated both for domestic production and imports, largely because of the unreliable characteristic of data from developing countries, lack of statistical significance of the estimated parameters, and the degree of conformance of the estimates to theoretical expectations.

On the production side, these attempts included the relationships between domestic production, lagged price, and other variables such as lagged domestic production, trend and binary variables. The results of the more relevant estimated production equations are given in Table 5.

On the imports side, the trials included the relationship between current imports and variables such as K (the P:CIF ratio), M (the difference between P and CIF), the trend (T), lagged imports (QIT_1). The retained equations are stated in Table 6.

Among all estimated relationships, the two selected as "best" were:

TABLE 5

ESTIMATED COEFFICIENTS FOR DOMESTIC PRODUCTION

Dependent Variables	Independent Variables							
	No.	Constant	PT_1	QXT_1	T	DV	R^2	Dw
Domestic Production (QXT)	1	Coef. -521.373 SE 162.250 t 3.21338**	.773803 .350014 2.21079**	-.134046 .251666 -.532635	10.2393 3.00912 3.40274**		.9055	1.5887
	2	Coef. -458.087 SE 97.6839 t -4.68949**	.790296 .435221 1.81585*		8.93832 1.54394 5.78928**	-4.89219 21.6041 -.226447	.9037	1.7781
	3	Coef. -552.533 SE 188.354 t -2.93349**	.887909 .476826 1.86213	-.160592 .270937 -.592726	10.6876 3.35073 3.18956**	-8.51275 23.0374 -.363519	.9067	1.6509
	4	Coef. -481.107 SE 165.164 t -2.91290**	.967495 .338426 2.85881**	-.262357 .224929 -1.16640	9.87668 2.95614 3.34107**		.9045	1.8790

*coefficient is significant at 10% significance level

**coefficient is significant at 5% significance level

TABLE 6

ESTIMATED COEFFICIENTS FOR IMPORT DEMAND

Dependent Variables Import Demand (QIT)	Independent Variables									
	No.	Constant	K	T	DV	P	M	QITΔ	R^2	Dw
	5	Coef. -327.616 SE 148.666 t -2.20370**	-28.8750 13.3322 -2.16580**	6.69789 2.27772 2.94062**	-94.8505 26.0482 -3.64134**				.6070	1.3823
	6	Coef. -298.609 SE 167.935 t -1.77813*		4.39086 2.72880 1.60908*	-156.467 67.8482 -2.30617**	1.32217 1.35411 .976417			.4936	1.2911
	7	Coef. 64.8032 SE 26.8107 t 2.41706**					-1.13516 .518212 -2.1905*	.399770 .259928 1.53800	.4677	1.4496

*coefficient is significant at 10% significance level

**coefficient is significant at 5% significance level

(1) $QXT = \underset{(-4.69)}{-458.087} + \underset{(1.82)}{.790296}\ PT_1 + \underset{(5.79)}{8.93832}\ T$

$$\underset{(-.226)}{- 4.89219}\ DV$$

$$R^2 = .90; \quad DW = 1.78$$

(2) $QIT = \underset{(-2.20)}{-327.616} - \underset{(-2.17)}{28.8750}\ K + \underset{(2.94)}{6.69789}\ T$

$$\underset{(-3.64)}{- 94.8505}\ DV$$

$$R^2 = .61; \quad DW = 1.38$$

The t-ratios are given in parenthesis. The rationale for the selection of these equations will be discussed in the next sections.

Evaluation of supply equation: This can be done from two points of view: economic and statistical.

1. Statistical properties:

(a) The coefficient of determination (R^2): This can be interpreted as the proportion of the variation in the sample Y_t explained by the regression equation.

As seen in Table 5, the production equations provide an extraordinary good fit to the domestic production. That is, the independent variables in the four equations give a strong explanation for the variation in the dependent variables QXT. The R^2s are all at least equal to 90 percent.

In the imports equations, the R^2s are a bit lower, but acceptable. The highest is .61 and the lowest is .46. At first glance, one can conclude that the independent

variables do not explain the variation in the dependent variable according to the statistical characteristics. However, they are acceptable for practical purposes since the government is the main importer of rice. In setting the level of imports, the government's main objective is to feed a growing population rather than to observe the market mechanism. By doing that, concern is focused more on political stability than economic situations. This kind of governmental behavior was most pronounced during the first 13 years of independence (i.e., from 1960 to 1973), during which time the government almost never reacted to world price changes. So it is not surprising to get low R^2s. These low levels may be due, of course, to other statistical problems such as mis-specification, but a close look at the equations may reveal that almost all the explanatory variables perform quite satisfactorily.

(b) Significance of coefficients: It is commonly said that if the "t" value exceeds two in absolute value, we reject the null hypothesis that $\beta^1 = 0$ against the two-tailed alternative at a 5 percent level of signif-icance. Consequently, from the equations in Tables 5 and 6, all the coefficients are significant at 5 percent except QXT 1 in equations 1 and 4; PT_1 and DV in equation 2; PT_1, QXT_1 and DV in equation 3; T and P in equation 6; and QIT_1 in equation 7.

(c) Durbin-Watson test: In time-series data, if successive residuals tend to be highly correlated, this correlation is called serial correlation or auto-correlation. Thus, autocorrelation refers to the inter-dependence among residuals. The test most commonly used to indicate the presence of serially correlated residuals is the Durbin-Watson statistic. From the DW table at 5 percent, serial correlation is zero for equation 2 and inconclusive for equations 5 and 6. DW cannot be used to test for serial correlation in equations 1, 3, 4 and 7 because of the use of the lagged endogenous variable (QXT_1 and QIT_1) as regressors.

2. Economic theories

In constructing an econometric model, the researcher typically, though not always, has an idea about the expected signs of the estimated coefficients. This requires both economic and statistical knowledge. We have already done the statistical evaluation. To do the economic evaluation, it is necessary to relate the signs and magnitudes of the independent variables to the dependent variable.

(a) In the domestic supply equations all the variables meet the theoretical expectation except the lagged dependent variable (QXT_1). There is a positive relation between rice production and rice price of previous years--meaning that if the price goes up,

farmers will grow more. There is also a positive relationship between rice production and the trend--which means that tomorrow will look like yesterday and today. These two relationships are verified in the Ivory Coast. Since 1960, rice production has been growing tremendously, essentially because of increasing inputs of labor, land and technology. Furthermore, the miracle of the years 1974-1976 comes from the price-increase policy of 1973-1974.

Contrary to the results, there should be a positive relationship between QXT and QXT_1. This may be due to a high correlation between QXT_1 and T because its deletion always increases the significance of T.

(b) In the imports equation the results indicate a negative relationship between K (the price ratio), M (price differential) and quantities imported. This is understandable, for despite the doubling in production since 1974, the imports continued to increase because of an underestimated population growth and a low real price of rice. To solve this problem, the policy implementation allowed consumer prices to rise. An 80-percent increase was adopted in 1973-1974. The response was a per-capita reduction in consumption from 50 kg in 1973 to under 30 kg in 1974 and 1975. Imports dropped to zero in 1975 and 1976.

Moreover, these negative signs of K and M

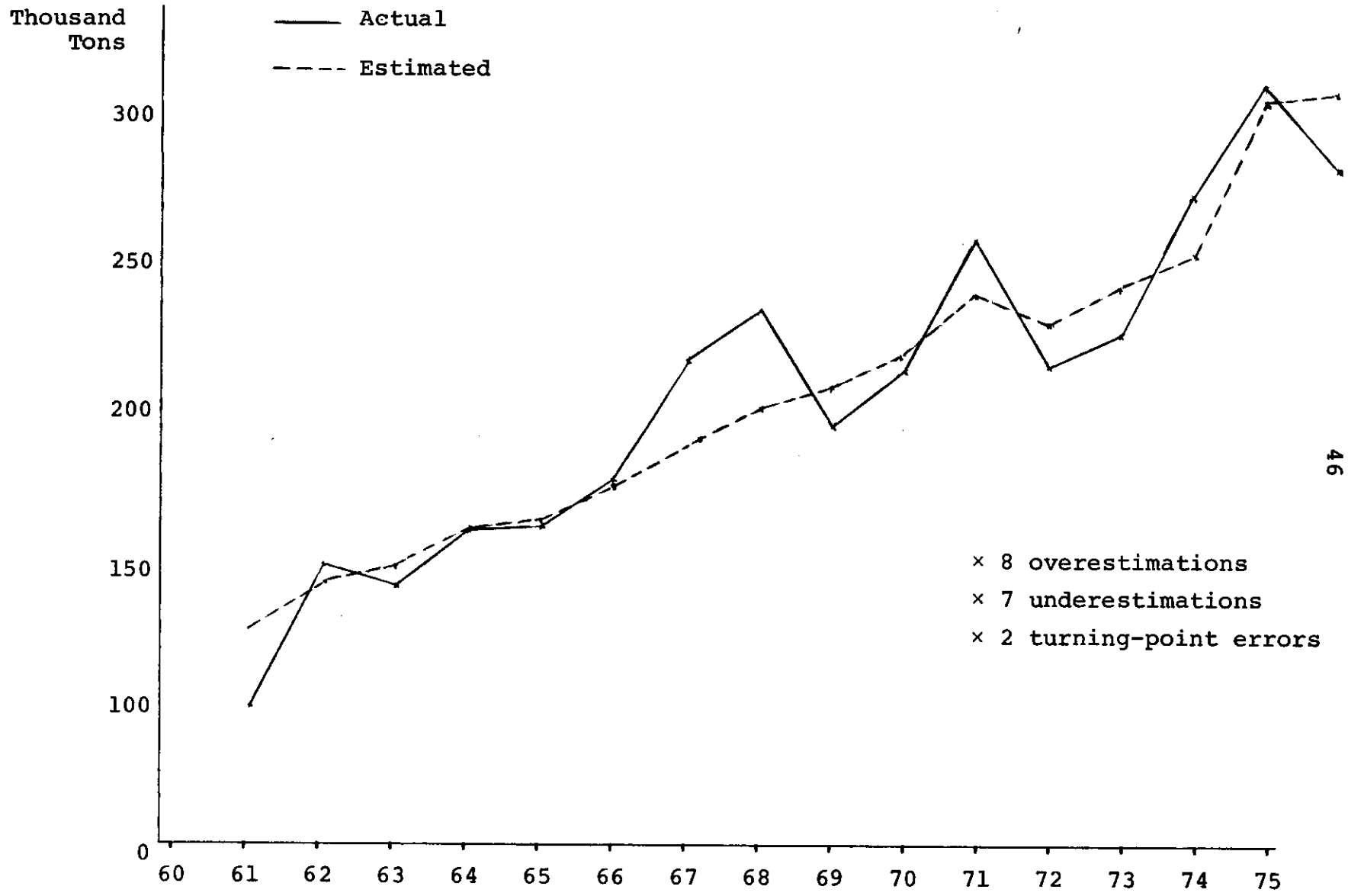

Figure 2. Domestic Production of Rice: Actual and Estimated

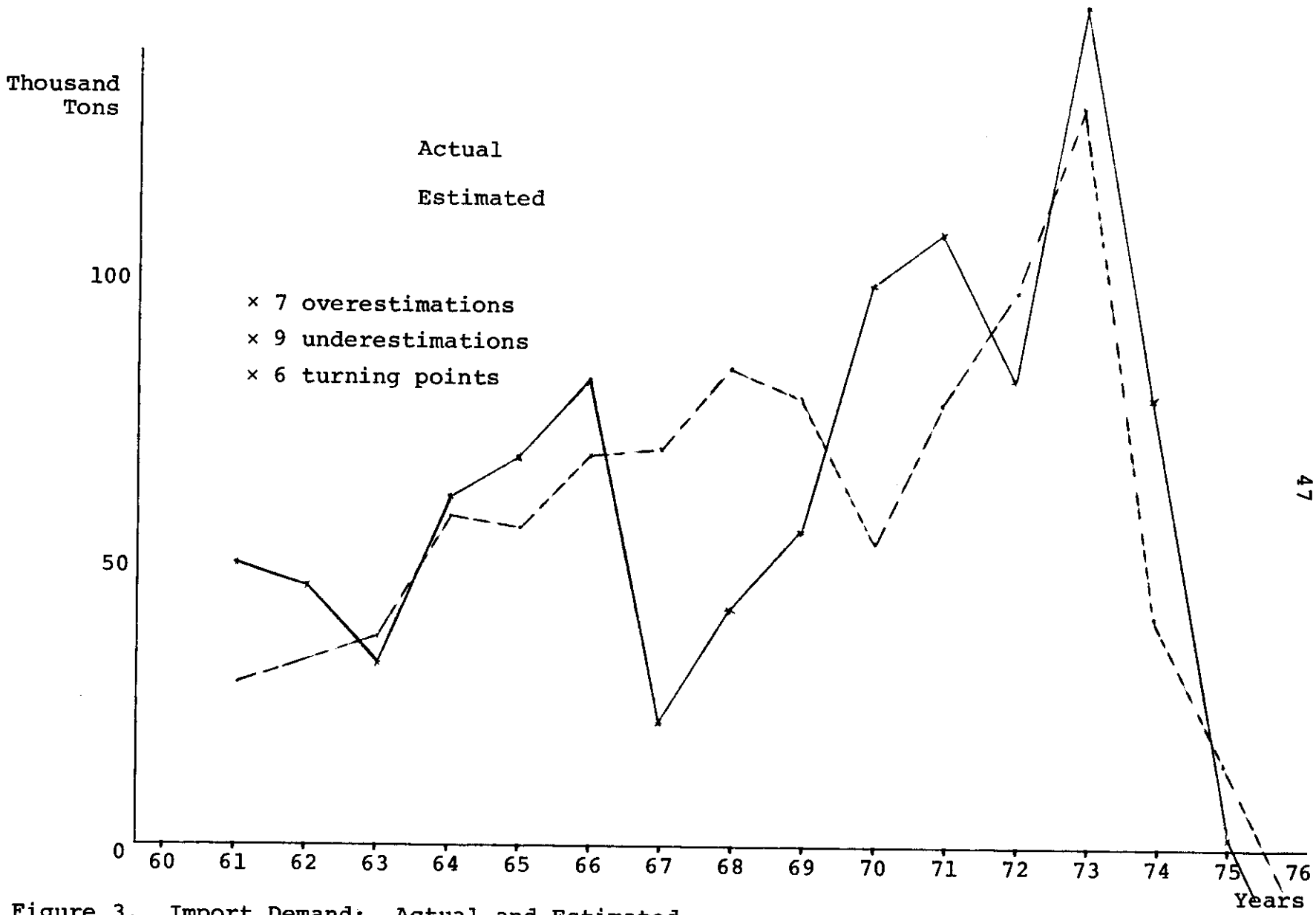

Figure 3. Import Demand: Actual and Estimated

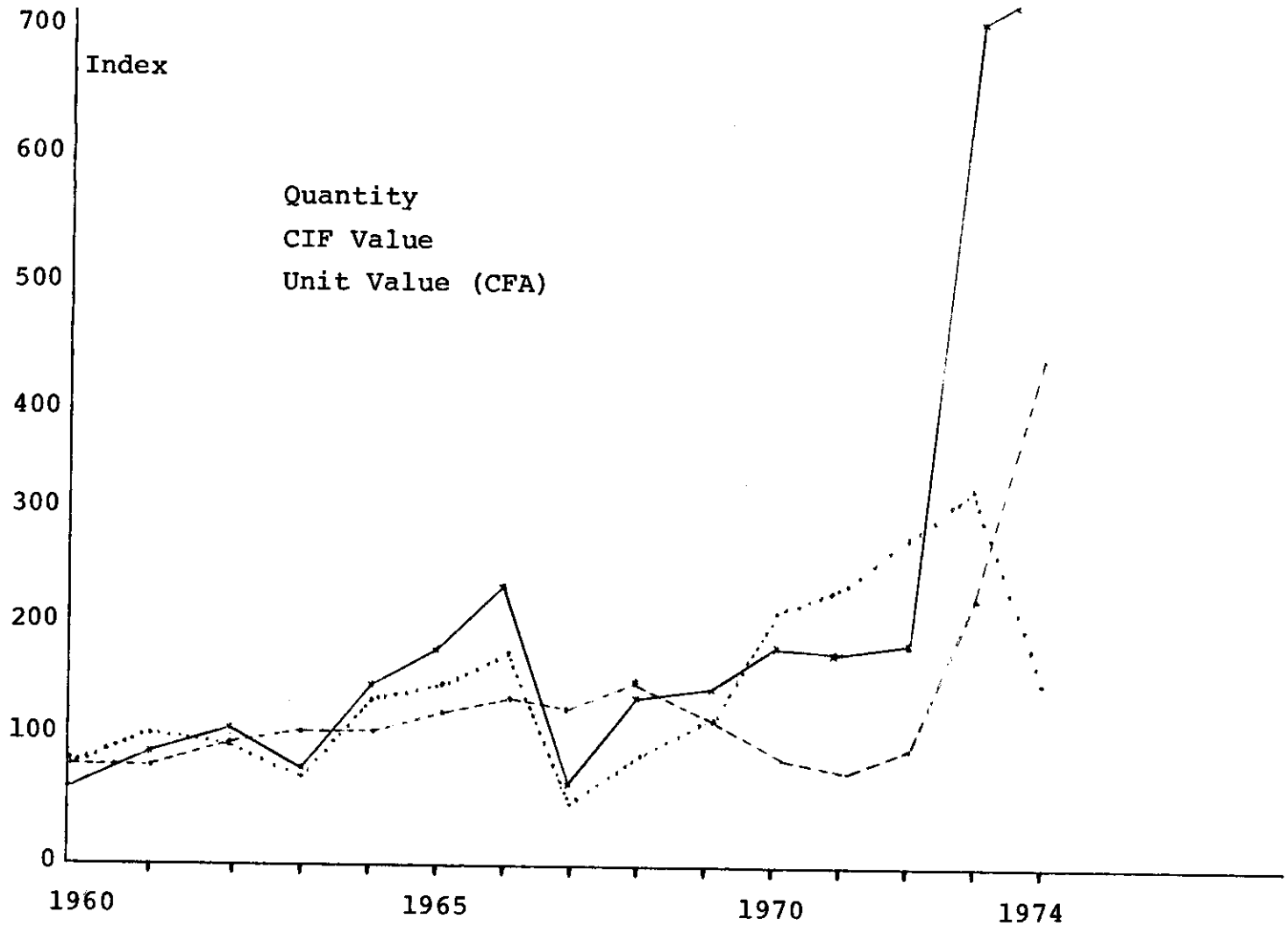

Figure 4. Index of Rice Imports (Base 1960/1964 = 100)

point out the positive relationship between imports and the CIF price. That is, when CIF goes up, K or M goes down, and the quantity imported increases. Although this relationship met the theoretical expectation, the government (as main importer) should have reacted negatively to an increase in imports as a function of CIF price--it did after 13 years of independence. Realistically, the government cannot decide to stop importing rice if domestic production falls short of demand. So to maintain its political power, the government has to either import or increase production.

From the above evaluation, both statistical and economic equations 2 and 5 seem to perform adequately, although PT_1 is not significant.

Demand

Selection of coefficients: The estimation of the demand relationship presented more problems in modeling than supply. One reason is because price data are highly indicative of a shifting demand relationship and generate a positively sloped line when plotted against quantity demanded. This is understandable, however, in light of the discussion above concerning the difference between output and market supply responses made by subsistence farmers. An additional

explanation would be the important role of rice in the Ivorian's diet. Given this fact and the growing world price, the government adopted a paddy price support policy in 1973-1974. Therefore, more farmers were attracted, but on whom did the burden of the subsidy shift? It fell, of course, on the consumer who does not have readily available substitutes for rice. Therefore, as producer price increases, consumer price is likely to do so until some reasonable level is obtained with no decreasing effect on demand. Rice is now very important in the Ivorian's diet. As noted earlier, rice consumption has increased over time and is still increasing. This trend, combined with the government import substitution policy, exhibits the necessary characteristic of rice on the Ivory Coast. Thus, a small change in rice price may not have any effect on the aggregate demand. That is, the demand is fairly inelastic and to make the curve steeper may require big price increases relative to other foodstuffs, so as to discourage rice consumption. This policy was adopted in 1975; during this period the government was obliged to adopt an 80 percent annual increase of rice price to meet the demand. Because of these difficulties with the three hypothesized equations, many other trials were conducted, both in log-log and linear forms. During these processes multicollinearity always presented a problem. High correlation

is found between price and income, price and the different substitutes, and income and the substitutes. But some satisfactory equations were obtained, although all of them did not meet our theoretical expectations. These equations are stated in Tables 7 and 8.

For practical purposes, the following stated equations are chosen as "best" among all the specifications estimated:

(1) $$PCD = \underset{(2.84)}{59.0041} - \underset{(-.64)}{.178359}\ P + \underset{(2.63)}{.0689461}\ PCY - \underset{(-1.40)}{169.784}\ PCT + \underset{(.70)}{20.9416}\ DV$$

$$R^2 = .50; \quad DW = 1.45$$

(2) $$\text{Log } PCD = \underset{(1.53)}{2.01558} - \underset{(-.87)}{.308956}\ \text{Log } P + \underset{(3.09)}{.356477}\ \text{Log } PCY - \underset{(-1.80)}{.456462}\ \text{Log } PCT + \underset{(.81)}{.299898}\ \text{Log } DV$$

The figures in parentheses are t-ratios. These two equations are very competitive. The second has higher R^2 and DW statistics, but the first has more significant corefficients. To be consistent with the supply function form, the first equation will be used as the relevant demand. An attempt to improve its R^2 has been undertaken by correcting it for first order serial correlation. This did not give the expected satisfaction because while R^2 did not increase, variables such as price, per-capita

TABLE 7

ESTIMATED COEFFICIENTS FOR DEMAND

Dependent Variables	No.		Constant	P	PCY	T	DV	PCT	R^2	Dw
			Independent Variables							
PCD	1	Coef.	-120.298	-.243222	-.0405056	2.82816	5.01963		.6588	2.1549
		SE	58.7457	.231647	.0361289	1.02952	14.2300			
		t	-2.04778**	-1.04997	-1.12114	2.74706**	.352751			
	2	Coef.	-112.773	-.177610	-.0341979	2.63630			.6546	2.1061
		SE	52.5117	.132466	.0301183	.838606				
		t	-2.14757**	-1.34081	-1.13546	3.14367**				
	3	Coef.	-112.537	-.245293	-.0373436	2.72740	7.95679	-17.0505	.6595	2.1058
		SE	85.3006	.244443	.0449446	1.32544	26.8057	129.024		
		t	-1.31930	-1.00348	-.830880	2.05773**	.296832	-.132150		
Log PCD	4	Coef.	59.0041	-.178359	.0489461		20.9416	-169.784	.4993	1.4500
		SE	20.7898	.278707	.0186039		29.9707	121.410		
		t	2.83813**	-.639951	2.63096**		.698736	-1.39843		
	5	Coef.	2.01558	-.308956	.356477		.299898	-.456462	.6184	1.5437
		SE	1.31454	.353492	.115260		.371054	.254961		
		t	1.53329	-.874011	3.90282*		.808234	-1.79032*		

*significant at 10% significance level

**significant at 5% significance level

TABLE 8

ESTIMATED COEFFICIENTS FOR DEMAND EQUATION

Dependent Variables		Independent Variables								
		No.	Constant	PCY	PCD	PCT	DV	PT_1	R^2	DW
Price		6	Coef. 67.5596	.0374187	-.220581	-110.063	61.7197			
			SE 22.5536	.0241724	.344683	143.469	28.0033		.9170	2.0048
			t 2.99552*	1.54799	-.639951	-.767152	2.20401**			
		7	Coef. 33.0605	.0458136	.100592	248.462		-.328137		
			SE 18.4356	.0300490	.468901	81.1965		.224487	.8936	1.9385
			t 1.70102*	1.52463	.216838	3.06009**		-1.46172		
		8	Coef. 52.7473	.0343475	-.121285		42.0026			
			SE 11.4357	.0233885	.313426		10.9081		.9122	2.0252
			t 4.61252**	1.46856	-.386966		3.85058**			
		9	Coef. 46.7989	.0856767	-.798202			.425092		
			SE 15.8811	.188697	.296348			.231270	.8181	1.8905
			t 2.94683**	4.54042**	-2.69347**			1.83807*		

*coefficients significant at 10% significance level
**coefficients significant at 5% significance level

income and per capita cassava demand lost significance.

Evaluation of demand equations: This section also is devoted to an estimation demand equation. This evaluation can be done both statistically and economically.

1. Statistical properties:

(a) Coefficient of determination (R^2): The R^2s vary from .81 to .92 for the equation specified as price dependent. They are, on the contrary, lower for the equations with PCD as dependent variable. At first glance we would expect one of the price equations to be chosen. However, the estimated price elasticities (-1.8; 2.33, 3.0, etc.) of demand were considered too high with price as the dependent variable. Therefore, only the equations with PCD as dependent variable are presented (see Table 7).

(b) Significance of the coefficients: Some evidence of multicollinearity among the exogenous variables was detected. When all the relevant variables were used, as in equations 3, 6 and 7, the individual t-test on the coefficients for P, PCY, DY and PCD indicated that the null hypothesis (that each coefficient is equal to zero) could not be rejected, although the value of the R^2 indicated a very good fit most of the time. Furthermore, the coefficients were very sensitive to slight modifications of the model.

(c) Durbin-Watson test: The d statistics in each equation indicate the absence of serial correlation, except in equations 4 and 5 where one can neither accept nor reject the hypothesis of serial correlation.

2. Economic theories:

This section discusses the evaluation of the demand equation with respect to the economic relationship among variables. From the equations in Table 7 it is shown that:

(a) For PCY: There is sometimes a negative relationship between the quantity demanded and per capita disposable income. In equation 4, a positive relationship between the two variables is observed. This characteristic of equation 4 meets with the theoretical expectations. However, the negative sign of PCY in the Ivory Coast does have an interesting meaning. It does not tell us that rice is an inferior good; it means, rather, that as the rural families are the largest production-consumption unit, a negative income elasticity might be expected. This means that as the general level of income rises, the autoconsumption could be so high as to decrease the market supply. In other words, the high degree of interaction between consumer price and income and production-consumption effect can result in a negative income elasticity.

(b) For PCT: The coefficient of per capita

cassava consumption displays a negative relationship with the quantity demanded. This means that when the quantity demanded of rice decreases because of an increase of its price, the quantity demanded for cassava will go up. This cross-relationship is called substitution effect. It is positive for substitute commodities such as rice and cassava and negative for complementary products in terms of price-quantity basis. In the several trials other potential substitutes were tried: yams, maize and banana plantain. The results when using these potential substitutes were inferior to those obtained with cassava.

(c) For P and T: Price and trend did not present statistical problems. They had the right signs; that is, price displayed its normal negative sign while the trend carried a positive sign.

From the above evaluations, the author feels comfortable only with equation 4, although the R^2 is somewhat low and most of the variables are insignificant at the 5 percent level of significance. Its power resides in the facts that it gives reliable estimates of elasticities (see Section III), and it is always expected to have a positive income elasticity because even though the farmers are the largest consumption unit, the government does intervene to meet the other consumers' needs. Therefore, this negative effect from the rural areas is not perceived at the macro-level.

(d) DV: The dummy variable seems to correlate well to the trend variable. The persistent insignificance may mean that T is capturing much of the unquantifiable variables it stands for.

Elasticities

The concept of elasticity is very important. It is a way of indicating the responsiveness of economic participants to prices or income changes. It is furthermore one of the most significant concepts in applied economics because it is always present and influences the behavior, the decision, and the coices of all individuals, businesses and the society as a whole. Consequently, the elasticities are frequently computed from the coefficients of regression equations. In this study, lagged price elasticity is calculated for both the domestic and total supply models. The price and income elasticities are calculated for the demand model.

Assuming that we have estimated $Q = \beta_0 + \beta_1 X_i$, holding other factors constant, the elasticity is defined as $\frac{\partial Q}{\partial X_i}\left(\frac{\bar{X}_i}{\bar{Q}}\right) = \beta_i \left(\frac{\bar{X}_i}{\bar{Q}}\right)$ where Q is the endogenous variable; X_i the appropriate exogenous variable; β_i the net slope relating X_i and Q; $\bar{X}_i$ and $\bar{Q}$ mean values of exogenous and endogenous variables, respectively. In Table 9 the elasticities are given which are evaluated at their sample

TABLE 9

ELASTICITY ESTIMATES

Elasticity	Values
Lagged-price elasticity of domestic supply	.25
Price elasticity of demand	-.26
Income elasticity of demand	+.35

means.

All the elasticities estimated conform with the expectations except the income elasticity, which was expected to be higher. This may be due to the nature of income data, which did not take into account much income from rural areas. Furthermore, the urban population seems to benefit most from an income-distribution standpoint. An economic survey of the World Bank shows that only 20 to 30 percent of the gross income goes to the rural areas, which contain 75 percent of the total population.

The estimated price elasticity of demand indicates that a one-percent increase in the price per ton of rice will decrease rice consumption by about .26 percent. From both low income and price elasticities of demand one would expect, based on homogeneity conditions, that the two elasticities would be close to each other; that is, no close substitute for rice. Actually, even though cassava displayed the right sign as a substitute, it

does not represent in reality the true substitute of rice. The low estimates may be due, however, to the effect of aggregation.

The supply elasticities are also somewhat lower than expected. Even though in the short run a low total supply elasticity is expected, in the Ivorian case the estimate is considered too low with respect to both the miraculous response of farmers to the rice policy of 1973-1974 and the decreasing effect on per-capita consumption of the price increase in 1974-1975. However, two things can explain the low level of total supply elasticity:

1. The effect of the first 13 years (1960-1973) characterized by the insignificant effect of the consumer price changes indicator of high farmgate price to farmers. During that period all the price changes were beneficial, either to consumers, or to the government in meeting import costs. Before 1974, producer price averaged 28 CFA/kg, and after 1974, 65 CFA/kg. To support this point of view an estimate was calculated using the mean value for the last five years. An improvement is seen; the short-run elasticity of domestic supply increases from .25 to .27.

2. The unstained government policy after 1974. In that period the government established two prices (a farmgate price of 65 CFA/kg and a mill price of 70

CFA/kg) to face subsidy costs. This resulted in a large supply of uncommercialized rice in 1975 and 1976. Thus the farmers were only worrying about their own consumption and repayment of loans--without any flattening effect on the supply curve.

The long-run supply elasticity could not be calculated because the lagged dependent variable displayed a wrong sign every time it was used. This would result in a very low long-run supply elasticity ($E_{LR} = \frac{\text{Coefficient on price}}{1 - \text{Coefficient on lagged dependent variable}}$) which opposes our theoretical expectation which says that in LR all the factors of production are likely to be variables bringing the concept of opportunity cost. This allows farmers to shift from the production of one commodity to another. If it is not profitable to do so, the supply curve may remain steeper. However, in the Ivory Coast, the steepness of the SR and LR supply curves is not due to the lack of alternative activities; instead, farmers are forced to produce rice if they want to be covered by the rice policy. Moreover, they don't feel the burden of the production costs.

Comparison of the elasticity estimates in this study with those in other studies is almost impossible because none are available from the Ivory Coast. It is equally difficult to compare this study's estimates

to others in countries similar to the Ivory Coast because of differences in methods and data. While estimates in this study are derived from time-series analysis, most estimates in other studies are derived from cross-section data. Cross-section material cannot usually be regarded as typical of the whole population because it most often includes only wage and salary earners, who in the Ivory Coast constitute only a small percentage of the total population. Also, cross-section analysis yields an estimate of relationships between income and consumption for a short period in which many factors affecting consumption are constant, while time-series analysis, on the other hand, estimates elasticities on the basis of a relatively long period during which some of the constant factors may change. These changes may have important implications for the estimated elasticities.

Comparison is also rendered difficult because the definitions of the variables in cross-section data may differ from the definition in time-series data. In cross-section analysis consumption is usually measured as expenditures, whereas for time-series analysis, consumption is most often measured in physical units of the product.

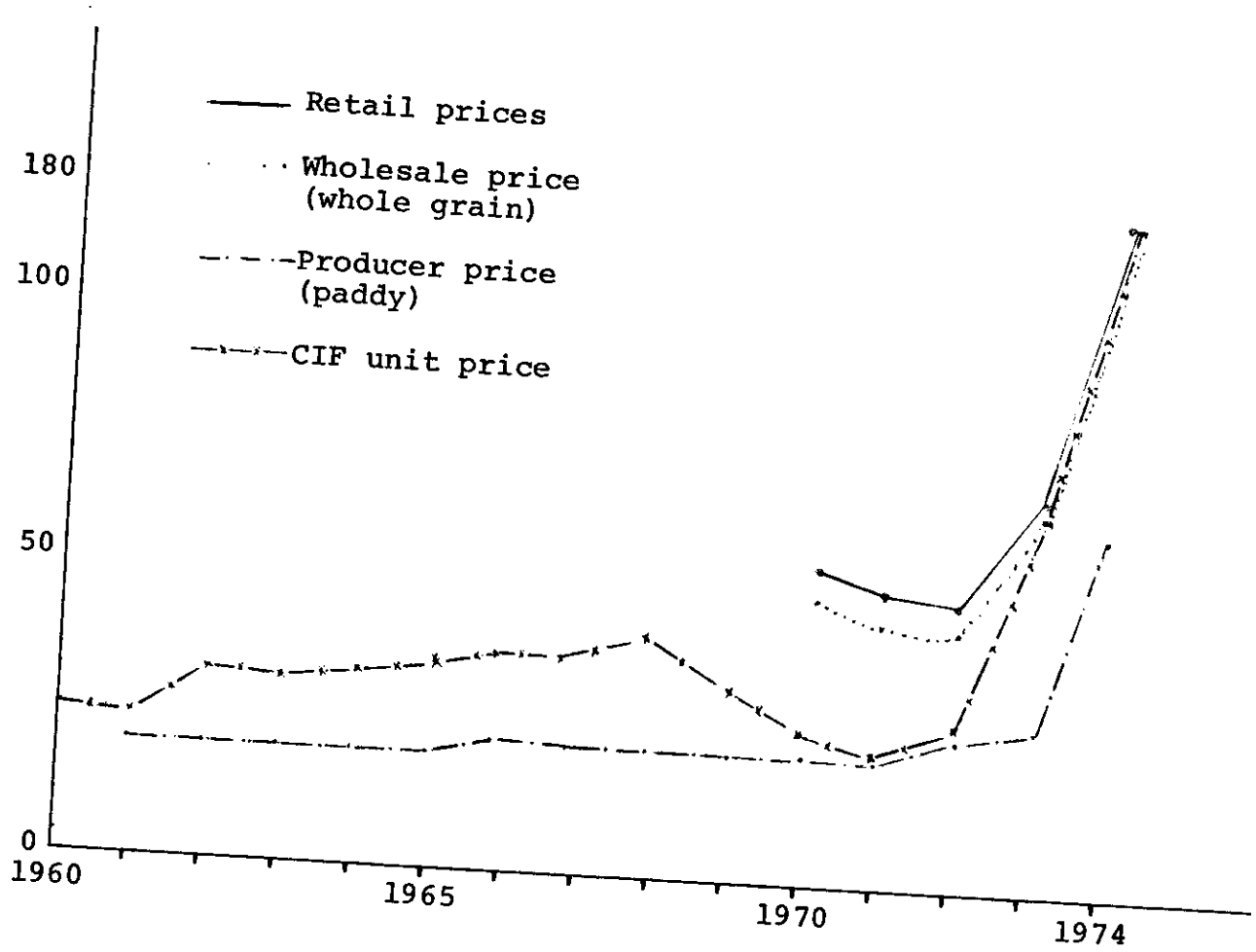

Fig. 5. Evolution of Prices (CFA Fr./kg)

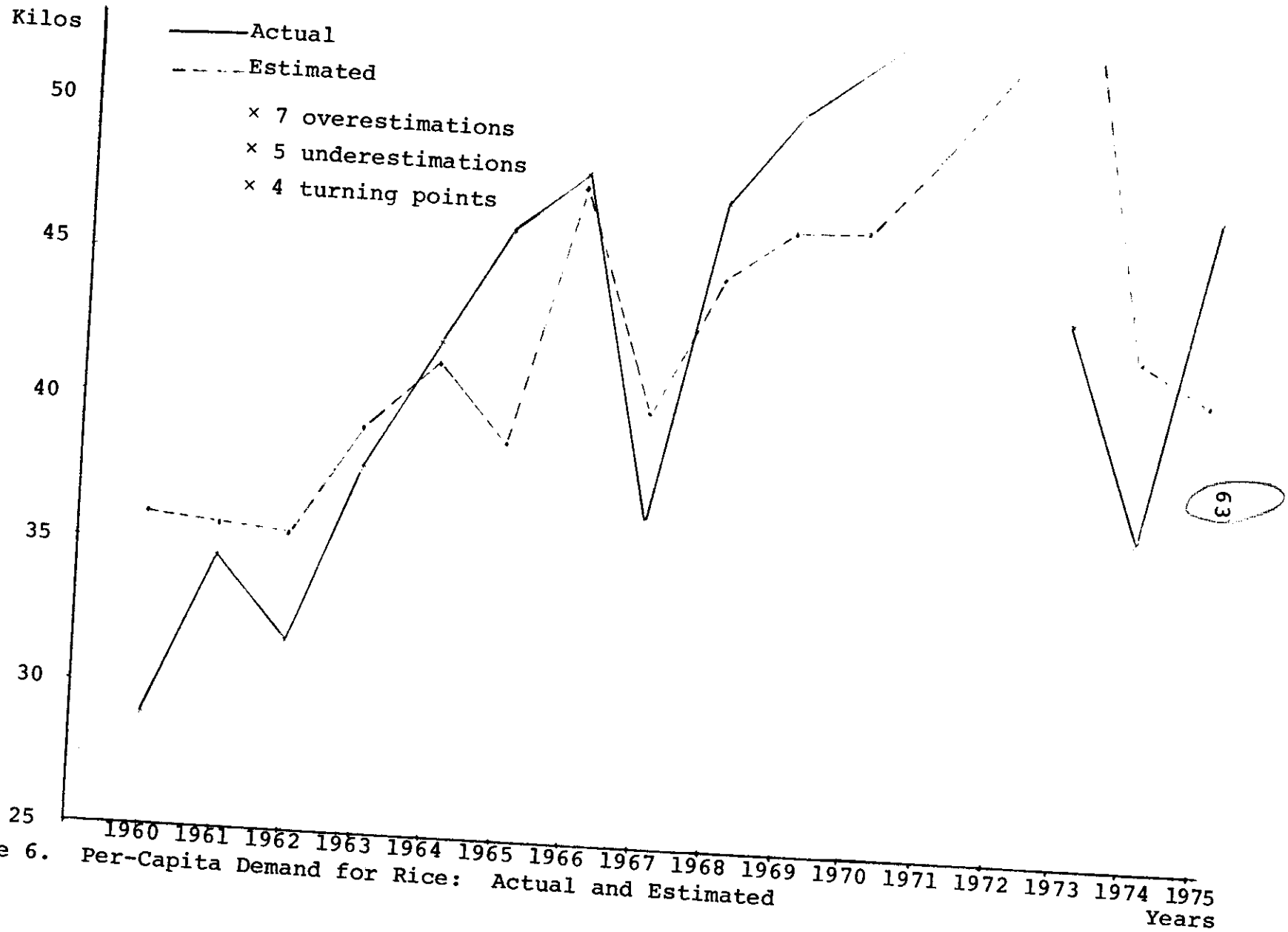

Figure 6. Per-Capita Demand for Rice: Actual and Estimated

CHAPTER V

PROJECTIONS OF DEMAND AND SUPPLY

The purpose of projecting the domestic demand and supply of rice in this study is to obtain quantitative estimates of the likely net trade position (import gap or export availability) for the Ivory Coast. Such estimates define the scope for interregional trade in rice and identify whether the country is close or far from self-sufficiency.

The estimated equations of demand and supply will form the basic framework for making the projections. Future prices could be established through the demand and supply equations; however, because the simultaneous equations system cannot be established satisfactorily, a value-judgment method will be used to determine the future prices. Any set of projections is only as good as the information, assumptions and techniques on which it is based. Therefore, because of the paucity and low quality of data used in this study, any attempt to use the results for either policy analysis or policy formulation must be approached with caution.

Additionally, studies dealing with long-term projections are necessarily subject to the limitations

inherent in supply-demand analysis. Often, and even in this study, it is assumed that the government retains the present agricultural programs, unless this is specifically modeled; that there are no other exogenous variables such as weather, insect disease or the attractive profitability of other industries to influence rice production; and that consumers do not change their consumption behavior. But these assumptions may not hold true over the projected period.

Projection of Supply

Rice production forecasts for the Ivory Coast have usually been based on the known capacity for expanding the principal techniques of production in the country. So the projections are made in light of recent performance and with the knowledge of planned rice development. Consequently it is assumed that the future will look more like the recent past than like earlier years. While this method appears to be a naïve quantitative technique devoid of a theoretical base it may be quite adequate in the Ivorian case since the data available show only relative magnitudes, rather than the true values of variables.

However, as Klein[1] cautions: "The use of econometric

[1]Klein, 1976, p. 4279.

results should be as quantitative as possible, but attempts at pure push button mechanistic uses are sure to fail and prove inferior to methods that combine formal estimated model with a prior information (qualitative as well as quantitative) and judgment. Economic prediction has been rendered less of an art and more of a science by the use of econometric methods but it has not been reduced to a pure scientific exercise." With these warnings in mind, this study attempts to incorporate information based on the author's insight and judgment into the forecast generation. To do so each of the regressors will be forecast separately and then used in the estimated equation to make domestic production for the years 1980, 1985 and 1990.

Retail Price

Theoretically the retail price would seem to be the most relevant variable of the domestic supply, although it was statistically insignificant. Furthermore, in almost all the LDCs the most important policy issue concerns food prices. Farmers prefer high prices for their products, while consumers want low food prices. In the face of this dilemma, most LDCs developed the interest to legislate fair margins and stable prices so as to weaken private traders who were seen as enemies of society by earning excessive profits. Most of the time national companies

are vested to deal with the problems. The Ivory Coast is no exception, since price is not determined solely by the interaction of the market forces of supply and demand. Government intervention, sometimes argued to be appropriate to control private firms' monopoly profits, makes it difficult to predict future price. Table 10 records the retail prices for the period under analysis.

During the first decade (1960 to 1970) of the independent Ivory Coast's economic development, the rice retail price increased from 45 to 76 CFA/kg or about 64 percent. But steady increases were not observed. In 1969, rice dropped about 6 percent from the previous year (54 to 51). Another drop was seen in 1965, -16 percent with respect to the 1963 price. Other drops occurred in 1968, 1971, 1975 and 1976. The sharpest increase occurred in 1974 due to the quadrupling world prices. The 1974 price increased some 86 percent with respect to 1973 and 158 percent with respect to 1960. From 1974 to 1976, the price started to decrease regularly.

These price figures actually show the "tatonnement" policy of the Ivorian government, for which a consistent rice policy was not seen as crucial until 1974. Therefore it might be appropriate either to start our search of future rice prices from 1974 or to use the average annual increase from 1960 to 1976 (about 7 percent). Additionally, the study will take into account information obtained through

TABLE 10

RETAIL PRICES FROM 1960 TO 1976

Year	Price CFA/kg	% Change
1960	45	
1961	54	20.00
1962	51	- 5.56
1963	54	5.88
1964	46	-14.81
1965	51	10.87
1966	56	9.80
1967	61	8.92
1968	58	- 4.92
1969	61	5.17
1970	74	21.31
1971	50	-32.43
1972	55	10.00
1973	63	14.55
1974	116	84.13
1975	108	- 6.90
1976	100	- 7.41

informal interviews with some Ivorians. It seems that from 1976 to 1977 the price of rice decreased by about 10 percent. Consequently, for the purposes of this study it is assumed that the retail price of rice will remain at its 1977 level (i.e., 90 FCFA/kg) through 1980. Afterwards a 5-percent increase is assumed through 1985. From 1985 to 1990 a 2-percent increase is assumed. These annual rates of increase are conservative when one considers that money prices are used in the analysis and that the inflation rate in the Ivory Coast has been quite high (11 percent in 1976).[2] But it is assumed that, given the increasing importance of rice in the Ivorian diet, the government will maintain its price-support policy and shift the burden of inflation on other sectors so as to keep the retail price of rice reasonable for both consumers and producers. Thus, using the above assumptions and increasing annually prices by 5 and 2 percent from 1980 to 1985 and from 1985 to 1990, respectively, the retail price is estimated in the Ivory Coast at 90 FCFA/kg in 1979, 106.4 FCFA/kg in 1984, and 124.3 FCFA/kg in 1989.

Trend and DV

The trend values to be used would be the last two numbers of the concerned years. As for the dummy variable, it is equal to one after 1974.

[2]World Bank, World Bank Report (Oxford: Oxford University Press, 1978), p. 76.

The domestic production is projected on a year-by-year basis. Given the assumptions on future prices, trend, and the dummy variable, current price can be used to derive the following year's production.

By replacing the variables by their values in the domestic supply equation estimated in Chapter IV, the domestic production projections can be calculated. By desire of comparison, a trend projection is also done by a hypothetical model of the form: QXT = F(T) where T is the trend starting from 60 and increasing as time goes on. The estimated equation is:

$$QXT = \underset{(-6.98)}{-553.206} + \underset{(9.56)}{11.0368}\ T$$

$$R^2 = .87$$

The t-values are in parentheses.

As can be seen in Table 11, the trend projections show consistently higher production estimates than those from the estimated domestic supply equation (Chapter IV) during the period 1980-84. In 1985 the projection based on the estimated domestic production equation is higher. From 1987 to 1990, the projections from the domestic supply equation take the higher position, while in 1986 the trend projection is higher. Compared to other projections done by WARDA and the Planning Ministry of the Ivory Coast, the above estimates are in the middle. WARDA and the Planning Ministry have projected domestic

TABLE 11

DOMESTIC PRODUCTION PROJECTIONS

(000 MT)

Year	Trend	Linear
1980	329.74	323.35
1981	340.77	335.84
1982	351.81	348.50
1983	362.84	361.40
1984	373.89	377.45
1985	384.92	387.74
1986	394.95	394.50
1987	406.96	409.24
1988	418.03	420.08
1989	429.07	430.91
1990	440.11	441.83

NOTE: These estimates are in milled equivalent and assumed 65 percent milling rate.

production at 293,000 and 417,000 metric tons, respectively, for 1980; 394,000 and 618,000 metric tons, respectively, for 1990 (WARDA) and 1985 (Planning Ministry).

Projections of Demand

Projection of demand requirements is often made by a simple linear extrapolation of the past requirements. This type of projection method is crude and has many major limitations. One limitation is that it relies heavily on the continuation of past trends and rates of change. Another is that the dynamics of technical and behavioral relationships are either concealed or ignored. Those concerns are relevant in the Ivorian case in two respects. First, because of the imponderables related to weather, disease, pest, new technology, politics, etc., what would be the normal period to serve as a base for the projections using past trends? That is a hard question which cannot be answered quickly. And in LDCs there is no answer, because political situations can quickly change; negative weather conditions, such as droughts, occur, etc. Second, the Ivory Coast has reached a development stage where income classes are very distinct in terms of food consumption. Even though rice is very important in the daily diet, rice-consumption levels for the high-income class have peaked; any further income growth will create a trend

towards higher-protein diets. To the extent that demand patterns can be expected to change in the next decade or so, biases will arise if rice is considered in isolation. Basically, extrapolation of past trends may be an unacceptable representation of the real world. But for comparison, a trend projection is done.

Two more acceptable procedures exist. The first method (method 1) would be to project population and per-capita consumption separately. Population could be projected using a demographic model plus assumptions about birth rates. By careful projection of incomes, a well-conceived projection of demand requirements could be generated through 1990. For the purpose of this study, retail price and per capita cassava consumption have to be projected too.

Retail Price

The study will use the same assumptions as in domestic supply projection to generate the rice future prices. They will be 90 CFA/kg in 1980; 116.9 CFA/kg in 1985 and 126.8 CFA/kg in 1990.

Population

Early population predictions made for the formulation of the "National Development Plan of 1971-1975" have been

revised upwards by census 1975 and Plan 1976-1980. These figures indicate an annual total population growth of 4.2 percent from 1975 to 1980, with a total population of 6,720,000 in 1975. From 1980 to 1990 a 3.9 percent annual growth rate is indicated. In this analysis, these rates are used. Thus the population is estimated at 8,255,000, 9,995,000, and 12,102,000 in 1980, 1985, and 1990, respectively. These figures will be used in the second technique, particularly.

Per-Capita Income

The per capita income movement for the period under consideration has been at an irregular rhythm. Per-capita income increased from 167 FCFA in 1960 to 325 FCFA in 1970, which represents an annual average growth of 9.23 percent. From 1970 to 1975, the total per-capita income increased from 325 to 700 FCFA, an annual average growth rate of 16.89 percent. These rates are in nominal terms since we have been dealing only in nominal values and not real values. However, a study done by WARDA in 1977 estimated the income annual real per capita growth to be 2.1 percent from 1975 to 1990.

In this study, considering a slowdown in economic growth within the next decade, we will use nominal values and assume an annual growth rate of 10 percent from 1975

to 1990. Thus, the per-capita income is estimated at 1127.35 FCFA, 1815.6 FCFA and 2924 FCFA in 1980, 1985 and 1990, respectively.

Per Capita Cassava Consumption

Among all the crops expected to be relevant rice substitutes (maize, banana plantain, yam) only cassava satisfied a priori expectations. The others displayed wrong signs, meaning that they are complements to rice. Thus, throughout the analysis, cassava has been considered to be the major rice substitute, but not a perfect one. Because rice has become increasingly important in the Ivorian diet and also because the government policy is to set rice price below that of the expected substitute, the per-capita consumption of cassava is assumed to decrease over time. A semi-log function, with time as a regressor, was fitted to forecast cassava consumption. But because of weak performance of that equation, the author's value judgment was based on the past trends, which indicated an averaged rate of growth of per capita cassava consumption of 5.16 percent from 1960 to 1965. From 1965 to 1970 a -11.36 percent average rate of growth is indicated. A -9.35 percent average rate of growth is indicated from 1970 to 1975. These figures show the decreasing trend of

per capita cassava consumption. However, the total consumption can increase over time due to population growth. In this study a first step was to assume average decrease rates of 5, 4 and 2 percent from 1975 to 1980, 1980 to 1985, and 1985 to 1990, respectively. When the values obtained were used in the demand estimated equation, the per-capita demand for rice was driven to negative values, meaning that rice will not be consumed in the Ivory Coast. This situation is obviously unrealistic. The cassava variable coefficient seems to be capturing the effects of other variables not included in the equation. To solve the problem, cassava demand has been held at a constant level of 70 kg/head/year. This is reasonable because per capita cassava consumption has dropped more than 18 percent from 1960 to 1975; the trend is expected to continue but at an increasing rate. Seventy kg represents a 34-percent decrease from the 1975 level (107 to 70).

Using the values of the variables forecast above in the estimated demand equation, per capita rice consumption is projected for 1980, 1985 and 1990. Projections for the total demand of rice for the three-year period are obtained by multiplying the values of projected per capita consumption of rice by the projected population respectively. Table 12 shows the figures.

The second method (method 2) assumes that income

TABLE 12

DEMAND PROJECTIONS (000 MT)

Year	Method 1	Trends	Method 2
1980	322.25	468.97	461.56
1985	782.70	621.70	659.55
1990	1,578.65	818.00	942.50

NOTE: Estimates are in milled equivalents.

and population are the key determinants of the demand, and is based on the following equations:

(1) $d = p + ny$

(2) $D_t = D_o (1 + d)^t$

where:

d = rate of growth of consumption

n = income elasticity

y = rate of growth of per-capita income

p = rate of growth of population

D_t = total demand in t

The estimate for the rate of consumption growth will be related to the assumptions made concerning the rates of population growth and per-capita income. This study will then assume a population growth rate of 4.2 percent in 1980 and 3.9 percent in 1985 and 1990. A

10 percent annual growth rate is assumed for percent per capita income during the same period. The income elasticity calculated in Chapter IV will be used. With these values, d can be calculated. Once this is done equation (2) above will permit the generation of total demand projections (see Table 12).

Except in 1980, the estimates from method 1 are consistently higher than those from method 2 and trend equation. In the 1990s, method 1 estimates might double method 2 and trend estimation. But that is unrealistic and there is no evidence that a 100-percent increase is expected in each half-decade. This fact confirms the concern expressed earlier about the reliability of the demand models already tried. Therefore, the so-called "best" equation among the acceptable ones still underestimates the influence of the unquantifiable variables. Trend and method 2 projections seem more reliable in the Ivorian case and hence shed some light on the future situation of the Ivory Coast rice industry. Table 13 describes the difference between future production and demand.

As can be seen in Table 13 and providing that the assumptions made will be true in the future, the domestic production will lag behind the total demand. The self-sufficiency ratios are .70, .59 and .47 in 1980, 1985 and 1990, respectively. This indicates that

TABLE 13

SELF-SUFFICIENCY RATIOS

Year	Production	Imports	Demand[1] (Method 2)	Self-Sufficiency Ratio[2]
1980	323.35	138.21	461.56	.70
1985	387.74	271.81	659.55	.59
1990	441.83	500.67	942.50	.47

[1]"Demand" is defined here as the net availability, that includes seed use losses and changes in stocks. It is then assumed that the projected production and demand are net of the diverse imponderables. Values from method 2 are used.

[2]"Self-sufficiency" is defined here as production divided by demand.

the gap will continue to widen over time. But the situation may be reversed if the government would adequately revise its rice policy, which resumes at holding the producer price between the world and the market clearing price. If the government, for whatever reason, continues to hold prices at levels that cannot cover production costs or at levels which require excessive subsidies, domestic production will increase at a very low rate, due to either the producer's inability to pay for costs or the government's failure to support the subsidies. On the other hand, this policy generates low consumer

price which, combined with income and population growths, will help increase the rate of demand for rice and hence widen the imports gap. The Ivorian government is then left with the option of positive price policy if it desires to close imports. But this policy, too, has its limitations. In the Ivorian case, a more gradual, though difficult, approach of technical and economic improvements in rice production seems the wiser course to pursue. This issue will be discussed in the section, "Policy Implications."

CHAPTER VI

POLICY ANALYSIS

Over two-thirds of the population in the Ivory Coast live in rural areas and earn a living mainly through farming. In order to protect the farmers' sources of income and help them achieve an improved standard of living, the government has established many policies. These policies are justified because agricultural production is much more risky than other industries and also because the profitability of agriculture is generally less than that of other industries. In 1973-1974 the rice sector received considerable attention from the government. Because rice is the only starchy crop grown in the country and because it is of increasing importance in the Ivorian diet, an adequate level of rice production must be established in order to support the vast demand. But are the specific policies used by the Ivorian government the appropriate ones? The purposes of this section are to trace the transfers of resources into rice production and to examine the efficiency and welfare effects of the policies.

As stated above, the Ivorian government over the past years has carried out several agricultural policies.

The first aim of these policies has been to keep the rice price from rising to its free domestic market level and at the same time to maintain the producer price above the world market price. While this policy has had a fundamental effect on producers, consumers and the government, it is difficult to quantify. But it is possible to define the aggregate costs and welfare transfers involved in such a policy. Figure 7 illustrates the impact of government policies based on the concepts of producer and consumer surplus.

As shown in Figure 7C, with no government intervention the price of rice would be at the low world price (Pw). The expected gap between domestic production and consumption as represented by the imports Q2-Q1, would be quite large. But this initial condition has never existed because government intervention has maintained price at Pd lower than the equilibrium price (Pe), but higher than the world price. At Pd, domestic production moves along S_1 to Q_3 and total demand falls to Q_4. The net imports are then $Q_4 - Q_3 < Q_2 - Q_3$. This policy of maintaining domestic price above world price, but below the equilibrium price, has four distributional effects:

1. Additional resources are pulled into rice production

2. The government earns tariff revenues from rice imports (it resells at a price higher than the

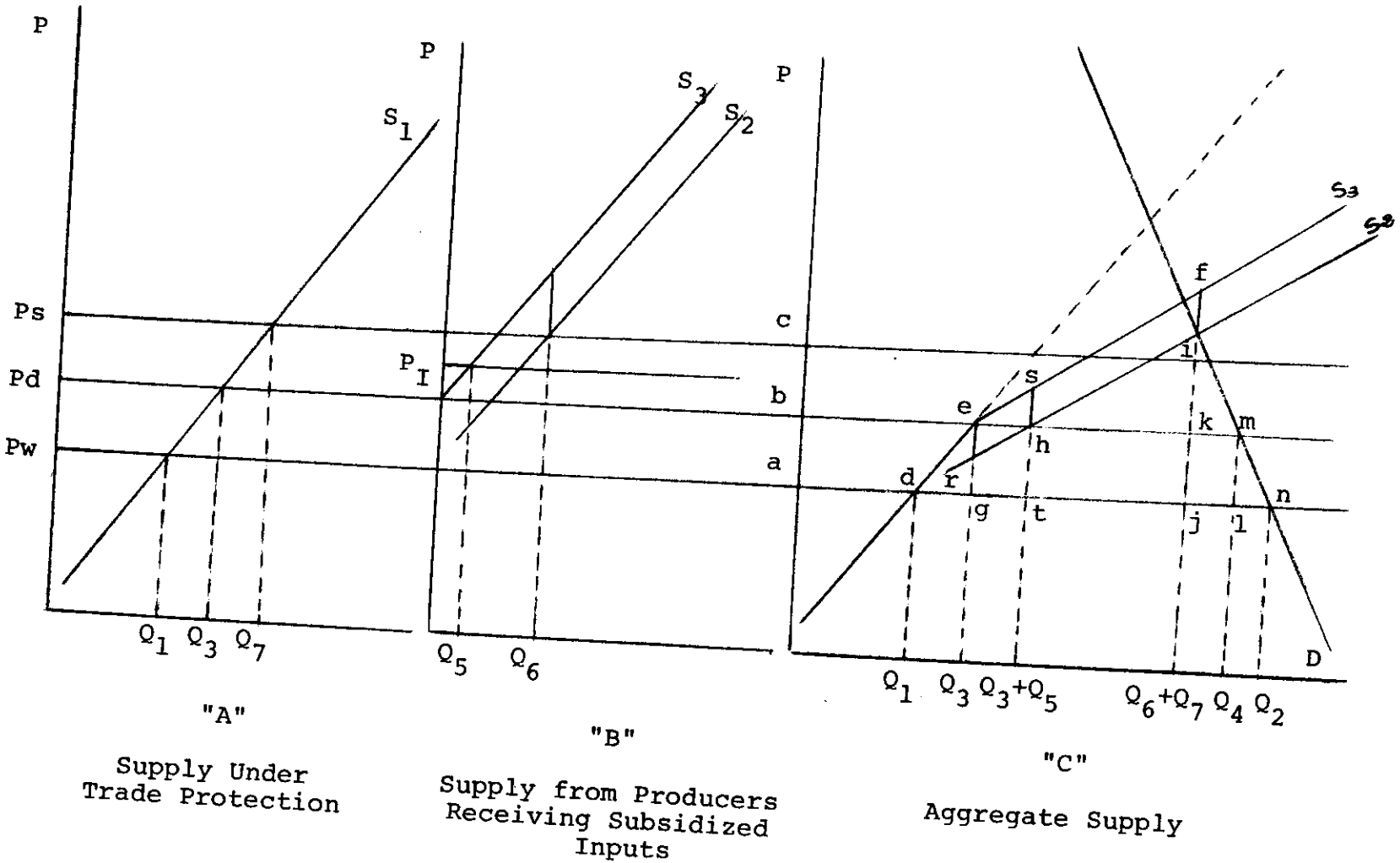

Figure 7. Effects of Rice Policies

CIF price)

3. The producers receive a transfer of welfare from consumers

4. The economy loses the consumers' surplus attached to the reduction in rice consumption

Since the government uses foreign exchange to import rice, there would be a balance-of-payment effect as well.

The second aspect of the Ivorian government rice policy is the adoption of a strategy which subsidizes investments to bring about the technological change necessary to shift the supply curve outward. The government has subsidized mechanical cultivation, land development, etc.; this resulted in effective supply shifts to S_2 for producers who received these subsidies. But in reality, the true shift has been much smaller, so that the real supply curve is S_3. The differential between S_2 and S_3 is the real resource cost, which represents a transfer of resources from the government to the producers that enables them to pay the higher costs of production. Under these circumstances, the production increases by Q_5 (Figure 7B) implying a real domestic price of Pi (with imports). The per unit government subsidy is this Pi - Pd.

These subsidization programs have three main effects. First, more domestic resources are drawn into

production, which now rises to $Q_3 + Q_5$. Second, the budget is affected due to both a fall in imports which are replaced by domestic production, and the increased need to pay for the additional subsidized factors of production. Third, only farmers using subsidized imports receive a transfer, which puts them in a competitive advantage over the other farmers. However, consumer welfare remains unchanged because consumption and price stay at Q_4 and Pd, respectively.

The 1974-1975 domestic price support policy introduced further producer subsidies by maintaining artificially high paddy prices, as shown by Ps in Figure 7A. Production increases along S_1 to Q_7 (Figure A). The effects of this policy are the same as those of the previous ones. But in constrast to input-subsidy policy, the output price support policy benefits much larger numbers of farmers who retain the bulk of price support in the form of transfer rather than means to pay for additional production costs. The price subsidy for all farmers is thus Ps - Pd.

To summarize the overall impact of these policies, we should focus on Figure C:

1. Consumers have had a clear loss in welfare (area a,b,m,n). This loss might not be as high as implied by producer prices because of the government subsidies on rice output. Most of this loss has been

transferred to either the government as import revenue or to producers in the form of higher prices.

2. Producers have clearly gained, both from the transfer of consumer surplus (area a,b,k,j) and from output price support (area b,c,i,k).

3. Initially, the government has gained from the tariff revenue on imports (g,e,m,l), but this has been reduced to j,k,m,l because of the effects of the different policies on domestic production. The government budget has also incurred a substantial obligation to subsidize inputs (area e,f,i,r) and to support producer prices above domestic market prices (area b,c,i,k). All these transfers from and gains to the government have resulted in using all taxes from rice sectors and in requiring other sectors of the economy to finance the intervention in rice.

Although it is difficult to calculate any quantities of these effects from the policies discussed, it is clear that the economy as a whole has suffered deadweight loss. The consumer surplus loss due to the fall in consumption from Q_2 to Q_4 (area l,m,n) is a net welfare loss which has neither economic nor social justification. Much more importantly, there has been a large deadweight loss of productive efficiency (area (d,e,f,j) caused by diverting resources from other uses into domestic rice production.

CHAPTER VII

SUMMARY AND CONCLUSION

Summary

The accelerated growth in the Ivory Coast brought about by the different development processes since 1960 has important implications for rice consumption requirements. Rice is being consumed in greater quantities as population and incomes have increased. This in turn produces an increased demand for the inputs required in rice production. But despite ambitious planning statements, self-sufficiency in rice was not viewed as an urgent goal before 1974. Increased rice production was planned through a gradual process of technological change, since world prices were consistently low and Ivorian production was not competitive. But in 1974, the quadrupling of world prices and doubling of Ivorian imports catapulted the government into a new policy of price support which fully subsidized SODERIZ for collection, milling, distribution and extension activities. This has given the government control of the paddy market.

Despite the SODERIZ activities, the production has not been able to close the import gap, except in

1976. It is in 1976 that the Ivorian government allowed the consumer price to increase about 80 percent over the preceding year, which in turn generated a decrease in per-capita consumption. But consumer price fell the next year, and resulted in a need for imports once again.

The major problem confronting the government in formulating an adequate rice policy is the paucity and unreliability of data on which to base projections and estimate relevant elasticities. But even where adequate methodologies are employed, the usefulness of the result is a function of the quality of data. National or secondary data are available but are often of suspect reliability. Also, given the fact that only a small percentage of rice produced reaches the marketplace, data are "made" rather than collected. With these difficulties in mind, this paper has attempted to analyze the supply and demand relationships for rice in the Ivory Coast. Price and income elasticities have been estimated. The specific objectives of this study were as follows:

1. To develop an economic model based on theory and knowledge of economic relationships of the Ivory Coast rice industry

2. To formulate, estimate and test the statistic model of the specified supply and demand relationship consistent with the economic model

3. To interpret and apply the model to current

conditions

4. To use the model in forecasting demand and supply for rice in the Ivory Coast

5. To state some implications regarding the impact of government policy on the Ivory Coast rice policy

The economic relationships affecting rice economy are graphically depicted and discussed. Multiple regression was used with time-series data from secondary sources for the period 1960 to 1976. The selection of variables was made according to economic theory and actual consumption and production situation in the Ivory Coast.

In the demand equation, per capita rice consumption was specified as the dependent variable. Retail price, per-capita income, per capita cassava consumption and a binary variable are the independent variables.

In the supply model, there are two equations: one for domestic production and one for imports. For the production equation, current domestic production is the dependent variable while the lagged price, trend and binary variable are independent variables. For the import equation, current imports are the dependent variable while the retail:CIF prices ratio, trend and binary are independent variables.

The specification of a demand model posed more problems than the supply. One reason is because price

data are highly indicative of a shifting demand relationship and generate a positively sloped line when plotted against quantity demanded. This is understandable in developing countries where, while output response may be positive due to an increase in prices, quantity-supplied response may well be negative. In other words, an increase in price of rice leads to an increase in the incomes of farmers (the largest group of consumers), which in turn leads to an increase of farm-level consumption--given a high income elasticity of demand. An additional explanation would be the increasing importance of rice in the Ivorian diet.

However, an equation with per-capita consumption as dependent variable has been estimated. In making projections two methods have been used. The first projects per-capita consumption of rice by projecting all the independent variables that are current--retail price, per-capita income, per capita cassava consumption, and the binary variable. The second method assumes that income and population are the key determinants and is based on the following equation:[1]

(a) $d = p + ny$

(b) $D_t = D_o (1 + d)^t$

The results from the first method are unrealistic.

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[1] See page 75 for details.

They assume a 100 percent quinquennial growth rate of total demand. So for policy purposes it is wise to consider the second method which, the author believes, illuminates realistically the situation of the Ivory Coast rice industry.

The results of domestic production are far better than those of total demand. The imports equation is close to the demand equation with respect to significance and goodness of fit. This is understandable because of the heavy government influence on imports; however, this influence is very difficult to estimate.

The price and income elasticities of demand, -.26 and +.35, respectively, are consistent with the expectations. However, the income elasticity was expected to be higher. But because of unequal income distribution and the aggregative characteristic of the data, the elasticity estimate may well display the behavior of the top 25 percent of the population (75 percent are the rural poor). The short run price elasticity of total supply (+.19) also appears to be lower than expected. The main reason may be the inadequate strategy for rice development adopted by the government since 1960. A policy analysis based on calculated elasticities shows that the government has a definite adverse effect on consumer welfare and on the nation as a whole. Producers, however, gain from resource transfers.

The projection figures showed that the Ivory Coast will be a consistent rice importer until 1990. This situation calls for an adequate price policy in the rice sector.

Conclusion

This paper has analyzed rice demand and supply in the Ivory Coast and attempted to estimate the price and income elasticities of demand, as well as the price elasticity of the supply of rice. With no emphasis on the evaluation of existing rice policies or programs the paper did not deal with adequate policies or strategies formulation through which the Ivory Coast could achieve self-sufficiency in the future, either short or long run. Rather, emphasis was made on analyzing equilibrium demand and supply relationships according to economic theory and the knowledge of the rice economy in the Ivory Coast. But from the results and discussions, one can conclude that despite the Ivorian government's increased concern with the importance of rice, and despite the different policies undertaken since 1960, the Ivory Coast is expected to continue to import rice in order to feed a growing population; and that the country does not enjoy a comparative advantage in rice production at prevailing world prices. The expansion of rice production, instead of lowering costs, resulted

mainly in bringing more factors into production that could have been more efficiently used to earn or save foreign exhange; and producing a welfare loss for the society. These factors could have switched to export diversification or other import-substitution activities.

The pattern of future government policy is difficult to predict, but unless a radical reorientation of rice policy occurs, the past performance of the rice industry provides little optimism for its future development. For short-term solutions, the government is left now with price policy. It has two options: to close the imports gap, or to abandon the high producer price support introduced in 1974-1975 and let the producer price come down to the world price.

The first option can only be achieved by raising the domestic price of rice to its equilibrium level. This policy will result in five distributional effects:

1. The burden of the present input subsidy would shift from the government to the consumers and result in greater consumer surplus loss

2. Producers would have effective incentives for increasing rice output, but

3. As rice price increases relative to other foodstuffs, there would be shifts away from rice

4. Because rice imports would fall, foreign exchange could be saved and resources pulled into rice

production could be used in other projects with higher economic efficiency

5. Government revenues on rice imports would disappear, however

The second policy would leave consumption levels and consumer welfare unchanged. Also, there would be a much-smaller loss of production efficiency, since production would decline while imports are used to equate supply and domestic demand.

However, because these shifts in relative prices have costly production and consumption effects, rice-price policy should be used only when the objectives of either reaching self-sufficiency, or using foreign exchange to close the gap by importing, are clearly specified and the attendant costs deemed justified. Otherwise a more gradual, though difficult, approach of technical and economic improvements in rice production seems the wiser course for the Ivory Coast to pursue.

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