THE UNIVERSITY OF MANITOBA

AN EVALUATION OF THE UNIFORM PRICING SYSTEM FOR MAIZE IN ZAMBIA

by

Crispin M. Muntanga

A Thesis

Submitted to the Faculty of Graduate Studies

in Partial Fulfillment of the Requirements for the Degree

of Master of Science

Department of Agricultural Economics

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ABSTRACT

AN EVALUATION OF THE UNIFORM PRICING SYSTEM FOR MAIZE IN ZAMBIA

A uniform price has been applied for each agricultural commodity marketed by the official marketing institutions in Zambia since 1973. The main reason attributed for adopting a uniform pricing system is that of equity. Since its inception, the uniform pricing system has received criticisms because of its inherent inefficencies in meeting the government objectives of; attaining regional self-sufficiency in food production, and ensuring efficient allocation of resources.

The uniform pricing system has encouraged the production of agricultural products even in geographical areas where it is not economically feasible to do so. This situation has resulted in excessive cost to the government in terms of transport cost for hauling the produce from surplus to deficit regions. This government expenditure has been particularly high for maize which is a relatively heavy but low valued crop.

The objective of this study is to analyse the uniform pricing system for maize by comparing it to the free market pricing system. By determining the regional optimal flow of maize and their corresponding equilibrium price differentials, the uniform pricing system can be judged as to whether it is efficient or inefficient.

From the results obtained for both years under consideration (1978 and 1981), it is evident that the uniform pricing system is highly inefficient. Specifically, the results show that some regions are not feasible for massive production of maize which currently exist. They also show that the regional price differentials as determined under a free market situation are too wide to justify a uniform price throughout the country.

To resolve the incompatibility between government objectives and regionally differentiated production capabilities, this study proposes a controlled regionally differentiated pricing system for maize. This pricing system takes into account regional demand and supply positions, accessibility to the major markets and agronomic conditions of each region. If this pricing policy is adopted, it will reduce transport cost for hauling maize from surplus to deficit regions. It will also help the government meet its objective of attaining regional self-sufficiency in maize prodcution.

ACKNOWLEDGEMENTS

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Chapter I

INTRODUCTION

Since 1973, Zambia has pursued a uniform pricing system[1] for each agricultural product marketed by the official marketing institutions. Among the different agricultural products that the uniform pricing system has been applied to, it has been effective in the case of maize, wheat, soybeans, sunflower, cotton and tobacco, and ineffective in the case of rice, groundnuts, beans, sorghum and beef.[2] The main reasons attributed for adopting a uniform pricing system were :

1. assist producers in remote surplus areas to get more for their produce,
2. encourage traditional producers to become part of the market system,
3. ensure that all farmers receive a price for their crops that will compensate them fairly for their labor,
4. reduce interregional and intersectoral income differences and,
5. assist in the progressive modernization of agriculture.[3]

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[1] Uniform pricing, as used here, refers to a particular type of price control such that the price for a given quality of a given commodity at a given stage in the marketing-processing chain and at a given point in time shows no regional variation.

[2] The uniform pricing system has been ineffective because of low prices offered by the government controlled marketing institutions compared to what private buyers are willing to pay for the same commodity.

[3] J. Weins, Uniform Pricing Policy, Planning Unit, Ministry of Agriculture and Water Development, 1981.

The adoption of a uniform pricing system has had a varied impact on producers from different regions of the country. For instance, producers in Western, Northwestern and Northern Provinces experienced a fall in the average producer price of maize, whereas producers in Eastern and Luapula Provinces experienced a rise in the average producer price of maize. Producers in the line-of-rail Provinces (Southern, Central and Copperbelt) had their producer prices unaffected - as shown in Table 1. These conflicting regional changes in the average producer prices have raised questions as to whether a uniform pricing system is capable of meeting its intended objectives.

Although objective 1 may have been realized by increasing the average producer price of maize in the Eastern Province (a surplus region), it is difficult to justify a reduction in the producer price of maize for some provinces vis-a-vis objectives 2, 3 and 4. The provinces which have experienced a reduction in the producer price of maize are not only the poorest in terms of low income levels but also have the most underdeveloped agricultural sectors.[4] If the government's objectives were to encourage traditional producers to become part of the marketing system, as well as reduce interregional and intersectoral income differenes then, its strategy should have been, among other things, to increase the producer price for all traditional farmers. Depressing the producer price in the poor provinces not only enhanced already existing regional income inequalities, but could also have discouraged the affected farmers from expanding their productive

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[4] D.J. Dodge, Agricultural Policy and Performance in Zambia - History, Prospects, and Proposals for Change, Institute of International Studies, University of California, Berkeley, 1977, p. 105.

TABLE 1: AVERAGE PRODUCER PRICE OF MAIZE BY PROVINCE (1965/66 - 1975/76)

PERIOD	LINE-OF-RAIL PROVINCES	EASTERN PROVINCE	NORTHERN PROVINCE	LUAPULA PROVINCE	NORTHWESTERN PROVINCE	WESTERN PROVINCE
			(Kwacha/90 Kg. bag of maize)			
1965/66	3.32	2.00	3.29	3.10	3.10	3.10
1966/67	3.10	2.00	3.29	3.10	4.40	4.38
1967/68	2.90	2.00	2.83	3.72	4.23	4.38
1968/69	3.20	2.30	3.02	3.67	4.25	4.30
1969/70	3.50	2.85	3.02	3.67	4.25	4.25
1970/71	4.00	3.60	3.31	3.77	4.39	4.38
1971/72	4.30	3.90	4.80	4.07	4.58	4.38
1972/73	4.30	4.15	4.30	4.30	4.30	4.30
1973/74	4.30	4.15	4.30	4.30	4.30	4.30
1974/75	5.00	5.00	5.00	5.00	5.00	5.00
1975/76	6.30	6.30	6.30	6.30	6.30	6.30

Source: Zambia, Ministry of Rural Development, in Dodge, ibid., p. 100

capacities. It is probably no coincidence that at the present time, a vast portion of the uncultivated agricultural land is found in the Western and Northwestern Provinces. According to the Third National Development Plan (TNDP),[5] these two provinces account for 46.8 percent of the uncultivated agricultural land.

Apart from the apparent weaknesses of the uniform pricing system in meeting its intended objectives, some people have argued that the uniform pricing system coupled with the government objective of paying higher prices to producers while at the same time depressing consumer prices have tended to be very costly to the government. According to a World Bank report,[6] government subsidies were estimated at K60 million during the 1976/77 crop year. The government of Zambia, through the TNDP, has also expressed concern over the growing subsidies, "... these subsidies originally designed to bridge the gap between the objective of providing remunerative producer prices and low cost food to consumers, have become an unbearable burden to the economy."[7]

In another study by Elliott,[8] it is revealed that the cost of operating the uniform pricing system was two-thirds of the value of all marketed maize during the 1975/76 crop year. The high cost

[5] Zambia, National Commission for Development Planning, Third National Development Plan, 1979-83, Lusaka: October, 1979, p. 70.

[6] World Bank, East Africa Regional Office, A Basic Economic Report - Zambia, October, 1977, p. 165.

[7] Zambia, National Commission for Developing Planning, op. cit., p. 70.

[8] C. Elliott, Equity and Growth - Unresolved conflict in Zambian Rural Development Policy, Geneva: International Labour Office, January, 1980 p. 32.

associated with the operation of a uniform pricing system accentuates the need to consider the adoption of an alternative pricing system which would be less costly to the govenment.

The other potent criticisms of the uniform pricing system as applied in Zambia have been focused on its allocative inefficiency. It has been argued that since its inception, the uniform pricing system has encouraged the production of maize (a low valued crop in relation to weight) further away from the market at the expense of less costly crops in terms of transport costs. According to Elling's[9] study, the cost of transporting maize from Chipata, in the Eastern Province, to Lusaka is 58 percent of the producer price of maize whereas that of ginned cotton and groundnuts is only 12 percent. However, since the introduction of a uniform pricing system, the production of maize in the Eastern Province has risen while the production of groundnuts and cotton has declined. For instance, in 1972, prior to the introduction of a uniform pricing system, 6,480 tons of groundnuts and 1,500 tons of cotton were produced in the Eastern Province. In 1973, when the uniform pricing system was introduced, the province's production of groundnuts and cotton had declined to 2,960 and 400 tons respectively.

Another criticism of the uniform pricing system has been its failure to take account of interregional differences in demand and supply levels of agricultural products. Thus, under the uniform pricing system the existing inequalities in the supply levels of

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[9] M. Elling, Background to Agricultural Development in Central Province, Zambia, F.A.O., United Nations Development Programme, AG:DP/ZAM/77/004, p. 54.

agricultural products in different provinces is perpetuated. For instance, surplus regions will become more surplus whereas deficit regions will become even more deficit. The incentive for deficit regions to expand their productive capacities is adversely affected due to artificially depressed prices as well as the fact that these regions can always make up the deficit by importing from surplus regions at no extra cost. Such a situation conflicts with the government's objective of attaining regional self-sufficiency in agricultural production.[10]

From the foregoing discussion, the problem of a uniform pricing system as applied in Zambia can be stated as one of inefficiency in terms of:

1. failure to meet its intended objectives,
2. failure to take account of interregional demand and supply levels and,
3. high costs to the government in terms of subsidies needed to operate it.

1.1 RATIONALE FOR THE STUDY

Given the dissatisfaction that has been expressed by the Zambian government officials, as well as the World Bank and its affiliate organizations concerned with agricultural development, a thorough investigation into the performance of a uniform pricing system as applied in Zambia is warranted.

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[10] Zambia, National Commission for Development Planning, op. cit., p. 144.

Besides Dodge,[11] who has completed a comprehensive study of the agricultural pricing system in Zambia, there have been other studies on pricing policy for agricultural products by World Bank and Food and Agricultural Organization (FAO) missions. These studies have pointed out the weaknesses of the uniform pricing policy and made suggestions for alternative pricing mechanisms.

In her study, Dodge has argued for the abandonment of a uniform pricing system in favor of producer prices based on world prices, "... we recommended setting producer prices on the basis of world prices, because this facilitates the attainment of the efficient interregional and intercrop allocation of production."[12] One of the World Bank documents on Zambia has also argued for the abandonment of a uniform pricing system in favor of a pricing system that would reflect import and export parities for deficit and surplus regions respectively. Other studies have argued for a free market pricing system. For instance, a pricing system which will take account of demand and supply levels in each region.

Despite the Zambian government's acknowledgement of the shortcomings of the uniform pricing system, it has not conceded to the alternative pricing systems that have been proposed by the critics of the uniform pricing policy. Though there are no clear cut reasons as to why the Zambian government has not decided to abandon the uniform pricing system, it seems plausible to advance the following three arguments:

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[11] D.J. Dodge, op. cit., Chapters V, VII and VIII.

[12] Ibid., p. 367.

1. The types of alternative pricing systems that have been suggested threaten the government's control over the operations of the agricultural sector. In Zambia, where the government has vowed to build a humanistic society, it becomes imperative for the government to control the operations of the major sectors of the economy.
2. If market forces were left to determine the producer price for agricultural products, there is every indication that the retail price of agricultural products in major cities will go up. This, in the politician's eyes, is viewed as a threat to the peace and tranquility that Zambia has enjoyed since independence. Any major increase in the retail price of basic foodstuffs is likely to evoke boycotts and strikes among the people living in the urban areas.
3. Although it may be true that the loosening of price controls on producer prices of agricultural products may stimulate increased production at a national level, it may also be true that both small and emergent farmers who still need government protection to effectively contribute to the economy will become vulnerable to fluctuating world prices. Such a situation may destroy these farmers who constitute over 90 percent of all farmers in the country.

It appears as though these three considerations have caused the Zambian government not to accept any of the alternative pricing systems advanced by the critics of the uniform pricing system.

1.2 SCOPE AND OBJECTIVES

Though a uniform pricing system is applicable to most of the agricultural products produced in Zambia, this thesis will focus only on maize. Maize is not only the most important agricultural crop in Zambia (see Table 2) in the sense that it is the nation's staple crop, it also has the potential of being grown in most parts of the country as shown in Figure 1. Also, among the agricultural products grown in Zambia, maize is considered as the most lowly valued in relation to weight. Therefore, transport cost becomes an important variable when hauling maize from one region to another.

Another reason for devoting the analysis to maize is that, maize is the only crop in Zambia whose regional demand and supply levels can easily be identified. Other crops like cassava and fingermillet are grown mainly for domestic consumption, i.e., not for the market. On the other hand, crops like cotton, groundnuts, sunflowers and tobacco are grown for industrial use. Hence, regional demand data for these crops can not be easily obtained. This makes it difficult to analyze the pricing system for maize and other crops within the same framework.

Given the above premises, and having identified some of the problems inherent in the present pricing policy as well as its proposed alternatives for agricultural products in Zambia, the objectives of this study are :

1. To determine the least cost routes for shipping maize from surplus to deficit regions.

TABLE 2: ESTIMATED PER CAPITA CONSUMPTION OF FLOUR, CEREALS, CASSAVA AND OTHER FOODSTUFFS IN 1980

PROVINCE	MAIZE	SORGHUM MILLET	RICE	CASSAVA	WHEAT	GROUNDNUTS
			(Kg.)			
COPPERBELT						
RURAL	108.4	53.0	0.2	3.0	17.0	1.00
URBAN	97.2	----	2.5	0.5	37.0	0.65
CENTRAL/LUSAKA						
RURAL	171.4	19.2	0.6	4.0	16.4	1.5
URBAN	98.2	0.1	3.3	0.6	42.5	0.65
EASTERN						
RURAL	143.2	6.5	1.1	0.6	1.1	8.00
URBAN	102.6	---	2.2	0.3	15.2	0.65
LAUPULA						
RURAL	32.5	12.5	3.4	74.0	1.5	3.00
URBAN	88.1	----	4.0	1.9	17.7	0.65
NORTHERN						
RURAL	33.6	54.0	1.2	50.0	1.6	5.00
URBAN	95.3	0.2	3.2	1.0	17.8	0.65
NORTHWESTERN						
RURAL	46.8	46.0	0.8	34.0	0.4	2.00
URBAN	104.2	3.0	8.6	9.0	9.6	0.65
SOUTHERN						
RURAL	155.1	14.0	0.1	0.3	4.3	11.00
URBAN	121.7	----	1.6	0.2	29.1	0.65
WESTERN						
RURAL	90.3	18.0	0.4	28.2	2.2	1.00
URBAN	95.4	----	0.6	8.0	24.7	0.65

Sources: Nutrition Annex; FAO Data.

INDEX

M maize
C cotton
G groundnuts
B beans
O oil seeds
VT virginia tobacco
BT barley tobacco
ML millet
SO sorgum
BW beeswax
R rice

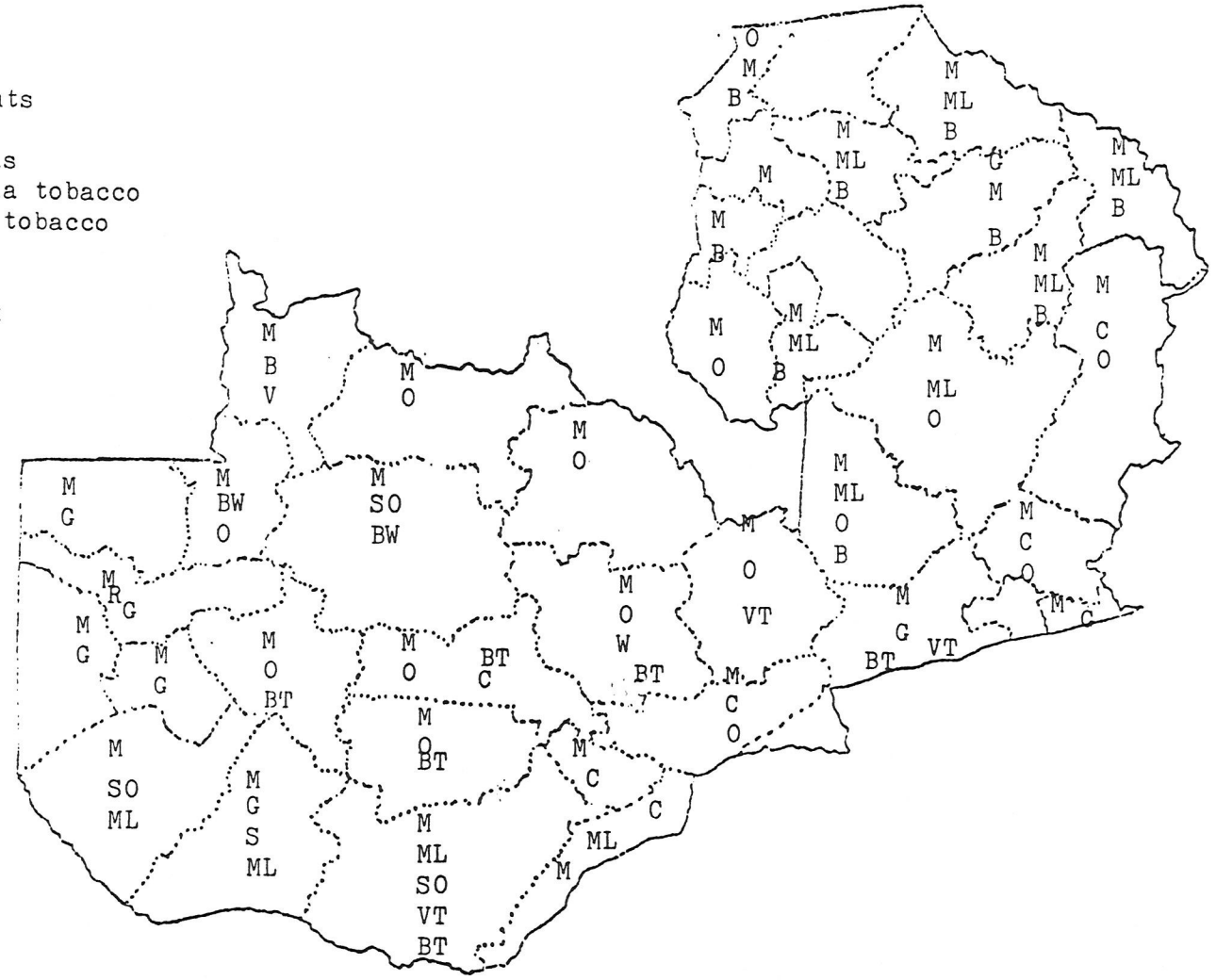

FIGURE 1: MAJOR CROPS GROWN IN ZAMBIA

Source: Zambia, Rural information Services, Lusaka: Z/GEN/54, 1974.

2. To undertake a comparative analysis of a uniform pricing system vis-a-vis a free market pricing system.
3. To design a pricing system that will be cognizant of transportation cost and interregional differences in supply and demand for maize without reducing the average supply of maize at the national level.

This study will attain the first objective by determining the optimal commodity flows that would have prevailed under a free market. The second objective will be attained by determining the regional equilibrium price differential for maize that would have prevailed under a free market and then compare these price differentials with the uniform price. The third objective will be attained by utilizing the information obtained from the optimal flow of maize, regional price differentials, sensitivity analysis, geographical location and the agronomic condition of the region as presented in section 2.5.

The data used in this study is the regional purchase and sales figures for maize provided by the National Agricultural Marketing Board (NAMBoard), and the official transport cost rates for shipping maize from one region to another during the period 1979 and 1981.

1.3 OUTLINE OF THE STUDY

To attain the stated objectives, this thesis proceeds in the following manner: Chapter 2 presents a historical analysis of the pricing system for maize prior to independence in 1964, between 1964 and 1973, and after 1973 to the present. It also analyzes the free market pricing system, the proposed controlled regionally differenti-

ated pricing system and briefly reviews background literature on the determination of prices over space.

Chapter 3 presents a detailed theoretical model which provides the background to the empirical model. The single product spatial equilibrium model as developed by Samuelson[13] and refined by Takayama and Judge[14] will be utilized. Chapter 4 specifies the empirical model for comparing a uniform pricing system with a free market pricing system. It also provides the self-sufficiency ratios which are needed for determining the magnitude of regional surpluses or deficits in maize production. Chapter 5 provides an analysis of the results. The summary and implications of this study are presented in Chapter 6.

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[13] P. Samuelson, "Spatial Price Equilibrium and Linear Programming", American Ecnomic Review, 42 (1952), pp. 283-303.

[14] T. Takayama and G.G. Judge, Spatial Temporal Price and Allocation Models, Amsterdam: North-Holland Publishing company, 1971, Chapter 3.

Chapter II

BACKGROUND TO THE PROBLEM

The pricing systems for maize in Zambia that emerged after independence are highly indebted to the pricing system that prevailed during the colonial period (1890-1964). This is evident from the pricing policies that were designed during the colonial period and those that came into effect after independence (1964). As a matter of fact, the pricing system that prevailed after independence up to the 1968/69 marketing season, was inherited from the colonialists. The pricing policy for maize went through some changes from 1964 until 1973 when a uniform pricing system was adopted. A uniform pricing system was also practiced during the colonial period from 1951 to 1957.

The basic differences in the pricing policy for maize during the pre and post independence periods were:

1. during the colonial period, the setting of the producer price of maize was only effective in the Southern, Central and later in the Eastern Province. Other provinces did not receive marketing services for their produce. After independence (at least after 1969), the government extended the marketing services to all farmers in the country and
2. within the restricted areas that received marketing services, two distinct pricing policies prevailed. One was applicable to

white settler farmers and another to the indigenous farmers, i.e., settler farmers received a higher price for their produce than their black counterparts. This discriminatory pricing policy was discontinued after independence.

It must, however, be emphasized that the agricultural policy of both colonialists and the current government has been that of providing cheap food to people in the urban areas. This was viewed by policy makers as one way of maintaining cheap labor in the industrial sectors.

In view of some similarities in the pricing system that prevailed during the pre and post independence periods, it becomes imperative to review both the colonial and the post independence agricultural pricing policies in general and for maize in particular. This background information will illustrate the difference in the basic objectives of the two governments and, hence, the need for different means to attain the objectives of the present government.

2.1 PRICING POLICY FOR MAIZE PRIOR TO INDEPENDENCE

Although the production of maize for the market in Zambia can be traced back to the last decade of the ninteenth century, a controlled pricing system did not come into effect until 1936 when the Maize Control Board was established. Prior to 1936, maize was basically a subsistence crop. The colonial government, while encouraging maize production among indigenous farmers, their main interest regarding agriculture was to attract white settler farmers into the region by

giving them the best land and higher prices for their produce. Indigenous farmers who lived in areas deemed desirable for white settlers were forced to migrate to other parts of the country.[15]

The emergence of a depression in the 1930's led to the closure of all copper mines but two.[16] This situation drastically reduced the demand for maize leaving its production in a surplus position. The government of the time found it increasingly expensive to dispose of the excess maize. They also felt that such a situation was threatening the future of settler farmers and, therefore, a maize control board charged with the responsibility of regulating the marketing of maize was formed.

Firstly, a quota method was adopted where indigenous farmers were allocated only one-fourth of the total market demand for maize. Besides the quota system, settler farmers were guaranteed a higher price for their produce. These measures were designed to achieve two objectives:

1. to support producer prices above world prices and,
2. to remove settler farmers from the threat of competition from the indigenous producers.[17]

The producer price of maize remained fairly stable until 1941/42 when the price was increased from K1.08[18] per bag of maize to K1.50 due to decreasing supplies of maize during the Second World War.

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[15] D. Dodge, op. cit., p. 8.

[16] Ibid., p. 9.

[17] Ibid., p. 10.

[18] Ibid.

During the same year (1941/42), the government reduced and froze the producer price of maize at K1.35 under the agreement that it paid the maize control board a subsidy to make up for any resulting losses.[19] The issue of subsidizing marketing organizations has also been adopted after independence and in most instances has been very controversial.

It must be noted that until about 1950/51, the operations of the marketing boards were restricted to settler farmers and a few indigenous farmers who were located near the line-of-rail in the Southern Province. Other indigenous farmers in the rest of the country did not have a guaranteed market for their produce. From 1951/52 the operations of the marketing boards were extended into the Central Province. A flat rate of K0.35[20] was charged for transport to all indigenous farmers per bag of maize. This was used as a transportation subsidy to farmers further away from the major markets. Thus, all farmers received the same producer prices regardless of their location. In short, a uniform pricing system was instituted. The uniform pricing system was introduced as a measure to check increasing population pressures on the land adjacent to the railway depots. The uniform pricing policy was later abandoned due to government's emphasis of attaining regional self-sufficiency in maize production. It has, however, been reintroduced and has been in effect since 1973.

From the above analysis, it is evident that the pricing policy for agricultural products in general and for maize in particular was biased towards favoring settler farmers and to some extent indigenous

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[19] Ibid.

[20] Ibid., p. 32.

farmers in the Southern and Central Provinces.[21] Undoubtedly, this pricing policy created a dualistic structure, i.e., on the one hand a relatively few large, highly developed settler farms and on the other, a multitude of autochthonic subsistence units.[22] This indicates the extent the colonialist's policy towards agricultural development was achieved, - i.e., to promote settler farmers and maintain a status quo among indigenous farmers.

2.2 PRICING POLICY FOR MAIZE BETWEEN 1964 AND 1973

As indicated in Section 2.1, the pricing policy for maize at the time of independence was basically applicable to farmers in the Southern and Central Provinces. Within these two provinces, two types of price structures existed: one applicable to settler farmers and another to indigenous farmers. The immediate concern of the Zambian authorities at independence was to abolish this biased dual pricing structure and adopt a universal price for both settler and indigenous farmers. Until the 1968/69 crop year, no attempt was made to integrate other provinces into the operations of the official marketing institutions.

Restricting marketing services only to Southern and Central Provinces meant that other provinces could not effectively compete in the production of maize for the market. Since, at the time, maize was

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[21] Only farmers in the Southern and Central Provinces were assured a market for their produce.

[22] Heide and Udo Ernst Simonis, Social Economic Development in Dual Economies. The Examples of Zambia: Weltforum Verlag, 1971, p. 276.

the only crop which could easily be sold on the market for cash, the uncovered farmers found themselves excluded from the modernization race. This situation enhanced already existing inequalities between the line-of-rail provinces and the rest of the provinces in the country. Realizing how ineffective this pricing system was towards redressing the uneven development founded in the colonial period, in 1968, the Director of the Department of Economics and Marketing in the Ministry of Agriculture addressed the question of determining the producer price of maize in uncontrolled areas.[23]

Subsequent to the director's address, a new pricing system was adopted. Under this new price sysem, farmers in deficit regions were granted higher producer prices compared to those in surplus regions. For example, a bag of maize in Kasama (a deficit region) was K3.90 whereas in Chipata (a surplus region) the price was K2.90 and for provinces along the line-of-rail the price was K3.20. Under this pricing system, prices reflected, to some extent, regional demand and supply positions. If it is assumed that farmers are responsive to price changes, then a relatively high price in deficit regions would stimulate increased maize production in these regions. Therefore, reducing the quantity of maize imported from surplus regions and hence reduce the gross transportation cost budget for hauling maize. This form of pricing sysem is very necessary for a country like Zambia where transport costs are very high due to poorly developed interregional road networks. This pricing policy would also be in line with the government objective of attaining regional self-sufficiency in

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[23] Dodge, op. cit., p. 99.

food production.

In the 1970/71 marketing season, for the first time, the government guaranteed a floor price of K3.20 per bag of maize at all depots throughout the country. The main reason attributed by the Zambian government officials for this new policy was to ensure a fair return to all farmers. This argument of fairness has been pervasive in introducing a uniform pricing system for agricultural products in Zambia. The other reason which might have influenced the Zambian government to grant a floor price could have been the low output recorded during the previous year. By granting a floor price which was higher than the producer price offered in the surplus provinces, the government hoped to stimulate increased production in these provinces. Unsurprisingly, in the following year, the production of maize in the Eastern Province increased.

During 1971/72 crop year, the producer price for the line-of-rail provinces as well as the floor price were each raised by 30 Ngwee[24] to K4.30 and K3.50 respectively. This was done to stimulate production of maize due to an anticipated shortfall in the supply of maize throughout the country. During the same period, the producer price of maize in the Eastern Province was also raised by 30 Ngwee despite the heavy costs incurred in the previous year by the government in shipping the surplus maize from the Eastern Province to the line-of-rail provinces where a market existed. It appears as though this increase in producer price in the Eastern Province was mainly due to the successful lobbying of Eastern Province politicians.[25] Given the

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[24] Ibid., p. 101.

surplus production recorded in the previous year, the most rational move the government could have taken is to leave the producer price in the Eastern Province unchanged and concentrate the increase in provinces where demand seemed to outweigh supply.

In the 1972/73 crop year, another change in the producer price of maize occurred. The floor price for a bag of maize was raised to K4.00, at the same time, the producer price in the Western and Northwestern Provinces were reduced to K4.30 from K4.58 and K4.38 respectively. This move which was done under the pretext of attaining a much higher degree of fairness among all farmers throughout the country seems to have contradicted both the government's objectives of attaining regional self-sufficiency in food production and correcting the uneven development that had emerged during the colonial period. The Western and Northwestern Provinces have always been in a deficit position as far as maize production is concerned.

In fact, the shortfall in the supply of maize in these two provinces have prompted illegal marketing of mealie meal.[26] The average price of mealie meal in these two provinces is higher than the official retail price.[27] Also, according to a report by the Central Statistics Office, the Western and Northwestern Provinces are the poorest in the country.[28] Given these facts, one fails to understand the government's rationale behind reducing producer prices for these

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[25] Ibid.

[26] Mealie meal refers to maize flour.

[27] M. Elling, op. cit., p. 54.

[28] Dodge, op. cit., p. 105.

deficit regions.

In April, 1973, the Zambian government announced yet another change in the producer price of maize. This time, a universal price for maize for the entire nation was introduced and put at K4.00 per 90 kilogram bag of maize. This pricing policy which is popularly known as a uniform pricing policy has been instituted not only for maize but for all agricultural products marketed by the official marketing institutions.

2.3 UNIFORM PRICING SYSTEM

The uniform pricing system, as defined in chapter one, refers to a particular type of price control, such that the price for a given quality of a commodity at a given stage in the marketing chain and at a given point in time shows no regional variation, i.e., the price for a given commodity is the same in all parts of the country. In the Zambian agri-food sector, the uniform pricing system is applied at four distinct levels:

1. prices paid by farmers for some purchased inputs such as fertilizer and seed,
2. prices received by farmers for some principle crops delivered to the official marketing organizations,
3. prices for some farm products between the marketing organizations and processors, and
4. retail prices paid by the consumers for some basic food items, i.e., mealie meal, rice, etc.

Although the uniform pricing system is applicable at four distinct stages, this thesis addresses itself to a particular crop (maize) at a specific pricing level - farm gate.

The basic argument behind the introduction of a uniform pricing system is that of equity. Most of the proponents of a uniform pricing policy (the majority of who are politicians) have argued that each farmer should receive the same price for his produce regardless of his locational position.[29]

The use of a uniform pricing system as a means of attaining equity among farmers is very difficult to justify in light of the fact that farmers are located in areas with varying degrees of comparative advantage as far as the production of maize is concerned. As shown in Figure 2, farmers in the Western, Northwestern, and Luapula Provinces and to some extent those in the Northern Province have poor agrcultural soils compared to farmers in other provinces. Given this condition, a higher degree of equity can be achieved by paying a higher price to farmers in less favored areas to help them meet higher costs required to produce the same number of bags of maize as those farmers in more favorable locations.

The other disadvantage confronting farmers in remote provinces is the difficulty they face in acquiring government subsidized agricultural inputs. Firstly, most of these farmers are too poor to afford a bag of fertilizer or a bag of seed maize and, secondly, for the very few who can afford to buy fertilizer and seed, in most instances, these inputs are not available at their local depots.

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[29] Ibid., p. 103.

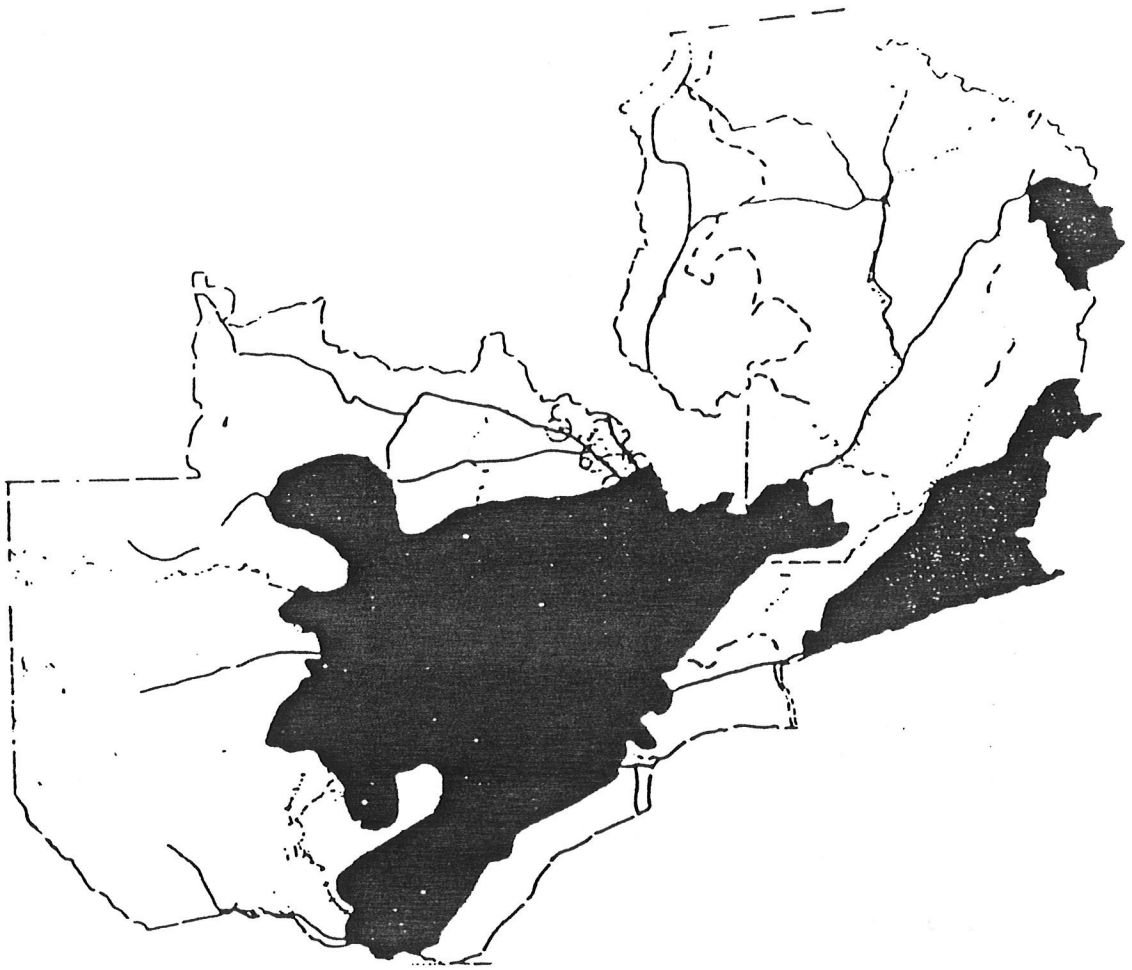

FIGURE 2: GOOD AGRICULTURAL SOILS IN ZAMBIA

Source: Zambia, Third National Development Plan (1978/83)

Poor timing in the distribution of farm inputs has been one of the major criticisms against the National Agricultural Marketing Board - the sole distributor of fertilizer and seed. This situation further accentuates the comparatively high costs of producing a bag of maize for farmers in the remote provinces. Farmers who are located along the line-of-rail provinces (Central, Lusaka and Southern), besides enjoying favorable climate and fertile soil conditions, have easier access to government subsidized agricultural inputs. This gives them a comparative advantage when compared to their counterparts not in the line-of-rail provinces.

In view of the varying agricultural conditions facing farmers in the different regions of the country, the Zambian government can attain a higher degree of equality among farmers by ensuring that the prices offered to farmers reflect these regional variations. For instance, regions which show a relatively higher cost of production must be granted relatively higher prices to help these farmers meet the excess cost of producing a bag of maize. Relatively higher prices must also be given to deficit regions to help stimulate increased investment in maize production.

It can also be argued that a uniform pricing system is generally inefficient since it violates the basic principle guiding prices among spatially separated markets, i.e., prices between two trading regions will differ exactly by their transfer cost.[30] Inefficient pricing can lead to inefficient allocation of resources. Under normal circumstan-

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[30] For a detailed discussion of prices for regions among spatially separated markets the reader is advised to read, T. Takayama and G.G. Judge, op. cit., pp. 47-62.

ces, resources will move to regions where they can earn higher net returns. The high net returns are normally signalled by the prices offered for the commodity in the different regions. But under a uniform pricing system such price signals are lacking, as a result factors of production tend to be immobile, which to some degree implies a misallocation of resources.

In Zambia, this inefficiency is reflected in the production of maize. The uniform pricing system has encouraged excessive production of maize even in areas where it is not economically profitable to do so. As Elling remarked, "...this distortion which is very marked in a big country like Zambia without any important inland waterways, can make economically desirable production financially unprofitable."[31] In Zambia, transport cost is a very important component in the costs associated with the marketing of agricultural products, especially maize which is a heavy but relatively low valued crop. Zambia does not have any major rivers to permit transportation by water. The only basic form of transport is by road. However, the poor road networks coupled with the ever increasing cost of energy makes such a form of transport more expensive. Because of these higher costs, the government has emphasized the attainment of regional self-sufficency in food production. Thus, the most important factor in the location of production of agricultural products is not necessarily where the crop can do better but also other considerations like local demand and supply and distance from the major consuming areas.

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[31] Elling, op. cit., p. 54.

Under a uniform pricing system, farmers can deliver their produce to any depot and receive the same price. In this situation, it is possible that a farmer located between two depots, one closer to the market, may decide to deliver his/her produce to the depot further away from the market. Such occurrences imply that unnecessary cost and time is incurred by the National Agricultural Marketing Board when transporting the produce to the main consuming areas. To avoid this type of waste, prices in depots should reflect both the demand and supply for the produce in each region and, the distance between a given producing region and the nearest market. The closer the region is to the nearest market the higher should be the price offered. This will encourage a more efficient movement of farm produce to the large urban centers.

2.4 FREE MARKET PRICING SYSTEM

Most of the critics of the uniform pricing system have implicitly suggested that a free market pricing system should be adopted. Others, particularly Dodge, have argued for second best - world market price equivalent. This section will examine the free market pricing system and will also point out some of the potential problems in applying both the free market pricing sysem or world price equivalent in the marketing of maize in Zambia.

The free market pricing system can be analyzed in the framework of the theory of perfect competition. There are basically four conditions that a perfectly competitive commodity market must satisfy:

1. that firms produce a homogeneous commodity, and consumers are identical from the sellers' point of view in that there are no advantages or disadvantages associated with selling to a particular consumer;
2. both firms and consumers are numerous, and the sales or purchases of each individual unit are small in relation to the aggregate volume of transactions;
3. both firms and consumers possess perfect information about the prevailing price and current bids, and they take advantage of every opportunity to increase profits and utility respectively; and
4. entry into and exit from the market is free for firms and consumers in the long run.[32]

If the above conditions are met, then, no individual or group of individuals, either producers or consumers can influence the market price of the commodity. The price will be strictly determined by the forces of supply and demand. However, in other market structures such as monopoly or oligopoly an individual or group of individuals can collude to alter the price of a commodity in a market place. This is achieved by altering the supply of the commodity on the market. On the consumers' side (monoposony or oligoposony) the price is altered by varying the demand of the commodity on the market.

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[32] J.M. Henderson and R.E. Quandt, Microeconomic Theory: A Mathematical Approach, 3d ed., New York: McGraw-Hill Book Company, 1980, p. 136.

In the literature, both oligopolistic and monopolistic market structures have been criticized for being wasteful in terms of resource use and for their unsatisfactory contribution towards social welfare. In particular, monopolists have been accused of amassing excessive profits from their business ventures. As a result, most economists have argued for a market structure which has features resembling those prevailing under a perfectly competitive market. In this way, net returns will not accrue to individuals but will tend to be distributed evenly among all members of society hence improving social welfare. Also, under competitive conditions, resources will be allocated more efficiently. They will move into places where they can realize higher net returns as dictated by the market. As Scherer pointed out, "[c]ompetition has long been viewed as a force that leads to an optimal solution of the economic performance problem, just as monopoly has been condemned throughout recorded history for frustrating attainment of the competitive ideal."[33] Cummings argues that "...prices are at least potentially valuable mobilizers and allocators of productive resources, ...if the role of prices is to be realized, the market in which these prices are determined must reflect the supply and demand conditions of the country."[34]

Although, theoretically, a perfectly competitive pricing system is considered to be the most efficient in terms of both resource allocation and provision of social welfare from a given output, it has

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[33] F.M. Scherer, Industrial Market Structure and Economic Performance, 2d ed., Chicago: Rand McNally College Publishing Company, 1980, p. 9.

[34] R.W. Cummings, Pricing Efficiency in the Indian Wheat Market, New Delhi: Impex India, 1967, p. 14.

never been followed anywhere in the world. Even if policy makers wanted to adopt it, its assumptions are so restrictive that they cannot be satisfied in a real world economy.

In the case of marketing maize in Zambia, there are a few basic factors that would make it difficult to adopt a free market pricing system:

1. The road system in Zambia is not well developed. In fact, some areas in the more remote provinces like Western, Northwestern, Luapula and Northern are not easily accessible. To move the produce out or into these areas, the government has to do so at a very high cost. Under these circumstances, if a free market pricing system is adopted then it is possible that some areas will become completely isolated from the rest of the country due to high transport costs associated with moving the commodities to and from these markets. Such a situation is not conducive to the development of a country as a whole.
2. One feature of the agricultural sector in Zambia is the provision of subsidies for basic inputs by the government. These subsidies are intended to assist subsistence/traditional farmers in purchasing fertilizer or improved seed. These subsidies are in the form of both transport cost and retail price of these inputs. Under these conditions, the introduction of a free market pricing system may cause some administrative problems in the allocation of these subsidies. One possibility is to discontinue providing subsidized farm inputs. However, such a move would complicate the government's

objective of trying to transform traditional farmers into modern farmers by providing them with improved seed and fertilizer.

3. Currently, there is only one organization (NAMBoard)[35] which is the sole ultimate buyer and distributor of maize and basic farm inputs like fertilizer and seed. The role of NAMBoard to the overall development of the agricultural industry cannot be over-emphasized. With the help of NAMBoard, the Zambian government has been able to provide marketing services to almost all the farmers in the country (though at times at a very high cost), which would probably not have been possible under a free market pricing system. Since, this would not require government intervention in the marketing of agricultural commodities.

4. In Zambia, one can divide the farming community into two categories. On the one hand there are a few well-developed commercial farmers constituting about 10 percent of the entire farming community. On the other hand, there are small scale farmers constituting over 70 percent of the entire farming community. Given this type of structure in the farming community, an adoption of a free market pricing system may not operate efficiently. It is possible that during the years of good harvest, commercial farmers may depress their prices to ensure their access to the market. Obviously, such a move would be more detrimental to the small scale farmers who do not

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[35] NAMBoard is a parastatal agricultural marketing organization in which the government has controlling shares.

have much income or capital reserves to sustain instabilities in the prices of their products.

5. One of the important factors in the attainment of an efficient pricing system is the smooth flow of information among all the participants. In Zambia as well as most other developing countries market information is not easily available. This is because most people cannot read newspapers and only a few own radios which currently are the main source of information. Given this, even if a free market pricing system is adopted, it may not operate as efficiently as its proponents perceive.

In view of the foregoing discussion, it is clear that even if the Zambian government wanted to introduce a free market pricing system, its performance may not only be inefficient but also detrimental to the development of the agricultural sector as laid down by the government. For instance, the government's goals of transforming the traditional farmer into a modern farmer, closing the gap between the rural and urban dwellers, correcting the uneven growth within the farming communities, etc., may be frustrated.

Despite the above shortcomings of a free market pricing model, this thesis will still utilize it as a norm for evaluating the performance of a uniform pricing system. It will also provide a range from which prices can be varied for the proposed controlled regionally differentiated pricing policy.

The other pricing alternative worth considering is the world price equivalent. One possible reason against the adoption of world price equivalent when determining the producer price of maize in Zambia is

that such an approach would expose the Zambian farmers to world competition as well as to the price instabilities inherent on the world market. As has been argued earlier on, in the Zambian agricultural sector more than 70 percent of the farmers are basically traditional farmers. This group of farmers need some kind of assistance in making the transition to commercial farming. Also, in the short-term, they need guaranteed stable prices to be able to survive. In fact, if a world market price equivalent is adopted, it means that the traditional farmers will have to compete against United States corn growers who supply almost 70 percent of the global export market.[36]

2.5 CONTROLLED REGIONALLY DIFFERENTIATED PRICING SYSTEM

In view of the inherent shortcomings of both the free market and world price equivalent pricing system, this study suggests that a government controlled regionally differentiated pricing system should replace the uniform pricing system if the resulting analysis indicates that a uniform pricing system is highly inefficient. Under this proposed pricing system, the producer price of maize in each region will tend to reflect the demand and supply positions. However, for surplus regions that are close to the major deficit regions and have both good climatic and soil conditions for the production of maize, an incentive factor could be added to regional producer prices. The price incentive is intended to stimulate increased production of maize

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[36] Tanzania, Ministry of Agriculture, Price Policy Recommendations for the 1977/78 Agricultural Price Review, Volume 1; Dar es Salaam, 1976, p. 5.

so that an ever increasing output at the national level can be ensured (of course, this is assuming that farmers are responsive to price changes). It is hoped that this proposed pricing system will reduce the share of the government budget used for subsidizing the transportation of maize from surplus to deficit regions and will help foster regional self-sufficiency in maize production.

In determining the appropriate regional price differentials,[37] this study will, given the imputed regional prices, utilize variables such as; regional self-sufficiency ratios, sensitivity analysis, geographical and the agronomic conditions of the region with respect to maize production.

The regional self-sufficiency ratio which is the ratio of total demand to total supply in a given region will be used to assess the status of each region regarding the government objective of attaining regional self-sufficiency in food production. If the self-sufficiency ratio is less than one, then that region is in a deficit position. If the current uniform price is used as the basis for determining price differentials, then the price in a deficit region must be above the uniform price. If the ratio is equal to one, then the region is barely self-sufficient. In such a situation, the regional price must at least be greater than the current uniform price. If the ratio is greater than one, then the region is in a surplus position. In this situation the regional price must at least be less than the current uniform price.

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[37] Appropriate price refers to the price which is both economically and politically rational.

The agronomic condition of the region, as shown in Figure 2, will be used to determine whether a region merits an incentive to stimulate increased production of maize. For instance, if a region is in a surplus position but located in favorable climatic and soil conditions, then the incentive factor will be considered when adjusting the price.

The geographical location of a region is used in relation to the major consuming markets. If a surplus region is relatively close to the main consuming areas, then an incentive must be added to the normal regional price to help stimulate increased production at the national level. On the other hand, if the region is further away from the market, even if it has favorable agronomic conditions, its determined regional price must not receive an incentive for stimulating production.

A sensitivity analysis, which indicates how much output in each region can be increased or decreased before changing the basic optimal solution, will be performed. The results to be obtained from this analysis will help to determine the appropriate price decreases in the surplus regions so that they do not fall into a deficit position. For instance, if the results of the sensitivity analysis in a given region show a narrow margin, then the price change (if any) in that region must be minimal. On the other hand, if the margin is considerably higher, then the price change can be allowed to vary according to the region's market price differential.

Under the assumption that farmers are responsive to changes in prices, then with the application of the above discussed variables, the following conditions may be ensured:

1. A stable flow in the movement of maize from surplus to deficit regions will be maintained. For instance, situations whereby the status of a region (whether surplus or deficit) may vary from year to year as envisaged under a free market pricing system will be avoided. Stability in prices will also be attained since the proposed price policy will try to ensure that a steady growth in the production of maize is attained.
2. The costs associated with hauling maize from surplus to deficit regions may be reduced since the price mechanism will, to some extent, reflect the transport cost. Though some people may argue that such a policy may be unfair to consumers in deficit regions, it can also be argued that even under a uniform pricing system this inequity prevails among consumers in surplus regions and producers in deficit regions who are forced to buy and sell produce at higher and lower prices (respectively) than would have prevailed if the prevailing economic conditions were allowed to determine prices. Given the inequity in both pricing systems, it is just as appropriate that those who cannot produce enough must pay both the cost of the commodity at its point of production plus the cost involved in its transportion.
3. Since producer prices will, to some extent, reflect regional demand and supply positions, resources will be more efficiently allocated than under a uniform pricing system ceteris paribus.

The proposed controlled regionally differentiated pricing system has advantages over the current uniform pricing system and stands a

much better chance of being politically acceptable in Zambia than both the free market pricing system or the world price equivalent. Recently, both Tanzania and Botswana have moved away from a uniform pricing system to a regionally differentiated pricing system. In Zambia, there is every indication that the officials in the Ministry of Agriculture and Water Development are not satisfied with the performance of the uniform pricing system. Recommendations have been made to review the uniform pricing system with the hope of developing a more efficient pricing policy.[38]

2.6 LITERATURE RELATED TO DETERMINING MARKET PRICES OVER SPACE

An analysis of equilibrium prices and optimal flow of commodities in spatially separated markets have been formalized by using spatial equilibrium models. These models permit the determination of the net price that will prevail in each region and the quantity of a given commodity that any one region will sell or purchase from every other region. Enke,[39] originally stated the spatial equilibrium problem as; two or more regions trading a homogeneous product with known demand and supply functions. The two regions are separated but not isolated by known transfer costs. Given these assumptions, the problem is to determine the equilibrim levels of production, consumption and price in each region and the optimal trade flows between regions. He demonstrated how to determine these variables by mathematical means

[38] Personal discussion with Mr. F. Mbewe, the Director of Planning in the Ministry of Agriculture and Water Development, Zambia.

[39] S. Enke, "Equilibrium Among Spatially Separated Markets: Solution by Electric Analogue", Econometrica, 14(1951), p. 41.

for a three region case, and an electric analogue for cases involving more than three regions.

Proceeding from the Enke formulation, Samuelson[40] developed a geometric expression for the spatial equilibrium problem for a two region case and further investigated the multiple region problem and suggested how it can be couched mathematically into a maximum problem that can be solved by trial and error or by a systematic procedure of varying shipments in the direction of increasing the social pay-off, i.e., maximizing a given function.

Since then, other studies both theoretical and empirical have appeared. On the theoretical side, works by Takayama and Judge,[41] Judge and Wallace[42] and, Dantzig[43] are worth mentioning. On the empirical side, quite a number of studies have been completed. A few of these studies are cited below.

King, Cassetti and Kissling[44] did joint studies on the determination of optimal bituminous coal flows in the Great Lakes region in the United States and fruit distribution in New Zealand. In both studies, the objective was to determine the optimal transport patterns. The

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[40] Samuelson, op. cit.

[41] Takayama and Judge, op. cit.

[42] G.G. Judge and T.D. Wallace, "Estimation of Spatial Price Equilibrium Models, Journal of Farm Economics, (4) XL, (November, 1958), pp. 801-820.

[43] G.B. Dantizig, Allocation of the Simplex Method to a Transportation Problem, ed. T.C. Koopmans, Monograph 13; New York: John Wiley and Sons, pp. 357-74.

[44] L.J. King, E. Cassetti and C.C. Kissling, "Optimal Transportation Patterns in Single Commodities in Capacitated Networks", Studies in Economic Planning Over Space and Time, eds. G.G. Judge and T. Takayama (North-Holland/American Elsevier, 1973) pp. 225-242.

study on the optimal bituminous coal flows included the bituminous coal producing areas and the coal receiving centers of the midwest and the Great Lakes region of the United States and Canada. In this study, some 104 transportation routes for which rates are readily available were considered. Each coal producing area or coal receiving center was treated as a node. A node identified with each coal producing region was the major transportation center within the region. In the study concerning fruit distribution in New Zealand, 88 nodes were identified. Using the same format, the optimal flow of fruit was analyzed.

Judge, Havlicek and Rizek[45] did a study on a spatial analysis of the United States livestock economy. The objective of the study was to analyze the optimum location of livestock slaughter and corresponding optimum geographical flows and prices of livestock and meat. In this study, the United States economy was partitioned into 26 regions. Taking the slaughter cattle-beef subsector of the livestock industry as the commodity space for the analyis and using the 1960 time period, optimum flows of slaughter cattle and beef and their corresponding prices were determined.

Fox[46] completed a study of the United States livestock-feed economy. The objective of the study was to ascertain the feed-price differentials between regions on the basis of given distributions of feed production and livestock numbers, and to provide insights

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[45] G.G. Judge, J. Havlicek and R.L. Rizek, "Spatial Analysis of U.S. Livestock Economy", Studies in Economic Planning Over Space and Time, eds. G.G. Judge and T. Takayama, ibid., pp. 261-73.

[46] A. Fox, "A Spatial Equilibrium Model of the Livestock-Feed Economy in the United States", Econometrica, 21 (1955) pp. 547-66.

concerning the incidence of changes in freight rates for feed. In this study, the United States economy was partitioned into 10 regions. By making use of the rule that at equilibrium no trader can make a profit by shipping additional feed from one region to another, optimal feed-flows were determined. From these optimal feed-flows, different freight rates were applied to ascertain the incidence of changes in freight rates.

From the above few cited studies, it is apparent that spatial equilibrium models have a wide range of practical application to various economic problems. Specifically, spatial models offer an operational tool to policy makers for determining the consequences under given conditions of changes in transport costs, geographical distribution of population, income and product supply, on the level of geographical prices and flows. The perfect market concept used in formulating the spatial equilibrium models provides a standard of comparison whereby the pricing and distribution of a commodity can be judged as efficient or inefficient.

Chapter III

THEORETICAL FORMULATION

The objective of this chapter is to develop a theoretical model for analyzing spatial equilibrium prices for a single commodity. This is realized by first determining the optimum or least-cost trading pattern, given supply and demand conditions within each region. Then, by applying the rule that prices between trading regions will differ exactly by transfer costs, the equilibrium price in each trading region can be determined. The analysis presents a geometric as well as an algebraic expression for determining spatial equilibrium prices.

3.1 GEOMETRIC PRESENTATION

The basic assumptions which permit the use of geometrical expression for interregional trade can be outlined as follows:

1. two regions (one surplus and the other deficit) trading a homogeneous product,
2. the demand and supply positions for each region is known,
3. no physical or institutional barriers exist to prevent the movement of commodities between regions and,
4. transfer costs between regions are known.[47]

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[47] P. Samuelson, op.cit., p. 284.

Given the first three assumptions and ignoring the transfer costs between regions, equilibrium prices and production in the two trading regions as well as the commodity flows between them is determined by the intersection of the demand and supply curves as shown in Figure 3.

In Figure 3, region X depicts the case of a deficit region whereas region Y is that of a surplus region. In the absence of trade between these two regions, X and Y, their equilibrium prices are determined by the intersection of their respective demand and supply functions. For instance, in region X, oa is the equilibrium price whereas in region Y, ob is the prevailing equilibrium price.

However, if trade between these two regions is permitted, the commodity will flow from region Y where the equilibrium price is relatively lower to region X where the price is relatively higher. This will continue until the prices in both regions are equalized, i.e., reach oc.[48] The equilibrium price oc is determined by the combined demand and supply functions for both regions (X and Y) as shown in the most rightward section of Figure 3.

An alternative and convenient way of presenting the single-product, two region case is the use of a back-to-back diagram as shown in Figure 4. In this formulation, the supply and demand curves in region Y in Figure 3 are plotted on the right half of the diagram in the conventional format whereas those of region X are reversed on the left half of the figure (as shown in Figure 4). The equilibrium price oc is given by the intersection of the excess supply curves of both regions X and Y (ES_X and ES_Y). The quantity of the commodity traded is

[48] R.G. Bressler, Jr. and R.A. King, Markets, Prices and Interregional Trade, New York: John Wiley and Sons, Inc., 1970, p. 88.

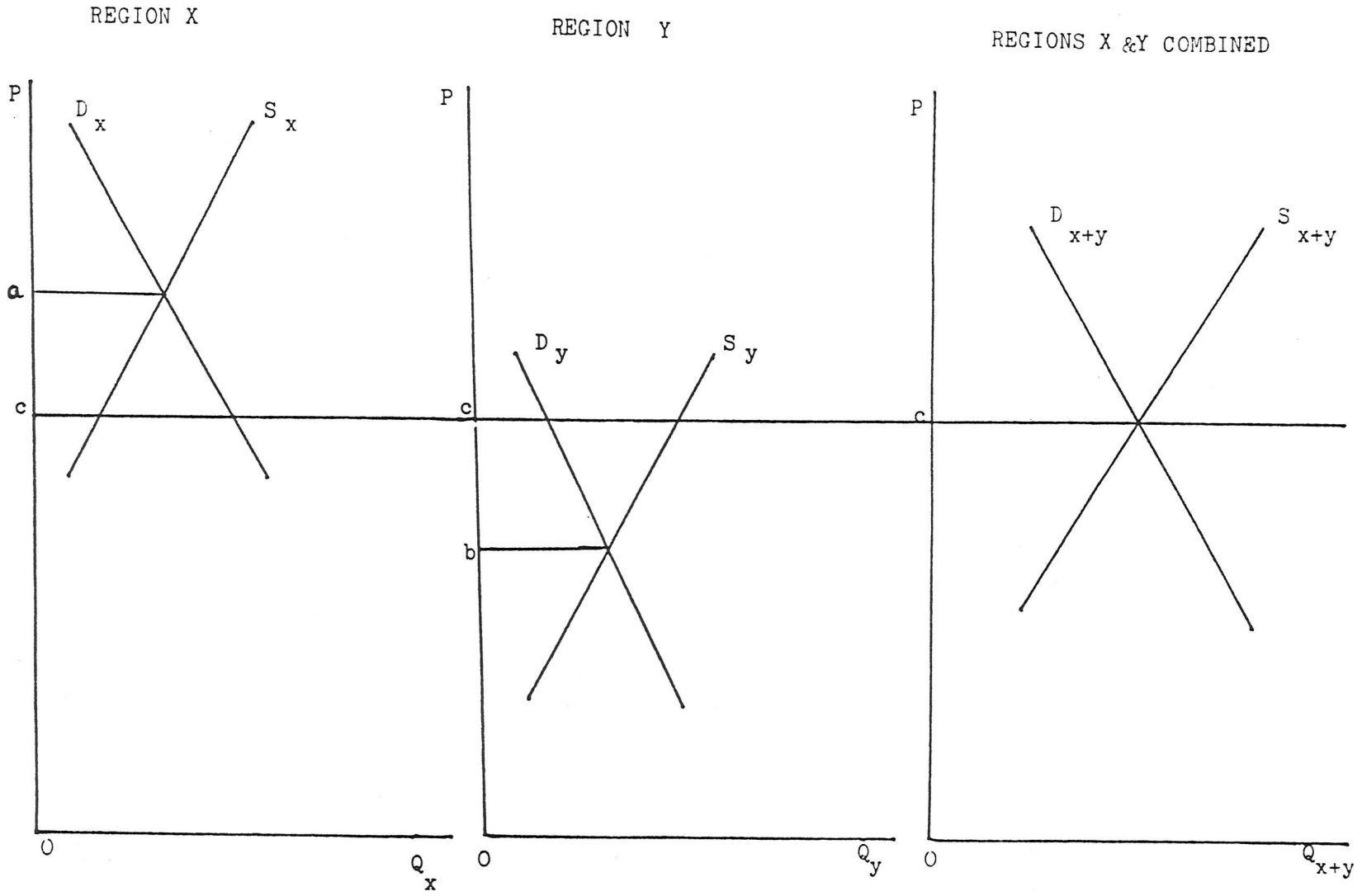

FIGURE 3: TRADE BETWEEN TWO REGIONS AS A RESULT OF DIFFERENCES IN THE SUPPLY AND DEMAND FUNCTIONS

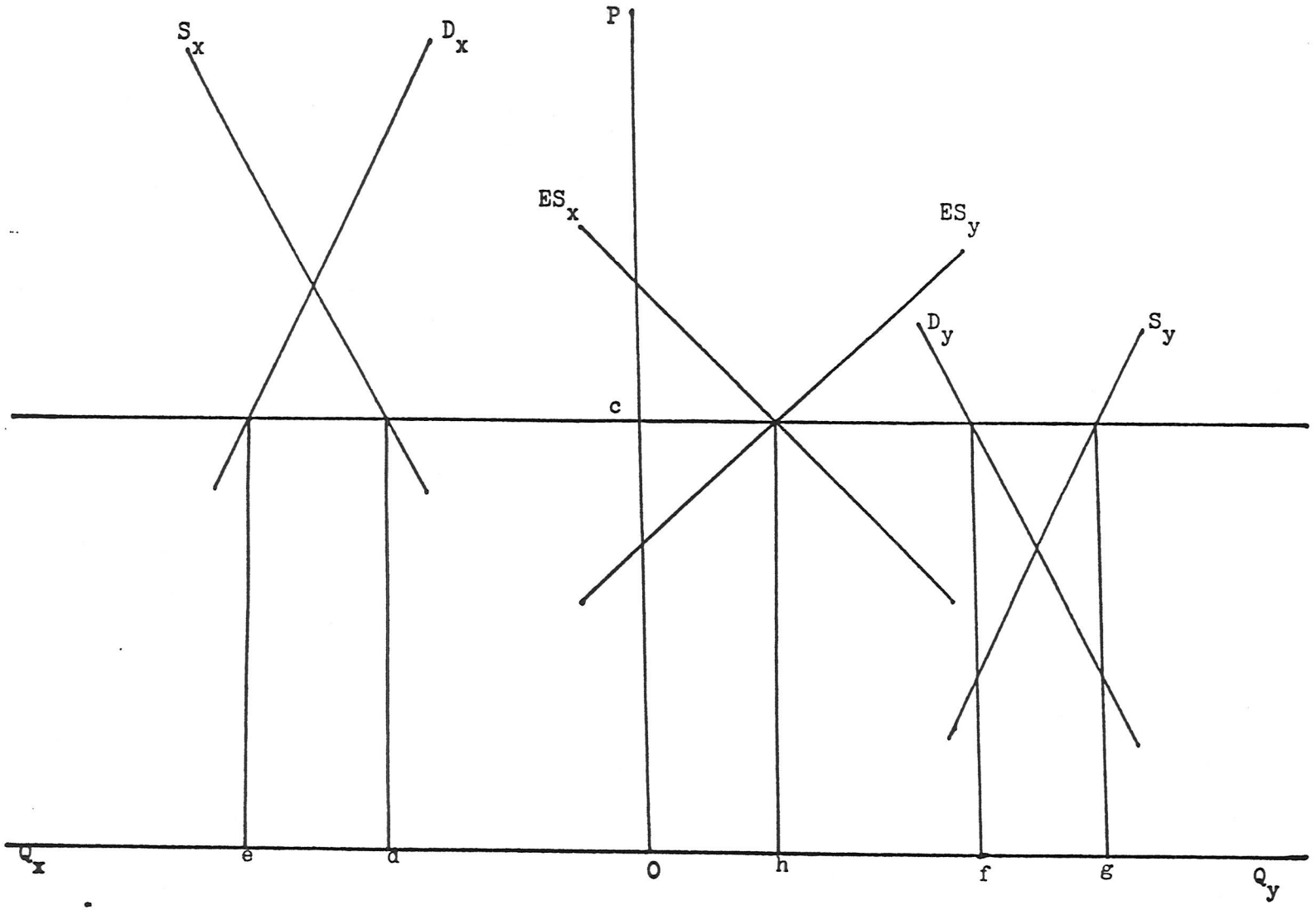

FIGURE 4: EQUILIBRIUM PRICES AND VOLUME OF TRADE (BACK- TO- BACK DIAGRAM)

given by oh. At the equilibrium price oc, the quantity traded (oh) is also equal to fg, the amount to be exported and the quantity ed, the amount to be imported.

The spatial equilibrium models which ignore transfer costs are obviously an oversimplification of the real world situation. The movement of a commodity from one region to another involves costs such as transport as well as handling charges. Hence, in determining equilibrium prices, transfer costs should be taken into consideration. In our graphical exposition, transfer costs are introduced into the analysis by raising the demand and supply curves of the exporting region by an amount representing the unit cost of interregional transfer cost (t). This is shown in Figure 5.

The effect of transfer costs on trade can be ascertained by comparing Figures 4. and 5. Though the commodity prices in both regions move towards equality, equilibrium is reached when their respective prices differ exactly by the transfer cost. The volume of trade falls with the introduction of transfer cost; the exact effect will depend on the shape of the two supply and demand curves, the price difference that exist in the absence of trade, and the magnitude of the transfer cost. However, trade will be possible and profitable as long as the original difference in the price is greater than the transfer cost.[49]

The relationship between transfer costs and the volume of trade can be illustrated more clearly by reproducing the excess supply curves of Figure 4 and then deriving the volume of trade line which is the

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[49] Ibid., p. 91.

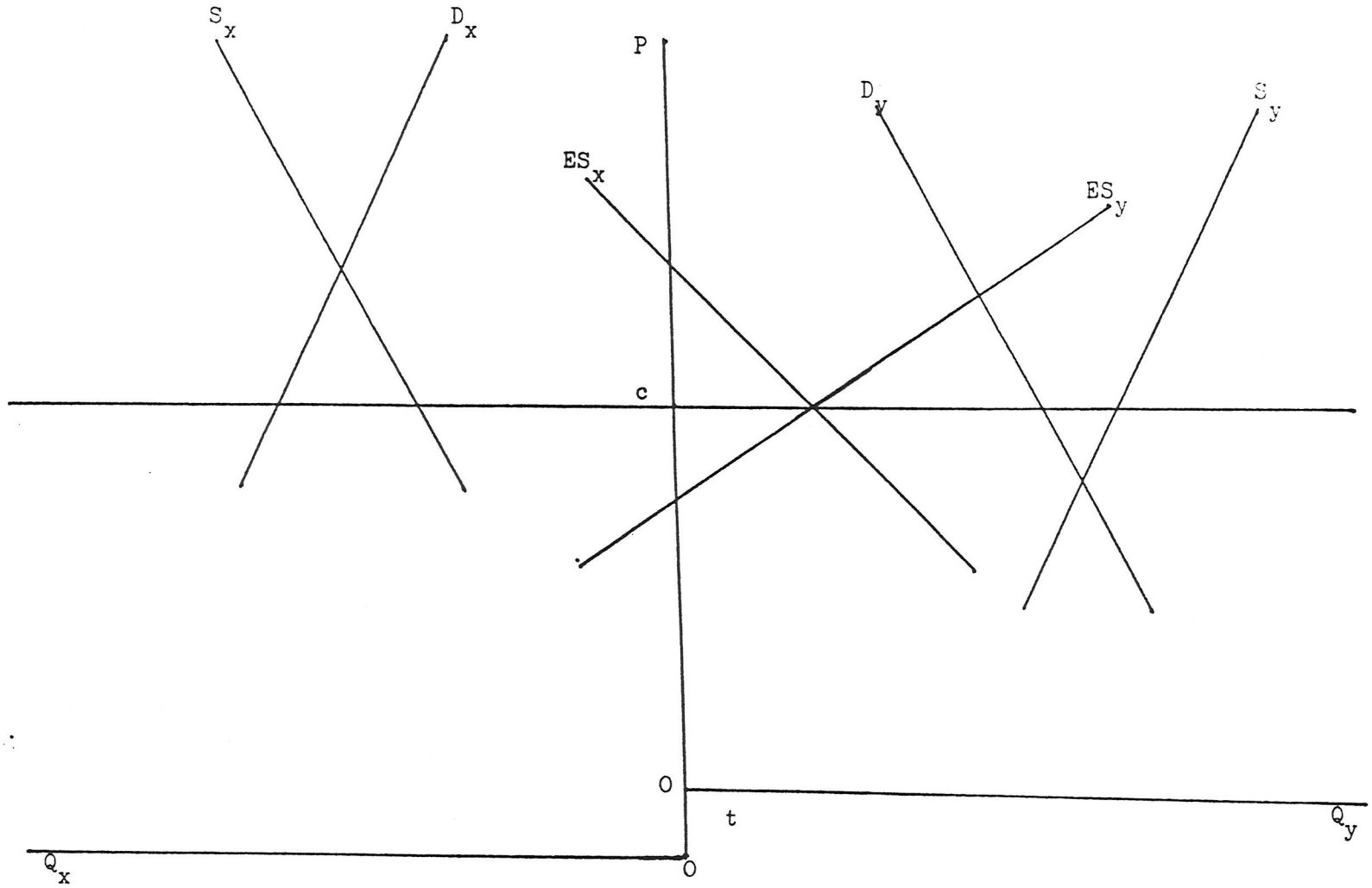

FIGURE 5: THE EFFECT OF TRANSFER COST ON EQUILIBRIUM PRICES AND VOLUME OF TRADE

difference between the excess supply of region Y and the excess supply of region X ($ES_Y - ES_X$) as shown in Figure 6. The volume of trade line demonstrates the effect of a change in transfer cost on total volume of trade. For instance, if the transfer cost is ot_1, the volume of trade will be oh_1. If the transfer cost changes to ot_2, the volume of trade will change from oh_1 to oh_2. Hence, trade between two regions is dependent upon the magnitude of the transfer cost. If the transfer cost is high, the volume of trade will be low and if the transfer cost is low the volume of trade will be high - ceteris paribus. The other information which is gained from Figure 6 is the behaviour of equilibrium prices to changes in transfer cost. We find that there is a direct relationship between the transfer costs and the equilibrium prices in the deficit region (X) and an inverse relationship between the transfer costs and the equilibrium prices in the surplus region (Y).

3.2 ALGEBRAIC PRESENTATION

In the previous section, a simple two competitive trading region case is presented in graphical form. This is intended to provide an insight as to the logic underlying the solution for the general case. In this section, an algebraic model developed by Takayama and Judge is presented.[50]

The economic environment which is required for the application of an algebraic model is similar to the one adopted for the graphical case except that instead of restricting our analysis to the two region

[50] Takayama and Judge, op. cit.

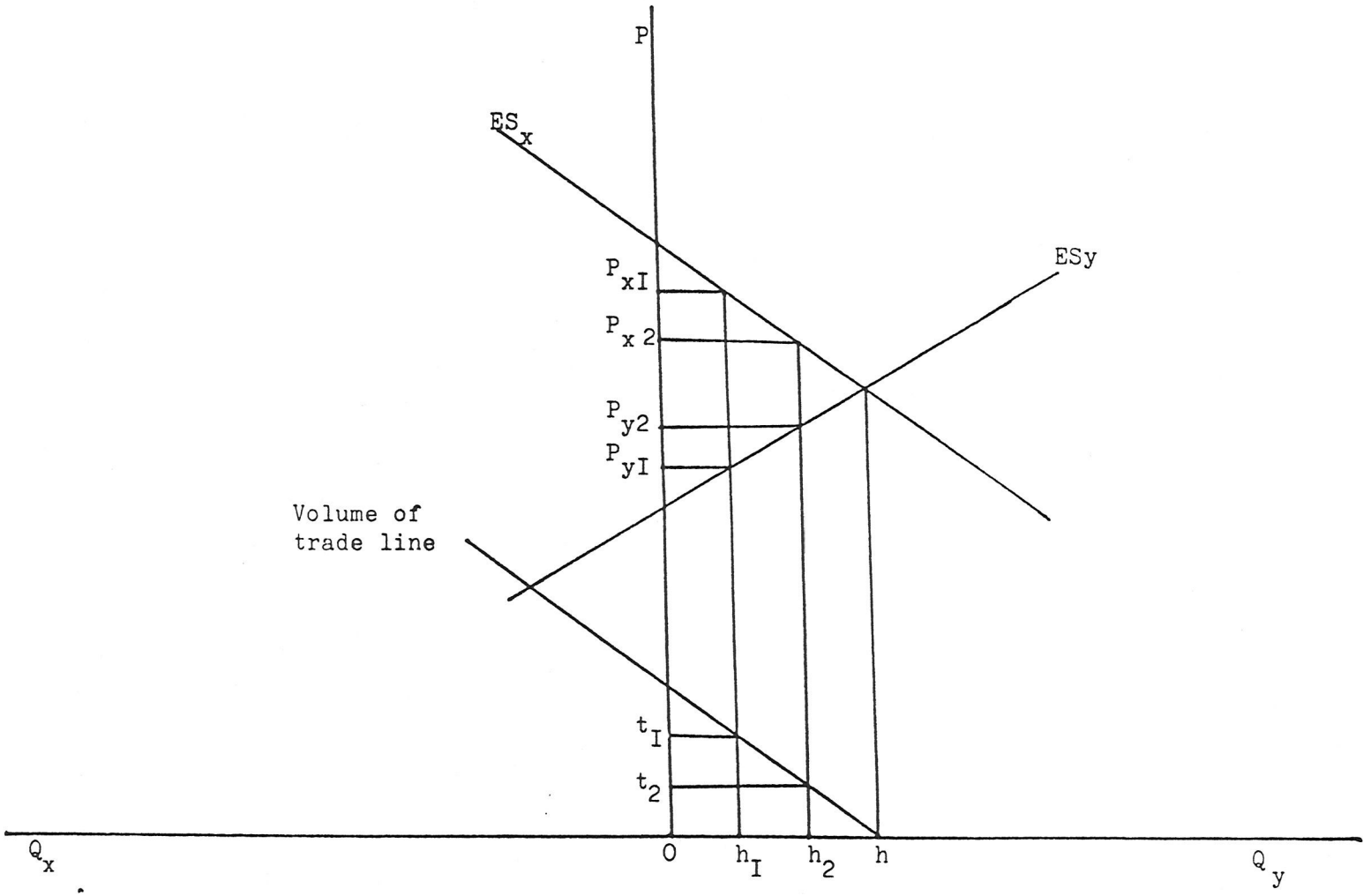

FIGURE 6: THE RELATIONSHIP BETWEEN TRANSFER COST AND THE VOLUME OF TRADE

case, we can now use any number of regions.

let: X_i represent exporting regions

Y_j represent importing regions

X_{ij} represent the quantity of commodity flow from region i to region j and,

t_{ij} represent transfer cost for moving the commodity from region i to region j, where, i = 1,2,...,m

and, j = 1,2,...,n.

Then, the optimal set of commodity shipments may be stated as a minimization problem, i.e.,

minimize

$$\sum_{i=1}^{m} \sum_{j=1}^{n} t_{ij} \; X_{ij} \qquad (1)$$

subject to

$$\sum_{i=1}^{m} X_{ij} \geqslant Y_j \qquad (2)$$

$$\sum_{j=1}^{n} X_{ij} \leqslant X_i \qquad (3)$$

$$X_{ij} \geqslant 0, \text{ for all } i \text{ and } j \qquad (4)$$

Condition 1 refers to the objective function which is being minimized. The solution to this problem gives the least cost and interregion pattern of trade subject to constraints 2,3 and 4.

Condition 2 implies that the quantity shipped into any importing region should not exceed the total amount of commodity available in the exporting regions. Condition 3 implies that the total amount of commodity exported from region i into region j should not exceed the amount of a commodity available in the exporting region (X_i). Condition 4 implies that all imports to deficit regions or exports from surplus regions must be positive. A negative shipment is unrealistic.

Given the above constraints, the optimum values ($\bar{X}_{ij}$) for the objective function (1) can be determined by specifying the Lagrangean equation:

$$\phi(X, P_y, P_x) = \sum_{i=1}^{m}\sum_{j=1}^{n} t_{ij} X_{ij} + \sum_{j=1}^{n} P_j \left(Y_j - \sum_{i=1}^{m} X_{ij}\right) + \sum_{i=1}^{m} P_i \left(\sum_{j=1}^{n} X_{ij} - X_i\right) \qquad (5)$$

where

$$X = (X_{11} \cdots X_{1m} \cdots X_{n1} \cdots X_{nm})$$

and P_y and P_x are Lagrangean multipliers which apply to linear restrictions 2 and 3.

$$P_y = (P_1 \ldots P_n) \geqslant 0$$

$$P_x = (P_1 \ldots P_m) \geqslant 0$$

In order to insure that the optimum values $(X, \bar{P}_i, \bar{P}_j)$ represent the nonnegative saddle point of the Lagrangean, we make use of the Kuhn-Tucker theorem and take the first partial derivative of the Lagrangean with respect to (X, P_i, P_j) as shown below:

$$\left.\begin{aligned}
&(a)\ \frac{\partial \bar{\phi}}{\partial X_{ij}} = t_{ij} - \bar{P}_j + \bar{P}_i \geqslant 0 \text{ and } \left[\frac{\partial \bar{\phi}}{\partial x_{ij}}\right]\bar{X}_{ij} = 0 \\
&\qquad \text{for all } \bar{X}_{ij} \geqslant 0 \\
&(b)\ \frac{\partial \bar{\phi}}{\partial P_j} = Y_j - \sum_{j=1}^{n} \bar{X}_{ij} \leqslant 0 \text{ and } \left[\frac{\partial \bar{\phi}}{\partial P_j}\right]\bar{P}_j = 0 \\
&\qquad \text{for all } \bar{P}_j \geqslant 0 \\
&(c)\ \frac{\partial \bar{\phi}}{\partial P_i} = \sum_{i=1}^{m} \bar{X}_{ij} - X_i \leqslant 0 \text{ and } \left[\frac{\partial \phi}{\partial P_i}\right]\bar{P}_i = 0 \\
&\qquad \text{for all } \bar{P}_i \geqslant 0
\end{aligned}\right\} 6$$

for all i and j.

The above conditions ensure that if $(\bar{X}, \bar{P}_y, \bar{P}_x)$ are the optimum vectors for the Lagrangean, then: condition (a) implies that if X_{ij} is positive then $t_{ij} - \bar{P}_j + \bar{P}_i$ must be equal to zero. This condition agrees with the basic law of market prices over space, i.e., that the price between trading regions will differ by their transfer costs. If the difference in prices is less than the transfer cost then the flows are not profitable.

Condition (b) implies that if the regional market demand price P is zero, then there is an excess supply of the commodity to region j. If the regional market demand price is positive then demand in region j,

is exactly equal to shipments to region j. And, finally, condition (c) implies that if the regional market supply price P is zero, then there is an excess supply of the commodity in region i, i.e., supply is greater than shipments from region i. On the other hand, if the regional market supply price P is positive, the regional supply in region i is exactly equal to shipments to the demand regions.[50]

Given the optimal solution for the commodity flow $(\bar{X}_{ij})$, the corresponding set of unique regional market prices corresponding to the $(\bar{X}_{ij})$ can be determined by the use of the duality theorem. Thus, given a minimum transfer cost solution, the dual can be formulated as:

maximize

$$\sum_{j=1}^{n} Y_j P_j - \sum_{i=1}^{n} X_i P_i \qquad (7)$$

subject to

$$P_j - P_i \leqslant t_{ij} \qquad (8)$$

$$P_j, P_i \geqslant 0$$

for all i and j.

The Lagrangean for the dual problem can be stated as

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[51] For a detailed explanation of the economic meaning of the Kuhn-Tucker conditions, see T. Takayama and G. Judge, op. cit., pp. 50-51.

$$\phi(X, P_Y, P_X) = \sum_{j=1}^{n} Y_j P_j - \sum_{i=1}^{m} X_i P_i + \sum_{i=1}^{m} \sum_{j=1}^{n} X_{ij} \left(t_{ij} - P_j + P_i\right) \qquad (9)$$

Again, by taking the first partial derivative of equation 9 with respect to (X, P_y , P_x) and by making use of the Kuhn-Tucker conditions the optimal regional prices $\bar{P}_j$, $\bar{P}_i$ together with their corresponding Lagrangean ($\bar{X}_{ij}$) can be obtained.

Chapter IV

MODEL SPECIFICATION

As stated in Chapter 1, the objectives of this thesis are to determine the optimal interregional flow of maize ($\bar{X}_{ij}$) as well as regional equilibrium prices, and then to compare these regional prices to the prevailing uniform prices. The spatial equilibrium model which was developed in Chapter 3 and its application as cited in section (2.6) are utilized to meet these objectives.

This chapter empirically specifies the model which is used to determine both the optimal interregional flow of maize and the corresponding regional equilibrium prices. Section 1 discusses some of the considerations used to determine the market regions. Section 2 identifies the market regions. Section 3 examines the data used in the study, determines the status of each region (whether surplus or deficit) and develops the self-sufficiency ratios. Section 4 specifies the estimating procedure.

4.1 DETERMINATION OF MARKET REGIONS

Theoretically, market regions are determined by the "locus of points so situated that the site prices (market prices net of transfer cost) for shipments made to competing markets are equal."[52] If we assume two market places, A and B; a farmer situated in region C is

[52] R.G. Bressler, Jr. and R.A. King, op. cit., p. 127.

said to be on the boundary between two market places A and B, if the difference in price between market A and B is equal to the difference in the transfer costs between the farmer and two markets. Algebraically, a farmer is situated on the boundary between two markets A and B if

$$P_a - P_b = t_a - t_b$$

where

P = market price

t =farm-to-market transfer cost, subscripts = alternative markets, A and B.

If $P_a - P_b < t_a - t_b$

then a farmer in region C is in B's market. On the other hand,if

$$P_a - P_b > t_a - t_b$$

then a farmer in region C is in A's market.

If this method is adopted, market regions in a country can be perfectly identified. However, in most empirical work, market regions have been assumed to correspond to political boundaries. This is probably because of the work load involved in determining the market regions using the above described method. Another factor could be the availability of data. Most census data is aggregated according to political boundaries, therefore, unless the researcher is prepared to collect his/her own data, he/she is forced to use the data compiled by the national census. Hence the data determines the choice of market regions.

This study, also, takes market regions as given by the administrative boundaries, though with slight modifications.[53] In this study, the Zambian economy is partitioned into fifteen regions which are identified in Figure 7. A major or central town in each region is used to represent the region. This representative town is used as a basis for determining the distances to other regions. The criteria for determining the regions is based on the following four considerations:

1. the availability of data at district level,
2. the level of development of the transport system in each province, i.e., quality of roads,
3. the size of the province and,
4. the concentration of population.

4.1.1 AVAILABILITY OF DATA AT DISTRICT LEVEL

Initially, the market regions were to be related to the districts of Zambia.[54] This is because the results obtained from spatial equilibrium models become more realistic as the number of regions increase.[55] However, due to the lack of data in some districts and by taking into account considerations 2 and 3 as listed above, the partitioning of the market regions at district level is almost

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[53] In this study, some market regions are identified at district level, some are a combination of two or more districts and others correspond to provinces.

[54] Districts constitute the smallest segments of the Zambian economy at which agricultural data is compiled.

[55] W.A. Tomek and K.L. Robinson, Agricultural Product Prices, 2d ed.,Ithaca: Cornell University Press, 1981,p.163.

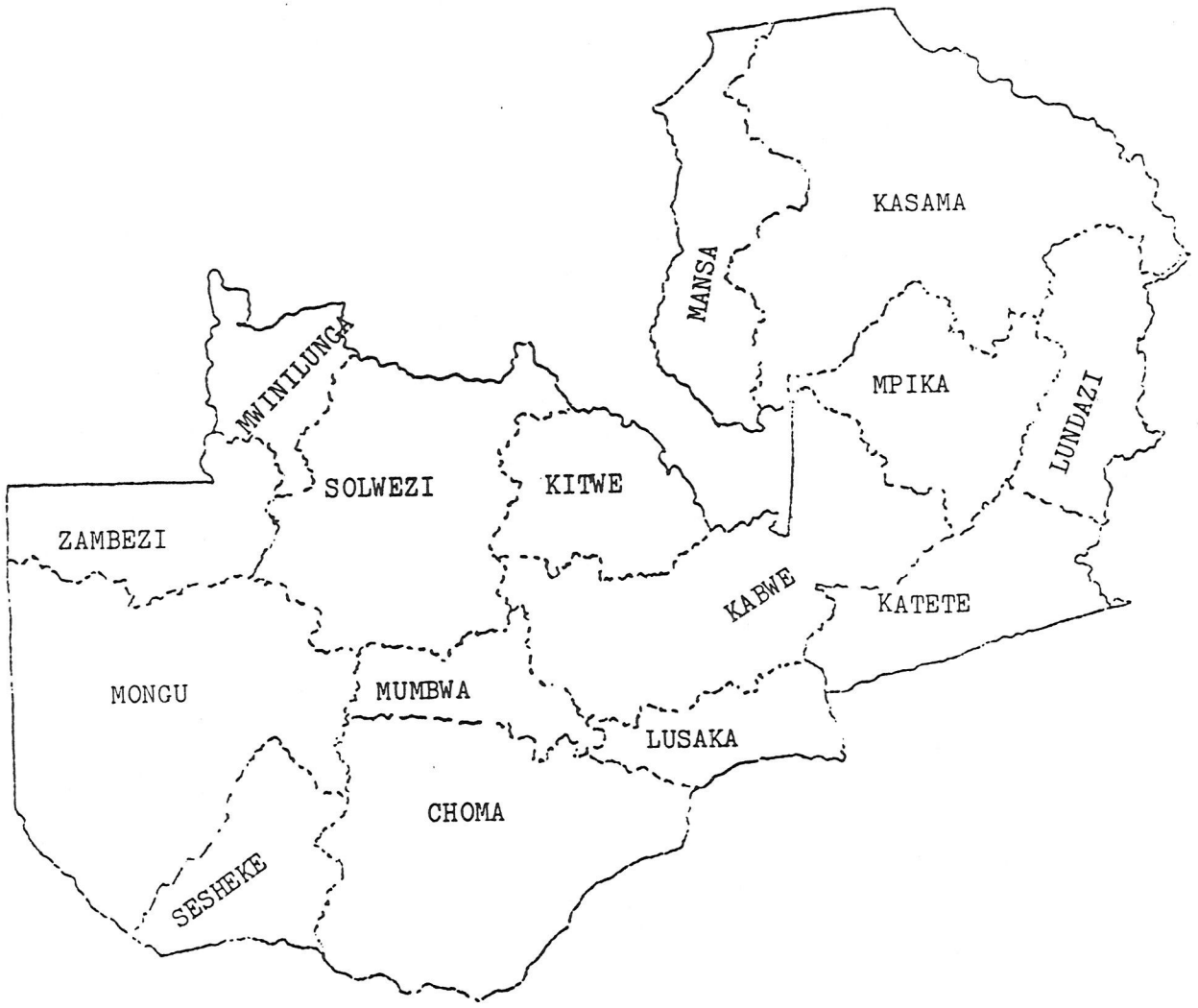

FIGURE 7: MARKET REGIONS

impossible. For instance, in the Southern Province, the purchase figures for maize are not readily available for some districts. As a result, the province is considered as a single market region.

4.1.2 ROAD NETWORK

The level of development of the road network is also considered in determining the market regions. For provinces which do not have a well developed road network, there is a tendency to subdivide such provinces into relatively more regions. This is because if some districts within a province are not easily accessible, it is not realistic to group them under a common market region. This is true for the Luapula and Northwestern Provinces where the road system is not well developed.

On the other hand, for provinces where the road network is well developed, there is a tendency to reduce the number of subdivisions. This is because the transport cost is relatively low in areas with comparatively well developed road networks. This implies that the price differentials among districts in a province with a well developed road network will be relatively small. Therefore, in order to have fairly standardized market regions throughout the country, provinces with comparatively well developed road networks should have comparatively less subdivisions. This is true for the line-of-rail provinces (Lusaka, Southern and the Copperbelt) as shown in Figure 8.

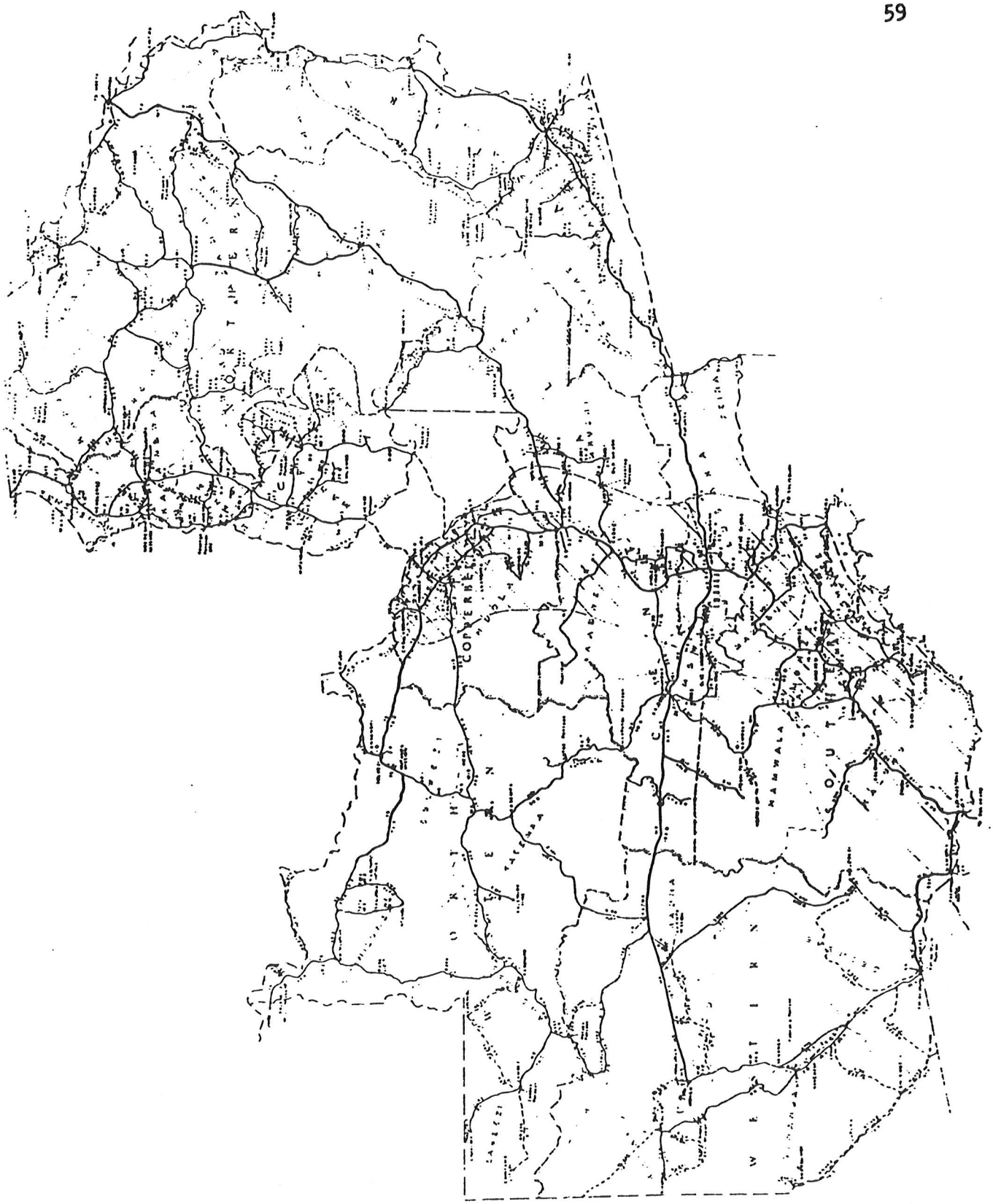

FIGURE 8: ROAD MAP OF ZAMBIA WITH PROVINCES ILLUSTRATED

Source: Zambia, Ministry of Works and Supply, Lusaka: Jan., 1978.

4.1.3 PROVINCE SIZE

The size of the province is also an important factor in determining the number of market regions to be partitioned in a given province. For relatively large provinces, there is a tendency to subdivide them into relatively more market regions. Whereas, for relatively small provinces, fewer market regions are formed. The rationale behind this is that since the distance between the producing and consuming regions determine the magnitude of the transport cost, then larger provinces must have more subdivisions than smaller provinces to reflect the difference in transport cost, ceteris paribus.

4.1.4 POPULATION CONCENTRATION

The concentration of the population is also used in determining the market regions. Where the population is concentrated in a few areas in a given province, less subdivisions are made in that province. For instance, in Lusaka and the Copperbelt Provinces where the population is concentrated in the city of Lusaka and in the neighboring mining towns respectively, no subdivisions have been made.

4.2 MARKET REGIONS

Using the above four criteria, fifteen market regions are identified for the Zambian economy[56] (see Figure 7).

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[56] All subdivisions are made at provincial level, i.e., no attempt is made to integrate districts from different provinces.

4.2.1 CENTRAL PROVINCE

The central province is partitioned into two market regions; Mumbwa and Kabwe regions. The Mumbwa region covers the Mumbwa district, whereas the Kabwe region covers the districts of Kabwe, Mukushi and Serenje. The rationale for these subdivisions is that the Mumbwa district is further away from the line-of-rail. Also, most of the surplus produce marketed from Mumbwa district is shipped to the Western province whereas that marketed from Kabwe, Mukushi and Serenje districts is sold to either Lusaka or the Copperbelt and/or Northwestern provinces. Hence the two separate market regions.

4.2.2 EASTERN PROVINCE

The Eastern province is partitioned into two market regions; Katete and Lundazi regions. Katete region is comprised of the Petauke, Katete and Chipata districts. Lundazi and Chama districts make up the Lundazi region. The main reason for partitioning the Eastern Province into these two market regions is because of the great distance (265km) between the two market regions.

4.2.3 NORTHERN PROVINCE

The Northern province is also partitioned into two market regions; Mpika and Kasama. The Mpika region is the Mpika district. Whereas the Kasama region includes Kasama, Mbala, Kaputa and Mporokoso districts. In the partitioning of this province, the size of the province and the level of development of the road network were the important considerations. The Northern Province is a large province

with a poorly developed road network especially in the northern part (see Figure 8). For this reason, the northern part of the province was delineated as a separate market region from the southern part.

4.2.4 SOUTHERN PROVINCE

The Southern province has only one market region, Monze. The main reason for having only one market region in this province, is that the purchase data for maize at district level within this province is not available.

4.2.5 LUSAKA PROVINCE

The Lusaka province has only one market region, Lusaka. This is because it is a small province and most of its inhabitants (about 90 percent) are concentrated in the city of Lusaka.

4.2.6 COPPERBELT PROVINCE

The Copperbelt province has only one market region, Kitwe. This is because it is also a relatively small province. In addition, most of its inhabitants are located in the neighboring mining towns (Kitwe, Mufurila, Chingola) and the city of Ndola.

4.2.7 LUAPULA PROVINCE

The Luapula Province, like the Lusaka and the Copperbelt Provinces has only one market region, Mansa. This is because it is a relatively small province as shown in Figure 8.

4.2.8 WESTERN PROVINCE

The Western Province is partitioned into two market regions; Mongu and Sesheke regions. The Mongu region covers Kaoma, Mongu and Kalabo districts. The Sesheke region covers Sesheke district. The main reason for isolating Sesheke district from the rest of the districts in the province is that most of the trade between Sesheke district and the other parts of the country is via the town of Livingstone, whereas the other districts are linked to other parts of the country via Lusaka.

4.2.9 NORTHWESTERN PROVINCE

This province is partitioned into three market regions; Solwezi, Mwinilunga and Zambezi. The main reason for partitioning this province into these regions is because of its relatively large size and poorly developed road network.

4.3 THE DATA

As indicated in section 4.2, the Zambian economy has been partitioned into fifteen regions. For the calendar years 1978 and 1981, regional sales and purchases of maize are provided in Table 3. The data showing excess demand (ED) and excess supply (ES) for deficit and surplus regions respectively, and the official interregional transport cost rates are given in Tables 4 and 5.

The purchase data reflect the number of 90 Kilogram bags of maize that have been produced in each region. These data were mainly collected from the National Agricultural Marketing Board's provincial

TABLE 3: REGIONAL DEMANDS AND SUPPLIES OF MAIZE IN ZAMBIA

REGIONS	1978 SUPPLY	1978 DEMAND	1981 SUPPLY	1981 DEMAND
	(90 Kg.)			
(1) CHOMA	3,076,981	717,886	1,554,452	645,487
(2) MUMBWA	388,025	182,995	338,347	140,232
(3) KABWE	1,656,084	771,021	2,765,245	590,832
(4) LUNDAZI	78,206	19,357	283,483	22,595
(5) KATETE	1,503,422	68,882	900,753	80,409
(6) MPIKA	92,771	25,086	165,927	15,975
(7) KASAMA	96,312	54,914	159,664	34,969
(8) LUSAKA	413,336	1,853,566	191,813	1,408,135
(9) KITWE	70,116	3,004,556	35,188	2,705,750
(10) MONGU	38,093	108,369	39,378	209,424
(11) SESHEKE	1,444	14,147	3,223	27,336
(12) MANSA	32,288	269,205	19,209	201,377
(13) MWINILUNGA	4,163	7,630	5,361	12,179
(14) SOLWEZI	24,917	50,012	21,265	79,823
(15) ZAMBEZI	10,975	33,940	14,914	54,179

TABLE 4: TRANSPORT COST TABLEAU AND EXCESS DEMAND (ED) AND SUPPLY (ES) 1978

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) SOLWEZI	(14) MWINILUNGA	(15) ZAMBEZI	ES
	(Kwacha/90 Kg. bag of maize)								('000) 90 Kg.
(1) CHOMA	2.0	4.6	6.3	2.7	6.1	6.3	8.3	9.4	2359.1
(2) MUMBWA	1.4	3.0	3.2	5.6	4.4	4.5	6.6	7.7	205.0
(3) KABWE	1.2	1.6	4.5	5.8	3.0	3.2	5.3	6.4	885.1
(4) LUNDAZI	5.6	7.9	9.5	10.1	9.4	9.6	11.6	12.7	58.9
(5) KATETE	3.5	6.0	7.7	8.2	7.5	7.7	9.7	10.8	1435.5
(6) MPIKA	4.6	4.2	8.1	9.4	4.0	5.8	7.9	8.9	67.7
(7) KASAMA	6.1	5.8	9.6	10.9	2.5	5.4	7.5	9.1	41.4
ED ('000) 90 Kg.	1440.2	2934.4	70.3	12.7	237.0	3.5	25.1	23.0	

TABLE 5: TRANSPORT COST TABLEAU AND EXCESS DEMAND (ED) AND SUPPLY (ES) 1981

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) SOLWEZI	(14) MWINILUNGA	(15) ZAMBEZI	ES
	(Kwacha/90 Kg. bag of maize)								('000) 90 Kg.
(1) CHOMA	2.6	5.8	7.8	3.4	7.6	7.8	10.4	11.8	909.0
(2) MUMBWA	1.6	3.7	4.0	7.0	5.5	5.7	8.3	9.6	198.1
(3) KABWE	1.5	2.0	5.6	7.2	3.8	4.0	6.6	8.0	2174.4
(4) LUNDAZI	7.1	10.0	12.0	12.6	11.7	11.9	14.5	15.9	261.0
(5) KATETE	4.3	7.6	9.6	10.3	9.4	9.6	12.2	13.5	820.3
(6) MPIKA	5.8	5.3	10.1	11.7	5.0	7.3	9.9	11.2	150.0
(7) KASAMA	7.7	7.2	12.0	13.6	3.1	6.7	9.3	11.4	124.7
ED ('000) 90 Kg.	1216.3	2670.6	170.1	24.1	182.2	6.8	58.6	39.4	

offices except for the Eastern Province where the data was obtained from the Eastern Province Marketing Cooperative Union.[57]

The sales data reflect the number of 90 Kilogram bags of maize sold by the National Agricultural Marketing Board in each region. The National Agricultural Marketing Board compiles these sales data at the provincial level. To determine regional sales data it was assumed that only people who live in urban areas consume the marketed maize. This is a realistic assumption since most of the marketed maize is sold to people in the urban areas. On the basis of this assumption and by making use of the National Agricultural Marketing Board's sales data in each province, and the urban population in each region, the regional demand for maize is ascertained, i.e.,

$$D_K = \left(\frac{S_L}{P_L} \right) P_K$$

where K = 1,2..., 15

L = 1,2..., 9

D_K = demand for maize in region K

S_L = total maize sales in province L

P_L = total urban population in province L

P_K = total urban population in region K

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[57] In the Eastern Province, the Cooperative Union has been more active in the marketing of maize than the National Agricultural Marketing Board.

Then, by taking the differences between the regional purchases and sales figures, the status of a region - either surplus or deficit is determined.

For the years under consideration (1978 and 1981), the following regions are identified as surplus.[58]

1. Choma
2. Mumbwa
3. Kabwe
4. Lundazi
5. Katete
6. Mpika
7. Kasama

And the following regions are identified as deficit;

8. Lusaka
9. Kitwe
10. Mongu
11. Sesheke
12. Mansa
13. Mwinilunga
14. Solwezi
15. Zambezi

The magnitude of the excess supply in a surplus region and the magnitude of excess demand in a deficit region is shown by determining the self-sufficiency ratios in each region.

For surplus regions, the regional self-sufficiency ratios (R_i) are defined algebraically as:

$$R_i = \frac{D_i}{S_i}$$

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[58] During drought periods, it is possible that these surplus regions can become deficit rigions.

where D_i = total demand in region i

S_i = total supply in region i

i = 1,2,..., 7

and for the deficit regions, the regional self-sufficiency ratios (R_j) are defined algebraically as:

$$R_j = \frac{D_j}{S_j}$$

where D_j = total demand in region j

S_j = total supply in region j

j = 1,2,..., 8

Using the data provided in Table 3, the self-sufficiency ratios are determined as shown in Table 6. These market region self-sufficiency ratios indicate the level of self-sufficiency in each region. A self-sufficiency ratio of one indicates equality between regional supply and demand. A ratio which is greater than one or less than one indicates regional excess supply or regional excess demand respectively. For surplus regions, the ratios indicate how much maize has been produced above the regional consumption requirement. For instance, a self-sufficiency ratio of 4 for the Lundazi region in 1978 indicates that the excess maize in Lundazi was 4 times more than what is regionally demanded. In the case of deficit regions, the self-suffi-

TABLE 6: REGIONAL SELF-SUFFICIENCY RATIOS

	1978	1981
SURPLUS REGIONS:		
(1) CHOMA	4.29	2.41
(2) MUMBWA	2.12	2.41
(3) KABWE	2.15	4.68
(4) LUNDAZI	4.04	12.55
(5) KATETE	21.83	11.20
(6) MPIKA	3.70	10.39
(7) KASAMA	1.75	4.57
DEFICIT REGIONS:		
(1) LUSAKA	0.22	0.14
(2) KITWE	0.02	0.01
(3) MONGU	0.35	0.19
(4) SASHEKE	0.10	0.12
(5) MANSA	0.12	0.10
(6) MWINILUNGA	0.55	0.44
(7) SOLWEZI	0.51	0.27
(8) ZAMBEZI	0.32	0.28

ciency ratios indicate the proportion of the regional demand that is met from regional supplies. For instance, a self-sufficiency ratio of 0.50 for Solwezi in 1978, indicates that the regional supplies from the Solwezi region could only meet half of the region's total demand for maize.

4.4 ESTIMATING EQUATION

In order to estimate the optimal commodity flows and the equilibrium prices in each region, the transportation model with the help of linear programming techniques is being used. From the transport cost tableau provided in Tables 4 and 5, the primal and the dual problems are specified as follows:

4.4.1 THE PRIMAL PROBLEM

$$\text{Minimize } Zp = \sum_{i=1}^{7} \sum_{j=8}^{15} t_{ij} X_{ij}$$

Subject to,

$$\sum_{i=1}^{7} X_{ij} \geqslant ED_j$$

$$\sum_{j=8}^{15} X_{ij} \leqslant ES_i$$

$$X_{ij} \geqslant 0, \text{ for all } i \text{ and } j$$

where;

Zp = the objective function

t_{ij} = the transport cost from region i to region j

X_{ij} = the commodity flow from region i to region j

ED_j = the excess demand in region j

ES_i = the excess supply in region i

The solution to the primal problem indicates the least cost routes for shipping maize under a free market pricing system. It also shows the exact number of 90 Kilogram bags of maize ($\bar{X}_{ij}$) that should be shipped to ensure minimum shipping costs.

4.4.2 THE DUAL PROBLEM

Maximize

$$Z_d = \sum_{j=8}^{15} ED_j \bar{P}_j - \sum_{i=1}^{7} ES_i \bar{P}_i$$

Subject to

$$\bar{P}_j - \bar{P}_i \leqslant t_{ij}$$

$$P_j, P_i \geqslant 0, \text{ for all } i \text{ and } j$$

where;

Z_d = objective function,

$\bar{P}_i$ = equilibrium price differential in region i,

$\bar{P}_j$ = equilibrium price differential in region j.

The solution to the dual problem provides the regional market prices under a free market pricing system. In this study these market prices are treated as regional market price differentials because production costs are not incorporated but assumed uniform.

Chapter V

ANALYSIS OF THE RESULTS

The purpose of this chapter is to analyze the results obtained from the model specified in chapter 4. The results of the primal formulation show the least cost interregional trade routes and their corresponding quantities of 90 kilogram bags of maize to be traded among regions under the free market pricing system. The model also shows the per unit cost in Kwacha that is incurred if the interregional pattern of trade deviates from the optimal flow obtained under a free market system. The solution to the dual formulation imputes market prices to the regional demand and supply locations. The ranges in which the transport costs and, the regional demand and supply of maize can be varied without changing the optimal solution are also provided.

It is worth noting that the results of this study tend to agree with most of the previous studies that have been done on the pricing of maize in Zambia. Specifically, the results of this study tend to reaffirm the assertion that producers in the Zambezi, Solwezi, Mansa and Mongu regions receive far below the market price for their produce.[59] It has also confirmed the assertions of Dodge,[60] Elling[61]

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[59] D. Dodge, op. cit., p. 103.

[60] Ibid., pp. 101-105.

[61] M. Elling, op. cit., p. 54.

and Elliott[62] that the Lundazi and Katete regions are at a locational disadvantage in as far as the marketing of maize is concerned.

5.1 OPTIMAL FLOW OF MAIZE

The results obtained for the optimal routes in the marketing of maize show a high degree of consistency for both years under consideration (1978 and 1981), as shown in Tables 7 and 8. Both tables indicate the trading regions and the optimal allocation of 90 kilogram bags of maize that can be shipped from one region to another. The last row and column (slack) of both tables show the difference between regional excess demand and imports and, regional excess supply and exports respectively. A zero slack indicates equality between excess demand or excess supply and imports or exports respectively. A positive slack indicates unbalanced regional demand and imports or regional supply and exports. Thus, for instance, in Table 7 a positive slack of 248,000 bags of maize for Katete region implies that supply in this region exceeds demand by 248,000 bags of maize at the prevailing market prices. The number of bags of maize that are shipped among regions in terms of 90 kilogram bags are given in the body of both Tables 7 and 8. From Table 8, Mpika should ship 81,000 bags of maize to Kitwe, 58,000 to Mansa and 11,000 to Zambezi under a free market pricing system.

From the results shown in Tables 7 and 8, generalizations about the optimum pattern of trade under a free market pricing system can be made, i.e., the Choma region should trade with the Lusaka, Kitwe,

[62] C. Elliott, op. cit., p. 32.

TABLE 7: OPTIMAL FLOW OF MAIZE IN ZAMBIA UNDER A FREE MARKET PRICING SYSTEM 1978

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) MWINILUNGA	(14) SOLWEZI	(15) ZAMBEZI	SLACK
				('000) 90 Kg.					(i)
(1) CHOMA	1440.0	900.6		13.0					0.0
(2) MUMBWA		83.0	70.0			4.0	25.0	23.0	0.0
(3) KABWE		757.0			128.0				0.0
(4) LUNDAZI									59.0
(5) KATETE		1188.0							248.0
(6) MPIKA					68.0				0.0
(7) KASAMA					41.0				0.0
SLACK (j)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

TABLE 8: OPTIMAL FLOW OF MAIZE IN ZAMBIA UNDER A FREE MARKET PRICING SYSTEM 1981

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) MWINILUNGA	(14) SOLWEZI	(15) ZAMBEZI	SLACK (i)
				('000) 90 Kg.					
(1) CHOMA	405.0	415.0		24.0		7.0	59.0		0.0
(2) MUMBWA			170.0					28.0	0.0
(3) KABWE		2174.0							0.0
(4) LUNDAZI									261.0
(5) KATETE	812.0								9.0
(6) MPIKA		81.0			58.0			11.0	0.0
(7) KASAMA					125.0				0.0
SLACK (j)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	

Sesheke, and Zambezi regions. The Mumbwa region should trade with the Mongu, Solwezi and Zambezi regions. The Kabwe and Katete regions should trade with the Kitwe region and, the Mpika and Kasama regions with the Mansa region. According to the results obtained for both years, the Lundazi region has no market for its surplus maize. This implies that if a free market price system is adopted, the producers from the Lundazi region would find it unprofitable to produce excess maize. Also, for both years, the Katete region has a positive slack. This indicates that the Katete region like the Lundazi region produces more than the market can absorb under the prevailing prices. Thus, if market forces determined the price for maize, producers in the Katete region would find it unprofitable to produce maize at the current level.

Information obtained about the optimal flow of maize under a free market pricing system contrasts with the flow of maize under the current uniform pricing system. Under the current uniform pricing system, all surplus producing regions have an equal opportunity for marketing their excess produce. Also, little attention, if any, is paid to the pattern of interregional distribution of maize because the transport cost does not affect production at farm level. It is, however, shown that if the free market price system is adopted, regions such as Lundazi and Katete will have to drastically reduce their maize production. Among the feasible surplus producing regions, shipments would be made to specific regions. In this manner, the transport cost budget to the Zambian government would be greatly reduced.

The saving in transport cost under a free market pricing system is indicated by the information shown in Tables 9 and 10. These tables show the difference between official transport cost rates and the true transport cost rates[63] as determined under competitive conditions. The zero entries indicate equality between the official transport cost rates and the true transport cost rates. They also indicate the least cost routes under a free market pricing system. The positive entries indicate that the official transport cost rates are greater than the true transport cost rates. The entries, expressed in terms of Kwacha, indicate the extra cost incurred per bag of maize by deviating the shipments from the optimal routes. Thus, for instance, if the produce from Choma is shipped to Mongu, then an extra cost of K1.50 will be incurred for every bag of maize shipped.

From both tables (9 and 10), it is evident that the extra cost the government has to pay for making both the Lundazi and the Katete regions competitive in the production of excess maize is considerable. For instance, if we take the average transport cost rate for Lundazi for the 1981 market season (K3.60), and multiply it by the excess production during that year, the cost to the government for shipping this output is K939,600.00. The cost to the government under a uniform pricing system is magnified by the distortion in the shipments that result from introducing non-optimal regions into competitive producing regions.

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[63] True transport cost rates refers to the rates that could have prevailed under competitive conditions.

TABLE 9: COST OF USING NONOPTIMAL ROUTES 1978

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) MWINILUNGA	(14) SOLWEZI	(15) ZAMBEZI
	(Kwacha/90 Kg. bag of maize)							
(1) CHOMA	0.0	0.0	1.5	0.0	0.1	0.2	0.1	0.1
(2) MUMBWA	1.0	0.0	0.0	4.5	0.0	0.0	0.0	0.0
(3) KABWE	2.2	0.0	2.7	6.1	0.0	0.1	0.1	0.1
(4) LUNDAZI	2.2	1.9	3.3	6.0	2.0	2.1	2.0	2.0
(5) KATETE	0.1	0.0	1.5	4.1	0.1	0.2	0.1	0.1
(6) MPIKA	4.6	1.6	5.3	8.7	0.0	1.7	1.7	1.6
(7) KASAMA	7.5	4.7	8.3	11.7	0.0	2.8	2.8	3.3

TABLE 10: COST OF USING NONOPTIMAL ROUTES 1981

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) MWINILUNGA	(14) SOLWEZI	(15) ZAMBEZI
	(Kwacha/90 Kg. bag of maize)							
(1) CHOMA	0.0	0.0	1.7	0.0	2.1	0.0	0.0	0.1
(2) MUMBWA	1.1	0.0	0.0	5.7	2.1	0.0	0.0	0.0
(3) KABWE	2.7	0.0	3.3	7.6	2.1	0.0	0.0	0.1
(4) LUNDAZI	2.8	2.5	4.2	7.5	4.5	2.4	2.4	2.5
(5) KATETE	0.0	0.1	1.8	5.2	2.2	0.1	0.1	0.1
(6) MPIKA	3.7	0.0	4.5	8.8	0.0	0.0	0.0	0.0
(7) KASAMA	7.5	3.8	8.3	12.6	0.0	1.3	1.3	2.1

The information shown in Tables 9 and 10 can also be used to determine regions with a comparative advantage in maize production, and to suggest less costly routes under a uniform pricing system. Regions with relatively more zero entries signify a comparative advantage in maize production than regions with fewer zero entries. From the results obtained, the Choma, Mumbwa and Kabwe regions show a comparative advantage over the other surplus producing regions. The Lundazi region is noncompetitive as far as the production of maize is concerned.

Under a uniform pricing system, the government can reduce transport costs by making sure that shipments are made to regions with least cost routes as determined under a free market pricing system. Given that the Lundazi region is the most constraining region in determining the least cost routes for all surplus producing regions, then, one possible method of determining the most efficient routes under a uniform pricing system is to first allocate the shipments from Lundazi region. Thus, for instance, maize from Lundazi could be shipped to Kitwe, Solwezi and Zambezi. Maize from Katete could be shipped to Lusaka, Kitwe, Mwinilunga, Solwezi and Zambezi. Maize from Mpika and Kasama could be shipped to Mansa. Maize from Kabwe could be shipped to Kitwe, Mwinilunga, Solwezi and Zambezi, whereas maize from Mambwa could be shipped to any deficit region other than Sesheke and Mansa and, maize from Choma could also be shipped to any deficit region other than Mongu and Mansa. This pattern of maize shipments reflects one possible set of cost reducing interregional flows of maize under the current uniform pricing system.

5.2 REGIONAL MARKET PRICES

The solution to the dual formulation imputes regional market price differentials which are given in Tables 11 and 12 for the years 1978 and 1981 respectively. The last column shows the price differences among surplus producing regions taking the Lundazi or the Katete region as the base. The last row shows the price differences among deficit regions in comparison to the price in either the Lundazi or the Katete region. The main core of the matrix in Tables 11 and 12 indicates the true transport cost rates for shipping maize from a surplus region to any deficit region under a free market pricng system.

The results show quite a considerable variation in regional market prices both within and among groups. For instance, the price can vary by as much as five Kwacha in the surplus regions taking Lundazi or Katete as the base. In the deficit regions, the price can vary by as much as seven Kwacha taking Lusaka as the base region. As shown in Tables 11 and 12, the price variation among all regions can be as much as eleven Kwacha.

Among the surplus producing regions, the Lundazi and Katete regions have the lowest market prices. This is, however, not surprising since both regions have a positive slack in their production as shown in Tables 7 and 8. The existence of a positive slack implies that the opportunity cost associated with the production of maize is zero, hence a corresponding zero market price. However, in this study, a zero market price does not imply a zero cost of production since this is assumed to be uniform. A zero market price is merely used as a

basis for comparing regional price differentials. The Kabwe and Kasama regions show the highest market prices among the surplus regions which implies a comparative advantage in the production of maize under a free market pricing system - assuming equal per unit cost of production among all surplus producing regions.

Among the consuming regions, the Lusaka and Sesheke regions show the lowest prices whereas the Zambezi, Solwezi and Mwinilunga regions show relatively higher prices. These results agree with Dodge's[64] assertion that the producers from the Zambezi, Solwezi, Mwinilunga, etc., have been at a considerable economic disadvantage with the uniform pricing system. Perhaps, the most striking piece of information gained from Tables 11 and 12 is the variation in market prices among some of the producing and consuming regions. These wide differences in market prices which reflect opportunity costs pose some doubt as to whether a uniform pricing system can really be justified even on the grounds of equity and, whether it is capable of meeting the government's objective of attaining regional self-sufficiency in maize production.

From the results obtained from the analysis of the regional market prices, the imposition of a national uniform producer price would be biased towards producers in surplus producing regions while leaving the producers in deficit regions either unaffected or adversely affected by such a policy. For instance, if one assumes that the uniform pricing system is based on average regional market prices, then it is evident that producers in deficit regions would receive

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[64] Dodge, op.cit., p. 105.

TABLE 11: EQULIBRIUM COST MATRIX 1978

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) MWINILUNGA	(14) SOLWEZI	(15) ZAMBEZI	PRICE DIFFERENTIALS (-i)
	(Kwacha/90 Kg. bag of maize)								
(1) CHOMA	2.0	4.6	4.8	2.7	6.0	6.1	8.2	9.3	1.4
(2) MUMBWA	0.4	3.0	3.2	1.1	4.4	4.5	6.6	7.7	3.0
(3) KABWE	-1.0	2.4	1.8	-0.3	3.0	3.1	5.2	6.3	4.4
(4) LUNDAZI	3.4	6.0	6.2	4.1	7.4	7.5	9.6	10.7	0.0
(5) KATETE	3.4	6.0	6.2	4.1	7.4	7.5	9.6	10.7	0.0
(6) MPIKA	0.0	2.6	2.8	0.7	4.0	4.1	6.2	7.3	3.4
(7) KASAMA	-1.5	1.1	1.3	0.8	2.5	2.6	4.7	5.8	4.9
PRICE DIFFERENTIALS (j)	-3.4	-6.0	-6.2	-4.1	-7.4	-7.5	-9.6	-10.7	

TABLE 12: EQULIBRIUM COST MATRIX 1981

DEMAND/ SUPPLY	(8) LUSAKA	(9) KITWE	(10) MONGU	(11) SESHEKE	(12) MANSA	(13) MWINILUNGA	(14) SOLWEZI	(15) ZAMBEZI	PRICE DIFFERENTIALS (+i)
	(Kwacha/90 Kg. bag of maize)								
(1) CHOMA	2.6	5.8	6.1	3.4	5.5	7.8	10.4	11.7	1.7
(2) MUMBWA	0.5	3.7	4.0	1.3	3.4	5.7	8.3	9.6	3.8
(3) KABWE	-1.2	2.0	2.3	-0.4	1.7	4.0	6.6	7.9	5.5
(4) LUNDAZI	4.3	7.5	7.8	5.1	7.2	9.5	12.1	13.4	0.0
(5) KATETE	4.3	7.5	7.8	5.1	7.2	9.5	12.1	13.4	0.0
(6) MPIKA	2.1	5.3	5.6	2.9	5.0	7.3	9.9	11.2	2.2
(7) KASAMA	0.2	3.4	3.7	1.0	3.1	5.4	8.0	9.3	4.1
PRICE DIFFEREN-TIALS (j)	-4.3	-7.5	-7.8	-5.1	-7.2	-9.5	-12.1	-13.4	

prices below the market prices, whereas most of the producers in the surplus regions would be paid prices above the market prices. Such a policy implies that farmers in the surplus regions would have an incentive to increase their output whereas those in the deficit regious would have no incentive to increase their output to meet the ever increasing demand. This policy, apart from being inequitable to farmers in the deficit regions, is diametrically opposed to the government's objective of attaining regional self-sufficiency in food production.

On the other hand, if one assumes that the uniform pricing system is based on the highest regional market price in the country, then, this implies that the prices for producers in surplus regions would be highly inflated. If this policy is adopted, then the government would have to support these artificially high prices in the surplus regions. Given that some of the surplus regions are not economically feasible for massive maize production, such price support would be an unnecessary cost to the government. Also, such a policy would still favor producers in the surplus regions. Thus, given the reasonably high ranges in market prices between the surplus and deficit regions, a uniform pricing system would never be equitable to both producers in the surplus as well as deficit regions.

5.3 A PROPOSAL FOR A REGIONALLY CONTROLLED DIFFERENTIATED PRICING SYSTEM

In the preceding sections, it has been shown that a uniform pricing system is inefficient in terms of equitable distribution of income among farmers, allocation of resources, and meeting the government objective of attaining regional self-sufficiency in food production. This section proposes a pricing mechanism which is capable of guaranteeing equitable returns to farmers in both deficit and surplus regions, improving efficient allocation of resources and assisting in the attainment of regional self-sufficiency in food production. A regionally controlled differentiated pricing system is proposed. Under this pricing system the producer price of maize will reflect regional market prices. By making use of the results obtained from Tables 7, 8, 9, 10, 11, 12, 13, the self-sufficiency ratios (Table 5) and the agronomic conditions of each region (Figure 2), guidelines towards this proposed pricing system have been developed.

Firstly, if we consider Table 13 which shows the allowable increase and decrease in the regional supply and demand positions for maize for the years 1978 and 1981, it is evident that there is considerable room for decreasing maize production in the surplus regions and increasing maize production in the deficit regions without changing the optimal flow of maize within the country. This result justifies price discrimination against surplus regions so that resources can be more efficiently allocated with the hope of stimulating increased production in the deficit regions. Also, the results of the regional self-sufficiency ratios indicate that the surplus regions produce more

than twice as much maize as is regionally demanded. This, too, shows that a modest decrease in price in the surplus regions would not upset the current status of these regions. However, for the purpose of maintaining a steady increase in maize production at the national level, an incentive should be added to the market price of the surplus regions which are situated in both agronomically and economically feasible areas. By making use of Figure 2 and Tables 7, 8, 9 and 10, the regions which deserve an incentive can be determined.

From Figure 2, which shows the agronomic conditions of the regions, the Choma, Mumbwa, Katete and some parts of Lundazi region indicate favorable soils for agricultural production. However, the presence of a positive slack for Lundazi and Katete regions in Tables 7 and 8, and also the comparatively fewer numbers of optimal routes for both Katete and Lundazi regions as shown in Tables 9 and 10, indicates that both the Lundazi and Katete regions are not economically feasible for the massive production of excess maize. Thus, this result precludes both the Lundazi and Katete regions from receiving an incentive to stimulate increased production of maize. Hence, if the government wants to promote maize production, their efforts should be directed to the Choma, Mumbwa and Kabwe regions which show both good agricultural soils and favorable locations to the major markets.

Regional producer prices should tend to reflect market prices as determined under a competitive environment. The regional market price differentials are illustrated in Table 14. This table shows the average price differentials between regions for the years 1978 and 1981. If we take the Katete or the Lundazi price as the basis for

TABLE 13: SENSITIVITY ANALYSIS FOR RIGHT HAND SIDE (RHS) RANGES

	1978			1981		
	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE	CURRENT RHS	ALLOWABLE INCREASE	ALLOWABLE DECREASE
	('000) 90 Kg./bag of maize					
(1) CHOMA	-2359	248	1188	-909	9	812
(2) MUMBWA	- 205	83	1188	-198	9	11
(3) KABWE	- 805	248	1188	-2174	9	415
(4) LUNDAZI	- 59	59	∞	-261	261	∞
(5) KATETE	-1436	248	∞	-820	9	∞
(6) MPIKA	- 68	68	128	-150	9	415
(7) KASAMA	- 41	41	128	-125	9	58
(8) LUSAKA	1440	248	1188	1216	9	812
(9) KITWE	2934	248	1188	2671	9	415
(10) MONGU	70	83	70	170	9	11
(11) SESHEKE	13	248	13	24	9	24
(12) MANSA	237	248	128	182	9	56
(13) MWINILUNGA	4	83	4	7	9	7
(14) SOLWEZI	25	83	25	59	9	59
(15) ZAMBEZI	23	83	23	39	9	11

TABLE 14: AVERAGE EQUILIBRIUM COST MATRIX FOR 1978 AND 1981

DEMAND/ SUPPLY	LUSAKA	KITWE	MONGU	SESHEKE	MANSA	MWINILUNGA	SOLWEZI	ZAMBEZI	AVERAGE PRICE DIFFERENTIALS (-i)
				(Kwacha/90 Kg. bag of maize)					
(1) CHOMA	2.3	5.2	5.4	3.0	5.7	6.9	9.3	10.5	1.6
(2) MUMBWA	0.5	3.4	3.6	1.2	3.9	5.1	7.5	8.7	3.4
(3) KABWE	-1.1	1.8	2.0	-0.4	2.3	3.5	5.9	7.1	5.0
(4) LUNDAZI	3.9	6.8	7.0	4.6	7.3	8.5	10.9	12.1	0.0
(5) KATETE	3.9	6.8	7.0	4.6	7.3	8.5	10.9	12.1	0.0
(6) MPIKA	1.1	4.0	4.2	1.8	4.5	5.7	8.1	9.3	2.8
(7) KASAMA	-0.6	2.3	2.5	0.1	2.8	4.0	6.0	7.6	4.5
AVERAGE PRICE DIFFEREN-TIALS (j)	-3.9	-6.8	-7.0	-4.6	-7.3	-8.5	-10.9	-12.1	

determining other regional prices, then, the price in Choma can be as high as K1.60 above the Lundazi or Katete price. The Mumbwa price can be as high as K3.40, the Kabwe K5.00, the Mpika K2.80 and the Kasama K4.50 above the Katete or Lundazi price. The actual price differentials will depend on which areas the government feels should be devoted to maize production. As for the deficit regions, the price differentials between the Lundazi or Katete price can be as high as K3.90 for the Lusaka region, K6.80 for Kitwe, K7.00 for Mongu, K4.60 for Sesheke, K7.30 for Mansa, K8.50 for Mwinilunga, K10.90 for Solwezi and K12.10 for Zambezi above the Lundazi or Katete Price. The actual price differences would depend on the responsiveness of these deficit regions to price changes. For instance, regions which have the potential for increasing the output of maize should be granted prices which reflect the market prices whereas the producer price for regions with no potential of increasing their output should depend on what the government deems is a fair price to consumers - of course taking into account the distance involved in shipping maize into the region.

The regionally controlled differentiated pricing system seems to be a more efficient pricing system compared to a uniform pricing system in terms of resorce allocation. By allowing producer prices to reflect regional market prices, the resources would be more efficiently allocated. Also, a regionally controlled pricing system is compatible with the government objective of attaining regional self-sufficiency in food production. It would also reduce the government budget for transport cost by either stimulating increased production in the deficit regions or giving a price which would take

into account transport costs. It would also ensure a steady growth in maize production which is threatened under a free market price system.

Chapter VI

SUMMARY AND IMPLICATIONS

An organized pricing system for maize in Zambia can be traced back to 1936. The reason for introducing an organized pricing system was to control excess production of maize which became very expensive to dispose of due to falling demand. Under the 1936 pricing system, a quota system was introduced in which indigenous farmers were allocated only one-fourth of the total market demand for maize. Since then, other forms of pricing mechanisms have been employed. Until 1964, the emphasis of the various pricing strategies introduced were for the benefit of settler farmers. This was accomplished by offering a relatively higher price for maize sold by the settler farmers.

After attaining independence in 1964, the government's emphasis on agricultural development shifted from that of promoting settler farmers to a nondiscriminatory pricing system. Both settler and indigenous farmers located in the same regions received the same price for their produce. However, farmers in the deficit regions received a higher price than farmers in surplus regions - especially those further away from the major producing areas. This pricing structure persisted until 1973 when a universal pricing system was introduced. Under the universal (uniform) pricing system, all farmers regardless of either their locational position from the market or whether they were in a surplus or deficit region, received the same price for their

produce. The uniform pricing system has been applied to all agricultural commodities marketed by the official marketing institutions. The main reason attributed for introducing a uniform pricing system is that of equity. It has been argued that each farmer should receive the same price for his/her produce regardless of his/her locational position.

Since its inception, the uniform pricing system has received a lot of criticisms from the World Bank, Food and Agriculture Organization (FAO) and some Zambian government officials. The most potent criticism against the uniform pricing system has been that of inefficiency. Because of its failure to take account of the supply and demand positions in each region, the uniform pricing system has encouraged excessive production of maize in areas where it is not economically feasible to do so. This situation has forced the government to incur excessive costs for hauling maize from distant surplus areas to the major consuming areas. It has been argued that the uniform pricing system is at variant with the government's objective of attaining regional self-sufficiency in food production. As an alternative to the current uniform pricing system, the free market pricing system and its second best, the World price equivalent has been recommended. However, despite the government's recognition of the weaknesses of the uniform pricing system, it has been hesitant to change it.

From the situation outlined above, the primary objective of this thesis has been to determine the optimal routes for hauling maize in Zambia. Another objective has been to determine and compare price variations under a uniform pricing system to those obtained under a

free market pricing system and the third objective is that if there are considerable differences between the uniform pricing system and free market prices then an alternative pricing system would be proposed. The pricing system to be proposed should be both economically and politically acceptable.

By making use of the spatial equlibrium model, the optimal flow of maize for the years 1978 and 1981 have been determined. For both years, the results persistently show that the Lundazi and Katete regions are not economical regions for the massive production of maize. This result has agreed with earlier studies that indicated the Eastern Province (Lundazi and Katete regions) was not economically feasible for the production of maize for marketing in the major consumption areas.

The results of the regional market price differentials show considerable variation in price among regions. For instance, the average price difference for the years under consideration is as high as K12.10. These wide variations in regional market prices make it very difficult to justify the reasons for introducing a uniform pricing system. The results also show that the price differentials are highest among deficit regions lying out of the line-of-rail provinces. This, too, justifies Dodge's[65] assertion that the victims of the uniform pricing system are those in the remote and deficit provinces.

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[65] D.J. Dodge, op. cit., p. 103.

6.1 POLICY IMPLICATIONS

The results obtained for the optimal flow of maize yields useful information for choosing regions suitable for the long-term production of maize. For instance, the indication that the Lundazi and Katete regions are not in the economically feasible regions for massive production of maize, calls for the introduction of policies that would eventually shift some resources, in these regions, from maize to other more profitable agricultural commodities. These results can also be utilized to improve the interregional pattern of trade under the current uniform pricing system by developing systematic interregional trade routes that reflect minimum costs.

It can also be argued that, since the Katete and Lundazi regions are consistently surplus producers of maize, then, their cost of production might be lower than those obtained in deficit regions. Hence, instead of completely discouraging massive production of maize in these regions, attention should be paid to improving the transportation system to the major markets. In this way, the per unit transportation costs may be reduced. Therefore, allowing both the Katete and Lundazi regions to export their surplus maize at relatively lower costs. However, this decision has to be weighed against the costs and benefits at the national level.

The results obtained for the regional market price differentials show a wide variation in regional market prices. This situation calls for a re-examination of the considerations on which a uniform pricing system is based. In fact, a combination of the results for the optimal flow of maize and the regional price differentials accentuates

the need to replace the current uniform pricing system with a regionally differentiated pricing system. In this way, resources may be more efficiently allocated and subsidies as well as artificially high prices to producers in surplus rigions can be greatly reduced.

It is also shown in this study that patterns of interregion shipment exist which can reduce transport cost under a uniform pricing system. This is achieved by directing shipments through less costly routes. However, these cost reducing patterns of interregion shipment under a uniform pricing system neither represent the least cost patterns of shipment, nor improve the efficiency of the uniform pricing system.

6.2 LIMITATIONS OF THE STUDY

The analysis in this study has focused on one crop - maize. More information could be gained if other agricultural commodities besides maize were considered. Also this study did not deal with the problem of determining which alternative crops would be most profitable for each region. To be able to realistically determine suitable regional producer prices and corresponding quantities of the various agricultural products to be grown in each region, it is necessary to know each product's own and cross elasticity of demand and supply for each region. This information could not be incorporated in this study because of lack of data pertinent to this type of analysis.

Another limitation of this study is the assumption that was made that supplies originate at a single point and are consumed at a single point in each region. In reality, of course, consumers and producers

are scattered all over each region. In recognition of this problem, as many market regions were delineated as the data would permit. As indicated previously, lack of adequate data has been a major constraint in determining market regions. Also, there is a general consensus that most data compiled in third world countries are unreliable due to limited qualified manpower and inadequate enumeration techniques. In this study, too, the quality of the data can be considered a serious limitation. In some instances, the data from the Ministry of Agriculture and Water Development does not correspond too closely with the data compiled by the National Agricultural Marketing Board.

6.3 SUGGESTIONS FOR FURTHER RESEARCH

Suggestions for further research would be to determine all major agricultural crops' own and cross price elasticities of regional demand and supply analysis. These results would enable a more comprehensive study to determine the quantities of individual crops to be produced in each region with their corresponding regional prices.

Another suggestion for further research would be to determine regional variations in the cost of production of agricultural commodities. These results will assist in assessing the costs and benefits associated with pursuing a policy of regional self-sufficiency in food production. For instance, if regional costs vary significantly, then the policy of regional self-sufficiency may be abandoned.

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