ANALYSIS OF DRY BEAN PRICE BEHAVIOR IN BURUNDI

By

Mevin Ndarusigiye

A PLAN B PAPER

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

MASTER OF SCIENCE

Department of Agricultural Economics

1990

ABSTRACT

ANALYSIS OF DRY BEAN PRICE BEHAVIOR IN BURUNDI

By

Mevin Ndarusigiye

Dry bean production and price statistics for Burundi from 1972 to 1987 indicate significant year-to-year (bean production) and monthly (bean prices) fluctuations. These fluctuations are influenced by, among other things, climatic conditions, unpredictable markets, government policy,and phytopathological factors. The objective of the study is to analyse the behavior of dry bean production in Burundi under uncertain prices and assess the degree of uncertainty for the period 1972-1987. The hypotheses are that dry bean prices in Burundi are uncertain, and that annual average dry bean production per capita has been falling because of dry bean price uncertainty.

Two types of regressions models, one with average annual data and another with monthly real price data, were used to test the hypotheses. The variance of the error term was computed to estimate the level of uncertainty in the period prior to the creation of a state-owned marketing board (SOBECOV) (1972-1978), compared to the period during which SOBECOV existed (1979-1987).

The findings indicate that dry bean prices were more uncertain in the first period than in the second period. In addition, the results showed that greater price uncertainty was associated with lower bean production. Consequently, bean price stabilization possibly leads to increased bean production.

To my wife Marie Mayoya

and to our children:

- Diane Nancy Ngabire;
- Juste Eric Munezero.

ACKNOWLEGDMENTS

I wish to express my sincere appreciation to Dr. Richard BERNSTEN, my major professor, for the continuous encouragement and the effort he put on reading and correcting this paper.

I am equaly grateful to the other members of the committee, Dr. Stan THOMPSON, and Dr. Robert MYERS, who assisted with the analytical part of the thesis.

I am also undebted to those who contributed to my training here at Michigan State University, especially the Faculty in the Department of Agricultural Economics.

My special thanks are due to my Family for the permanent support and love.

TABLE OF CONTENTS

Page

LIST OF TABLES

Page

LIST OF FIGURES

LIST OF MAPS

CHAPTER I: INTRODUCTION

1.1. Problem Statement

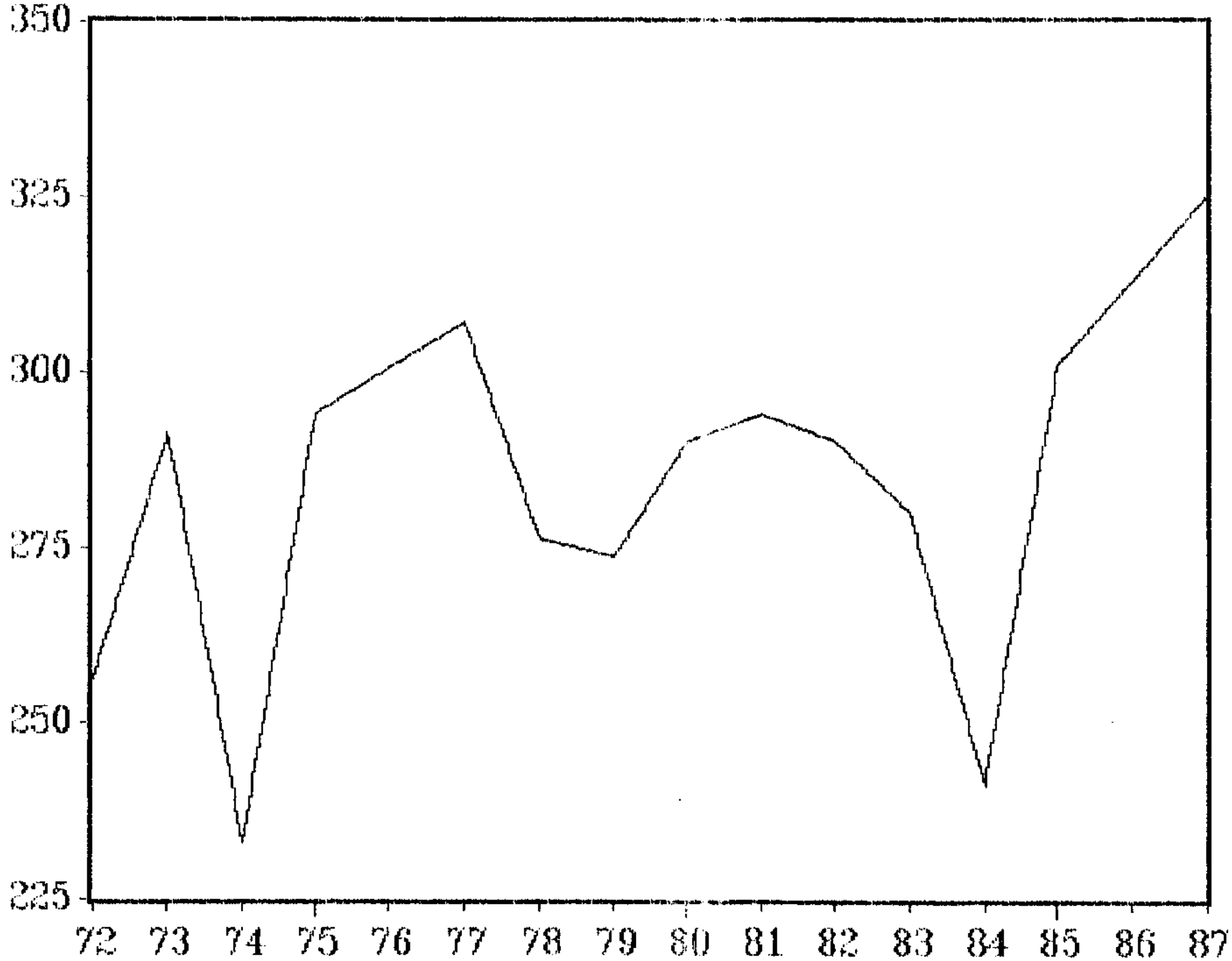
Dry bean production and price statistics for Burundi from 1972 to 1987 indicate significant year-to-year (bean production) and monthly fluctuations (bean prices) (Figures 1 and 2 and Appendix I). Dry bean price fluctuations are influenced by, among other things, unpredictable markets, climatic conditions, government policy, and phytopathological factors.

Prices for beans are unpredictable for various reasons. First, the government does not guarantee harvest prices. Thus, at planting time, farmers must make their planting decisions with uncertain expectations of future bean prices.

Second, the main climatic condition affecting bean production is rainfall. Too much or too little rain reduces bean production. In addition, rain starting late or early and ending early or late modifies the agricultural calendar. Therefore, bean production will be reduced, resulting in an increase in dry bean prices.

Third, government policy may contribute to bean price uncertainty. For example, sudden release of beans through food aid programs and unexpected and sporadic changes in the post harvest bean price announcements increase bean price uncertainty.

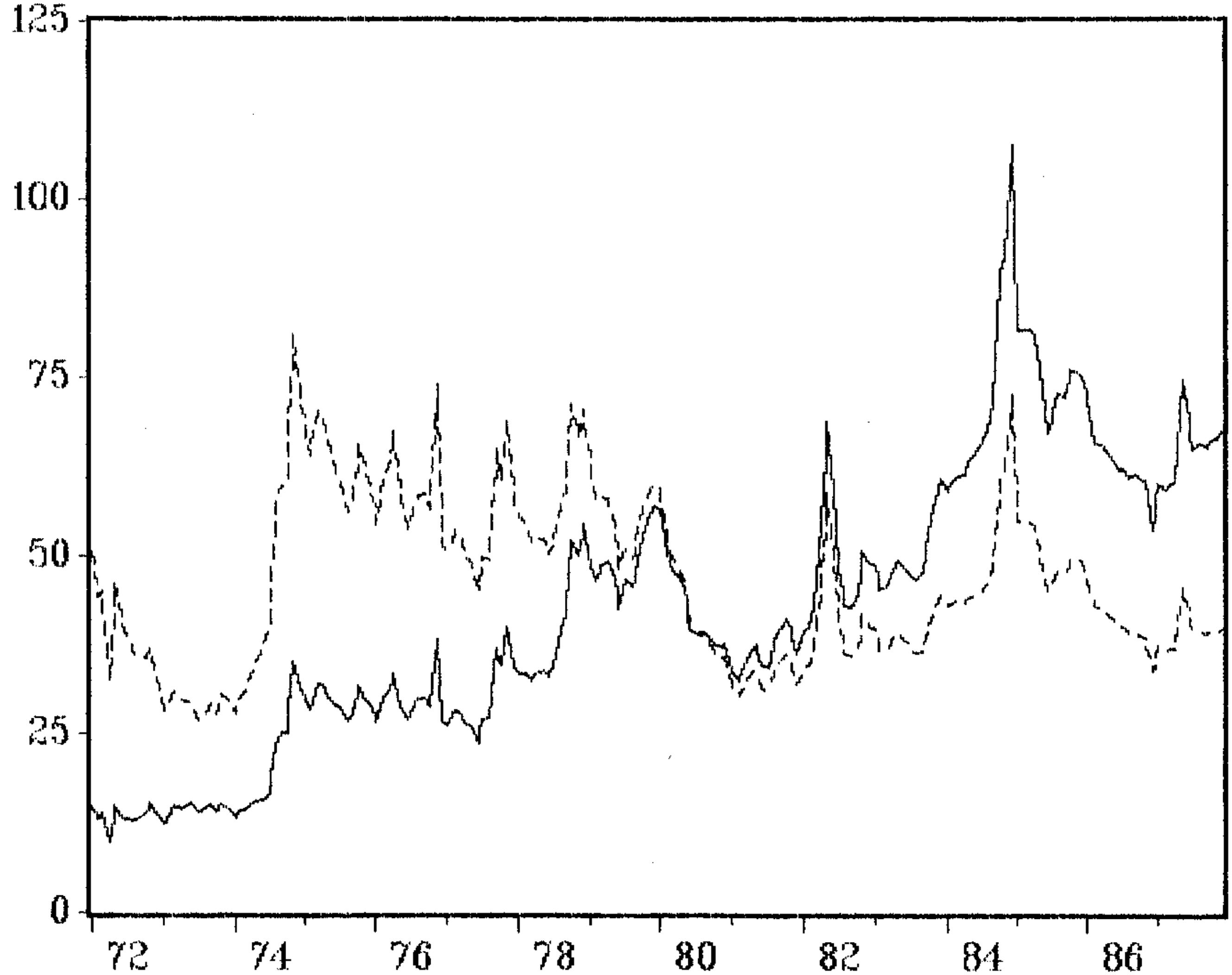
Figure 1. Annual Average Dry Bean Production ('000mT), Burundi, 1972-1987.



Source: Verbal Communication.
QB : Bean Production

—— QB

Figure 2. Monthly Nominal And Real Dry Bean Prices (FBu/kg), Burundi, 1972–1987.



Source: SNES.
RPB : Nominal Prices
RPB20 : Real Prices

—— RPB ---- RPB20

Fourth, phytopathological factors such as fungal and bacterial diseases (e.g., Melanogromyza Phaseoli) (Berti, 1985) and insect pests can seriously reduce agricultural production, resulting in dry bean price fluctuations.

Uncertain prices represent a risk to farmers because they must decide well in advance of harvest (when the prices are revealed) on the amount of resources to use. Under price uncertainty, most farmers will allocate fewer resources (i.e. land, agricultural inputs, labor) than would be the case under price certainty, resulting in inefficiency in production.

1.2. Objective

The main objective of the study is to analyse the behavior of dry bean production in Burundi under uncertain prices and assess the degree of price uncertainty for the period 1972 - 1987.

It is important to study the price behavior of agricultural products in Burundi because about 90% of the population depend on agriculture for their income. Furthermore, as most farmers are not only producers, but also consumers of their crops, market some of their harvest for cash income, and buy agricultural outputs in the markets; prices have an important impact on farmers' production plans, income, and consumption patterns.

1.3. Hypotheses

This study proposes the following hypotheses:

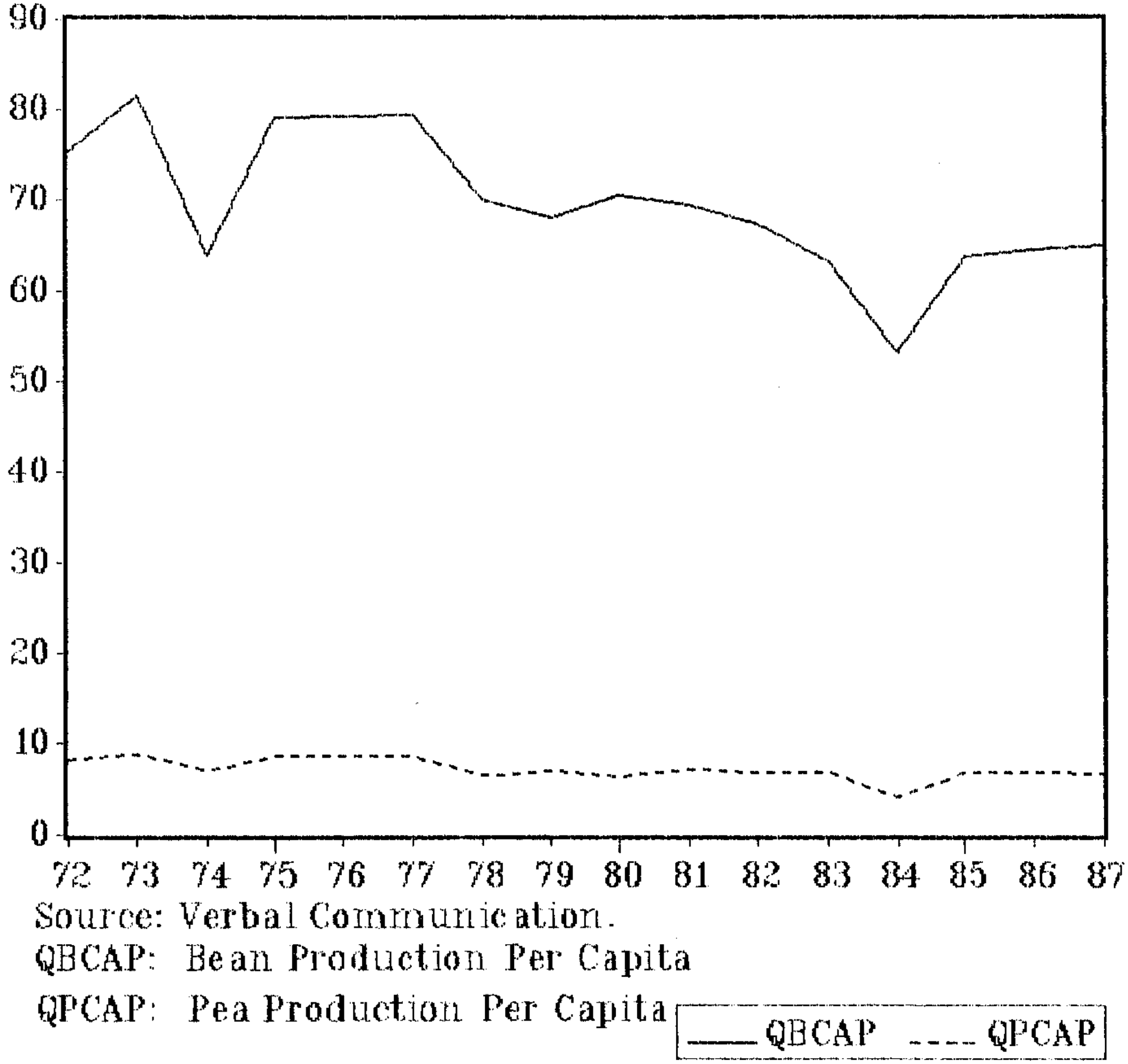
1. dry bean prices in Burundi are uncertain; and
2. the fall in annual average bean production per capita in Burundi (Figure 3 and Appendix 2) is associated with dry bean price uncertainty. The assumptions behind the second hypothesis are that farmers' decisions to produce beans are made ex ante and that farmers are averse to risk.

1.4. Definitions

Uncertainty

Certainty is defined in terms of knowledge of the decision-maker about an event's outcome. If knowledge is insufficient to specify a unique outcome, the individual faces uncertainty. However, uncertainty is not only a lack of information, but it also represents a unique situation with little or no empirical basis for the formation of probability distributions. Thus, an uncertain event has more than one outcome (Lindon, and Barry, 1987). Consequently, uncertainty results from a situation where the decision-maker does not have full knowledge or control of all relevant outcomes of the available actions.

Figure 3. Annual Average Bean And Pea Production Per Capita (kg), Burundi, 1972–1987.



Source: Verbal Communication.
QBCAP: Bean Production Per Capita
QPCAP: Pea Production Per Capita

Risk

Risk and uncertainty are often used interchangeably. However, they are different. Risk refers to uncertain events whose outcomes alter the decision-maker's well-being (Lindon, and Barry, 1987). Therefore, risk represents a situation in which the probability distribution of outcomes is somehow known. Uncertainty, on the other hand, consists of events over which there is no control.

Price instability/variability

Price instability and price variability are related to each other. Instability refers to a state where prices fluctuate due to the behavior of market participants, such as producers (supply), the government (policy), consumers (demand), and institutions (marketing coordination). For instance, price instability may result from the cyclical factors that affect agricultural production (i.e. drought cycle) and/or time lag between farmers'decision to produce and when they harvest. Price changes that do not follow a predictable pattern result in price variability. Factors that may cause price variability are, among other things, supply and demand conditions, climatic conditions, and seasonal variations in production. Consequently, uncontrollable factors, embodied in price variability, result in price instability (in the sense of uncertainty). The magnitude of these uncontrollable factors determines the level of price uncertainty.

1.5. Paper Organization

The paper consists of five chapters. Chapter One describes the importance of the study. It presents the objectives and formulates hypotheses to be tested. Chapter Two presents background information on Burundi, discusses related studies and price policy options. Chapter Three describes the research design and methodology, including data sources, analytical tools, data processing, and model specification. Chapter Four presents the results and discusses the findings. Chapter Five summarizes the study, draws policy implications for Burundi, notes the limitations of the analysis, and addresses future research needs in order to formulate appropriate policies for the bean subsector.

CHAPTER II: BACKGROUND ON BURUNDI, RELATED STUDIES AND PRICE POLICY OPTIONS

2.1. Background

Location

Burundi is a landlocked country in Central Africa. It is bordered by Zaire in the west, Rwanda in the north, and Tanzania in the south and in the east (Map 1). The total area of Burundi is 27,834 square kilometers, about the size of Maryland in the United States.

Administrative and Agro-Ecological Structures

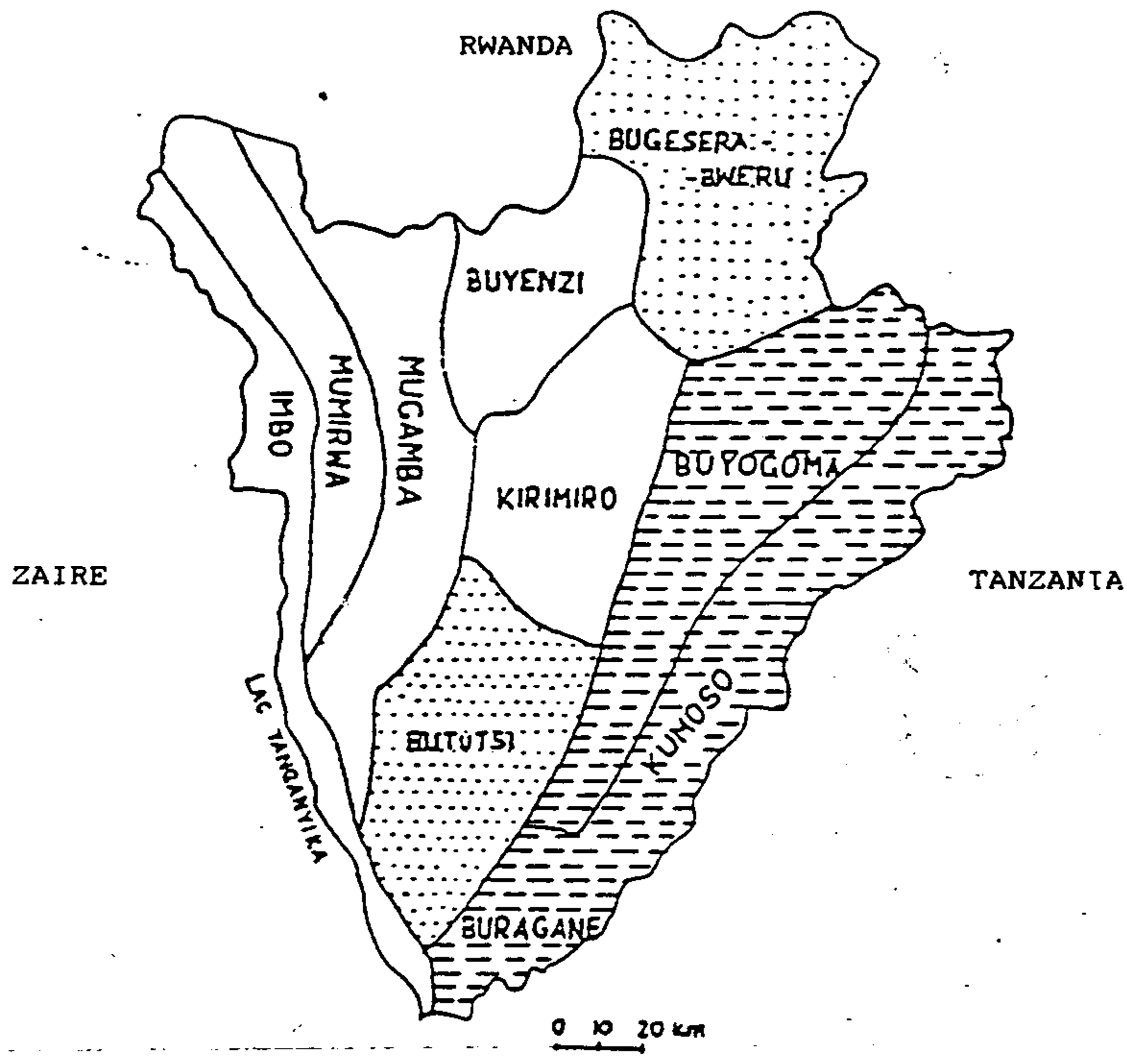
Burundi is divided into 15 provinces and 114 communes. The main cities are Bujumbura, the capital, and Gitega. The population of Bujumbura was 208,380 in 1987 (AID Mission, undated).

The country is divided into 11 natural regions which represent agro-ecological zones. They are: Bugesera, Buragane, Bututsi, Buyenzi, Buyogoma, Bweru, Imbo, Kirimiro, Mugamba, and Mumirwa (Map 1).

Language

The national language is Kirundi. French, the second language, is the language of education and administration. Other languages are English and Kiswahili.

Map 1. Natural Regions in Burundi



Physical Characteristics

Most of Burundi consists of plateaux of 1,400 to 1,800 meters (Kuntz, 1984). The average temperature is 20°C (about 70°F). The average annual rainfall is 1,200 mm. In general, Burundi has a tropical climate with two dry seasons. The long dry season starts at the end of May and ends at the beginning of September. The short dry season occurs in January and ends in February. The rainy season goes from February to May.

Burundi's soils, although suitable for extensive cultivation are extremely fragile. They are mineral-poor, requiring regular inputs of nitrogen, and have poor phosphorus-retention qualities. Also, because they are highly silaceous, they have poor water-retention capacity (Kuntz, 1984).

Demography

The population of Burundi was estimated at five millions in 1987 (Population Reference Bureau, 1988). Hence, population density is 186.6 inhabitants per square kilometer. The population growth rate was 2.9% in the late 1980s. The rural population represented 93% of the total population in 1987 (IBRD, 1989).

Migration

The pressure on land resulting from population growth caused extensive migration to Tanzania, Zaire, and Uganda (Africa, South of Sahara, 1989). However, measures in those countries to restrict employment to nationals are closing these outlets, reducing agricultural productivity in Burundi.

Within Burundi, there exist two types of migration: rural-rural and rural-urban migration. Rural families move to irrigated regions of the lower Rusizi delta and there is a steady migration to the Moso lowlands and Rumonge. In addition to permanent rural-rural migration, there is a steady influx of people to Bujumbura. Also, people leave the rural area temporarily to seek wage employment in the city.

Economic Indicators

The annual growth rate of real Gross National Product (GNP) between 1965 and 1987 was 1.6%. During the same period, the annual rate of inflation was about 8.5% (World Bank, 1989).

Inflation has varied greatly from year-to-year, and has contributed to price variability. During the conflict between Uganda and Tanzania in 1978-1979, there was a shortage of imported fuel, which caused oil prices to increase sharply. Consequently, inflation rose from 6.8% in 1977 to 23.8% in 1978 and to 36.6% in 1979. The inflation rate fell to 12.3% in 1980, declined further to 5.6% in 1982, but rose again to 7.4% in 1983 (Kuntz, 1984). As a result, the share of the primary, secondary and tertiary sectors to the Gross Domestic Product (GDP) has fluctuated.

Out of Burundi's GDP, the primary sector (agriculture, livestock, forestry, and fishing) accounted for an average of 63% during 1972-1987. The secondary sector (industry, commerce, construction, etc.) represented 13%. The tertiary sector (services) constituted 24% of the GDP. Over the past 16 years, the primary sector's contribution has been declining, while the secondary and the tertiary sectors'contributions have increased. Table 1 presents nominal GNP per capita and the contributions of the three sectors to GDP.

Table 1. Nominal GNP per capita and GDP at factor cost (1980=100) by sector, 1972-1987, Burundi.

Year	GNP/capita (US$)	GDP Share (%)		
		Primary	Secondary	Services
1972	70	66	10	24
1973	80	69	10	21
1974	90	67	10	23
1975	100	69	10	21
1976	120	67	11	22
1977	140	66	12	22
1978	150	63	14	23
1979	170	63	13	24
1980	210	62	14	24
1981	250	63	14	23
1982	240	60	14	26
1983	240	61	14	25
1984	230	58	16	26
1985	230	60	15	25
1986	240	59	16	25
1987	250	N.A.	N.A.	N.A.
Average	176	63	13	24

Source: World Bank (1987).
N.A. : Data not available.

Agriculture

Agriculture is the most important component of the primary sector in Burundi. It employed 53% of total population, and constituted 94% of total exports in 1986. Also, about 77% of total imports were financed by agricultural exports in 1986 (FAO, 1987-88).

The major cash crops in Burundi are coffee, tea, and cotton. The main food crops are beans, sweet potatoes, cassava, bananas, maize, sorghum, peas, and rice.

Agricultural production has declined in recent years as indicated by the index for total agricultural production per capita which was 98 during the period of 1985-87 (1979-81= 100) (FAO, 1987-88). In terms of the annual average growth rate, agricultural production fell from 3.3% during the period 1965-1980 to 1.7% during the period 1980-1987 (IBRD, 1989). This rate is far below the 2.9% rate of population growth, which has resulted in increasing pressure on land, which, in turn, obliges people to migrate from high density regions like Buyenzi and Kirimiro to low density regions like Imbo and Moso.

The *Fourth Five Year Plan* (1983-1987) prescribed spontaneous land settlement (Gajardo, 1986). Rural-rural permanent migration was proposed as a temporary solution to the land constraint, and, hence, to increasing food production. The Plan proposed to increase the productivity of beans, maize and peanuts; to reduce post-harvest losses for beans, maize, cassava and sweet potatoes;

and to reorganize the marketing of beans, maize, sorghum and cassava. All these measures had an objective of increasing food production in order to increase market sürpluses (Gajardo, 1986).

The average farm size per household is small, approximately 1.7 hectares (ha) in 1980. It is projected to fall to 1.1 ha in 1995 and to 0.7 ha by 2010 (_____, 1982) if the current 6.6 fertility rate (Population Reference Bureau, 1988) is maintained.

Yields of beans and peas (a food substitute for beans) are low, averaging about 500 kg/ha and 650 kg/ha, respectively, over the past 16 years (Tables 2 and 3). A USAID study estimated that the potential yield of beans is 800 kg/ha (AID Mission, undated). This suggests that bean production can still be increased.

Table 2. Average annual bean production, area harvested and yield, 1972 to 1987, Burundi.

Year	Production ('000 metric tons)	Area ('000 ha)	Yield[a] (kg/ha)
1972	256.3	322.0	796
1973	291.3	534.0	545
1974	232.9	535.0	435
1975	294.0	551.0	533
1976	300.6	494.4	608
1977	307.0	461.2	665
1978	276.3	500.3	552
1979	273.7	532.0	514
1980	290.0	592.0	489
1981	294.0	608.2	483
1982	290.0	617.0	470
1983	280.0	620.0	451
1984	241.0	650.0	370
1985	301.0	669.0	449
1986	313.0	695.0	450
1987	324.9	722.0	450
Average	285.4	568.9	516[b]

a. Yields are calculated.
b. The average yield should be 502 kg/ha if we divide the average production by the average area.

Source: SNES (1987).

Table 3. Average annual pea production, area harvested and yield, 1972 to 1987, Burundi.

Year	Production ('000 metric tons)	Area ('000 ha)	Yield[a] (kg/ha)
1972	27.7	46.0	602
1973	31.4	42.0	747
1974	25.2	45.0	560
1975	31.8	45.0	706
1976	32.4	34.3	944
1977	33.0	36.0	916
1978	25.0	51.0	490
1979	28.0	51.0	549
1980	26.0	51.0	509
1981	30.0	48.9	613
1982	29.0	41.0	707
1983	30.0	30.0	1000
1984	18.0	30.0	600
1985	32.0	55.0	581
1986	33.0	55.0	600
1987	32.8	55.0	596
Average	29.1	44.8	670[b]

a. Yields are calculated.
b. The average yield should be 650 kg/ha if we divide the average production by the average area.

Source: SNES, (1987).

Table 2 also shows that from 1972 to 1987, bean yields decreased, whereas the area harvested increased. This implies that Burundi's agriculture has become more extensive over time. Also, bean production has considerably fluctuated from year-to-year. In 1984, for instance, bean production dropped sharply because of drought, but has increased steadly since then (Figure 4).

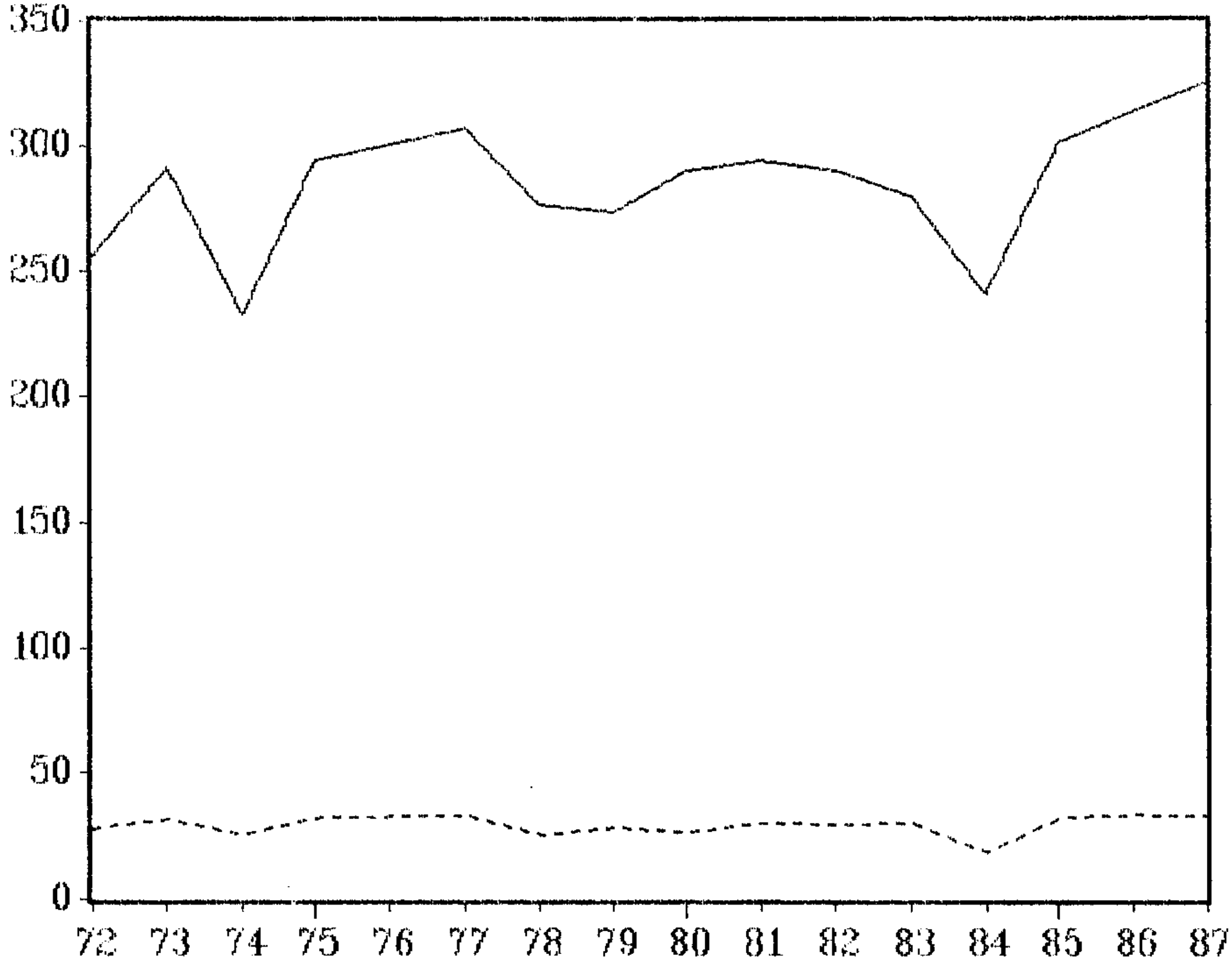
Table 3, on the other hand, indicates that both pea yields and area harvested fluctuated erratically from year-to-year. For instance, yields dropped by 426 kg/ha from 1977 to 1978 and increased by 293 kg/ha from 1982 to 1983. The area harvested dropped from 45,000 hectares in 1975 to 34,000 hectares in 1976; then increased from 30,000 hectares in 1984 to 55,000 hectares in 1985. Total pea production, however, has not fluctuate much, except in 1984 because of the drought (Figure 4).

Imports and Exports

In 1983, Burundi's imports consisted mainly of intermediate goods (75%), followed by consumer goods (19%), and capital goods (6%). Consumer goods were composed of primarly dairy products. Bean imports were not mentioned. Intermediate goods included agricultural inputs, petroleum products, and textiles (Kuntz, 1984).

Burundi exports mainly primary products (96%). Manufactured products represented 3%, and the re-exports were 1% of total exports in 1983 (Kuntz, 1984).

Figure 4. Annual Average Bean And Pea Production ('000mT), Burundi, 1972–1987.



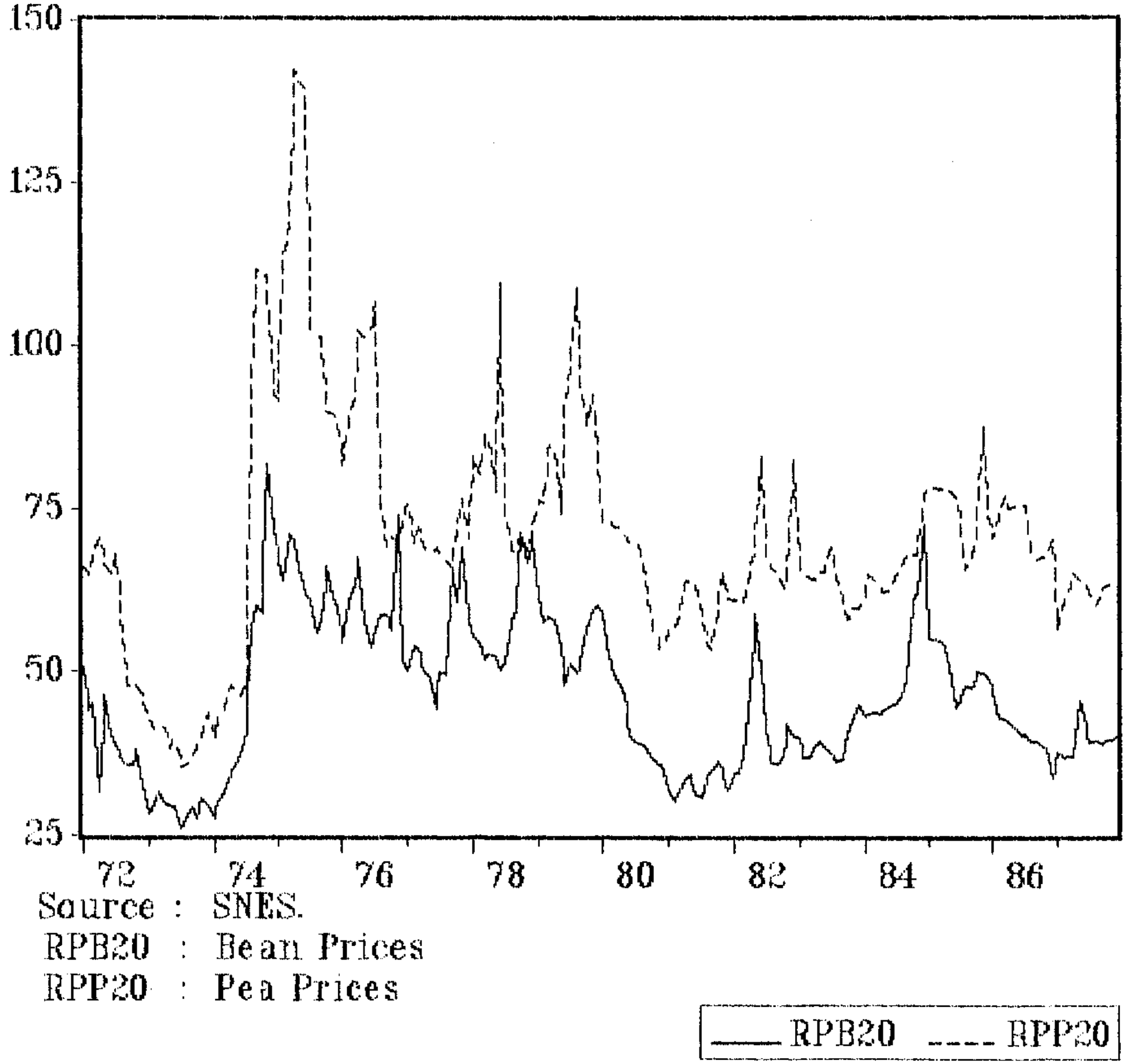
Source : Verbal Communication
QB : Bean Production
QP : Pea Production

Markets

Cash crop production and marketing are managed by parastatals, such as the Office des Cultures Industrielles du Burundi (OCIBU) (coffee), the Office du Thé du Burundi (OTB) (tea), and the Comité de Gérance du Coton (COGERCO) (cotton). The marketing of these cash crops is very well organized.

In contrast, food crop marketing is poorly organized. The extreme fluctuations in real bean prices (Figure 5) suggests that there is a need to reorganize the marketing of beans. Although the Société Burundaise d'Entreposage et de Commercialisation des produits Vivriers (SOBECOV) was established in late 1978 and given a mandate to stabilize prices by constituting and managing a buffer stock of beans and rice, time series data (Figure 5 and Appendix 1) indicates it has failed to stabilize prices.

Figure 5. Monthly Real Dry Bean And Pea Prices (FBu/kg), Burundi, 1972-1987.



Source : SNES.
RPB20 : Bean Prices
RPP20 : Pea Prices

Bean surpluses have accumulated in favorable production regions like Bugesera and Moso (Map 1), whereas other regions like Mugamba and Bututsi have experienced deficits. Therefore, local bean shortages are not only due to low bean production, but are also a result of, among other things, the lack of adequate transportation, distribution problems, and information to market participants. Interregional transactions are still limited in Burundi, probably because market participants do not know markets conditions in other areas of the country, apart from Bujumbura.

Food crop markets in Burundi are thin, with less than 10% of food production marketed (USAID Mission, undated). As a result, small fluctuations in production strongly affect market prices.

The government has promoted food production in an effort to generate surpluses. For example, in his speech on New Year 1981, the former President of Burundi recommended that the nation increase food production:

> We request that in agriculture and livestock every farmer make an effort to produce large quantities of food crops in order that there will be enough to eat and to sell in other parts of the country (USAID Mission, undated).

Following the President's message, the Minister of Agriculture and Livestock proposed several means to increase production.

> Increasing food crop production is an absolute necessity. There is a need to organize the population in order to make better use of markets; it is necessary to teach people elementary techniques to increase yields in their fields (fallows, organic fertilizers, improved seeds, etc.) (USAID Mission, undated).

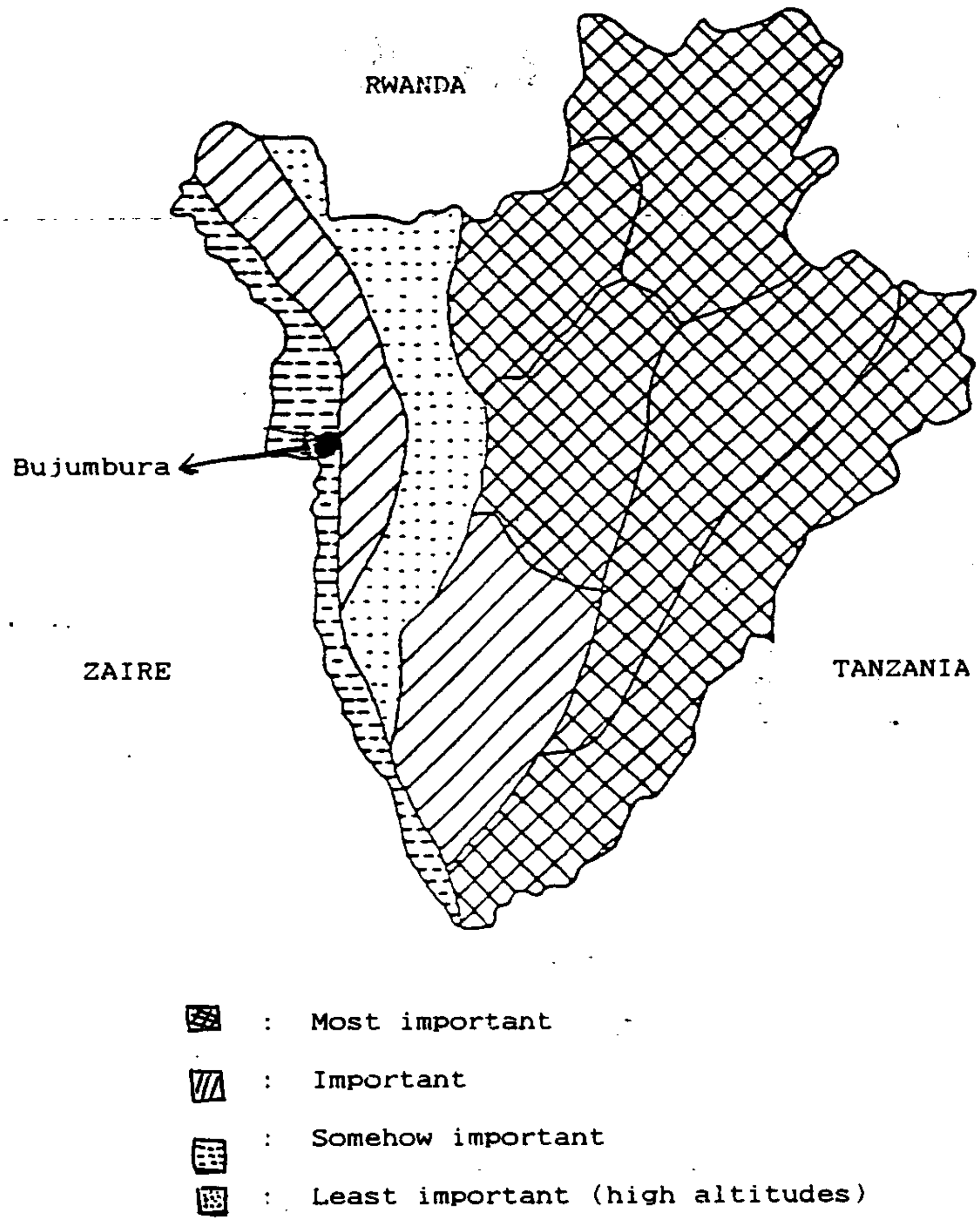
While the government is committed to agricultural development and to increasing production, as long as farmers are not assured of incentive and stable prices, it is unlikely that they will use their resources to generate surpluses.

Importance of Beans

Beans are the staple food in Burundi (Map 2). They are also the major source of proteins and energy for the rural population (Arnould, 1982), whose consumption of meat or fish is limited. Findings in Rwanda, a country with consumption patterns similar to Burundi, show that beans provided 50% of the protein in four out of nine communes surveyed and meat provided no more than 4% of the proteins in eight out of the nine communes (Loveridge, 1988).

At high altitudes, bean yields are low. Therefore, these farmers grow peas instead. In those areas in Burundi, peas are generally regarded as a substitute for beans in production.

Map 2. Importance of Beans in Land Use



Technological Change

From 1962 to 1979, bean research was limited to experiment station trials. Beginning in 1979, new bean varieties were introduced, including *Karama* from Rwanda, *Calima* from Colombia, *Doré de Kirundo* and *Jaune Pointillé* from Burundi (Berti, 1985). Those varieties are high yielding and resistant to diseases. However, farmers must plant these varieties in pure stands, whereas 90% of the beans grown in Burundi are intercropped (Berti, 1985). Moreover, farmers prefer light-colored, low-yielding beans to the black-seeded, high-yielding new bean varieties (CIAT, 1981). Consequently, farmers have not widely adopted the new varieties.

2.2. Related Studies

This section discusses how prices affect farmers' production behavior. There exist two alternatives as to when producers make crop production decisions vis-a-vis crop prices. According to Hebert (1984), farmers can decide to produce <u>ex post</u>, which means they decide how much to produce after the price is revealed. This situation occurs when the government announces prices prior to the planting period. In this instance, there is no price uncertainty. Alternatively, farmers can decide how much to produce <u>ex ante</u>, meaning they decide to produce before the post-harvest price is known (Hebert, 1984).

In Burundi, farmers make their bean production decision _ex ante_ because prices are not announced prior to planting. Burundi farmers are considered risk averse, since they get their income mainly from agricultural products. For example, findings in neighboring Rwanda indicate that 70% of farmers' income come from agricultural outputs (Loveridge, 1988). In addition, since Burundi farmers produce first to meet their own consumption needs, they have to minimize the risk of failure to feed themselves before they can allocate resources to generate surpluses to sell to the market (characteristic of thin markets).

Manifestations of farmers' risk aversion behavior include the cultivation of small plots of diversified crops and a reluctance to rely on markets as a primary source for household food consumption needs (Jayne, 1987).

Shaffer, et al. (ICRISAT,1985) indicate that unpredictable markets discourage farmers to invest and specialize. Farmers are reluctant to commit their scarce resources when they face uncertain prices. Therefore, price uncertainty reduces resources used in agriculture and is likely to discourage investment in improved farm technology.

2.3. Agricultural Price Policy Options

The objectives of agricultural price policy are to provide uninterrupted supplies of food, to generate stable revenues to farmers, to guarantee affordable food to low-income population, and to speed up industrialization through backward and forward linkages, which consist of some industries supplying inputs to produce a commodity and other industries using the product as an input.

According to FAO (1987), the most widely used specific national commodity intervention measures relevant to price policy are guaranteed floor prices, buffer stocks, buffer funds, ceiling prices, food aid, and food subsidies.

Guaranteed floor prices

Guaranteed floor prices provide farmers with both a minimum price for their commodities and a market. However, to function effectively, government must have the financial capability to buy the commodity in case farmers cannot sell everthing they produce on the private market. Also, setting a minimum floor price requires knowledge of the the costs of production of the commodity, since government must set prices such that farmers are adequately remunerated for their factors of production.

To date, few cost of food production studies have been carried out in Burundi. Costs of family labor, inputs used, and in-kind payments to hired labor are difficult to estimate. Floor prices which do not consider those costs would likely be biased against farmers. Another question, beyond the scope of this study, is whether the floor price should be pan-territorial and/or pan-seasonal.

Buffer stocks

Buffer stocks are stocks of non-perishable agricultural commodities are usually government-controlled, built up by purchasing when supplies are ample and prices low, and sold when supplies become scarcer and prices are higher. The goal of a buffer stock policy is to stabilize or reduce seasonal price variations of agricultural commodities. These stocks require that the institution holding them have good management and administrative capability. Also, while buffer stocks can dampen short-run fluctuations, they are powerless against long-run price trends, which are often the problem to which a solution is sought.

Currently, Burundi has a shortage of skilled personnel. The problem of human resources, however, can be solved in the short-run by on-the-job training of the current SOBECOV staff, supplemented by consultations by experts. Training of highly qualified managers and administrators should constitute a long run solution.

Buffer funds

Buffer funds are compensatory financing funds used to stabilize prices. When the producer price of a commodity decreases, these funds are used to compensate farmers for the difference between the market price and the normal price. In contrast, when producer price increases, the excess above the normal price is held by the government to be used when prices fall. Hence, buffer funds present the advantage of not incuring storage costs of goods. However, they require that the institution in charge has high management capability. Most often, accumulated funds are diverted to other uses. In Burundi, buffer funds are currently used to stabilize cash crop prices, especially coffee.

Ceiling prices

Ceiling prices are intended to stabilize consumer prices below some desired maximum level. The ultimate goal of ceiling prices is to provide consumers, mainly low-income household, access to food at a reasonable cost. Findings in neighboring Rwanda indicated that 49% of farmers were net buyers of beans. Therefore, if half of rural population does not produce enough food for the needs of the household, it is desirable, from a welfare perspective, that the government take measures to protect farmers-net buyers of beans against exceptionary high bean prices. Yet, such a consumer price subsidy would require that prices. Yet, such a consumer price subsidy would require that government bear the burden of the subsidy, which would severely strain government resources. Also, a price ceiling could be a producer price disincentive, since the price of the commodity would decrease.

Food aid

Direct food aid is intended to moderate or prevent food price increases due to insufficient production. Therefore, it is a short-run remedy to food supply shortages. However, a significant amount of food aid would increase the quantity of food supplied and, hence, it would artificially decrease the price to the consumer. As a result, food aid can constitute a disincentive to producers.

The challenge facing the Burundi government is to identify the combination of these agricultural price policy options that would help to stabilize food crop prices, without reducing producer incentives or putting a great financial burden on the government.

CHAPTER III: RESEARCH DESIGN AND METHODOLOGY

3.1. Data Sources

This study uses five data sources. First, the study uses secondary data collected from official publications of the Ministry of Planning which reported monthly retail prices of dry beans and dry peas in Bujumbura from 1972 to 1987. Second, FAO publications (*Production Yearbooks* and the *State of Food and Agriculture*) provided data on the index of agricultural production and the growth rate of agricultural production in Burundi. Third, World Bank publications are used to obtain information on the socio-economic conditions in Burundi, such as GNP, GDP, and CPI variables, as well as data on demographic conditions. Fourth, verbal communication with the Vice-Director of the National Service of Studies and Statistics (SNES) in December 1987 provided annual data on bean and pea production and area harvested. Finally, findings in Rwanda, a neighboring country similar to Burundi, helped to illustrate the importance of beans in nutrition and the contribution of agricultural products to household income.

3.2. Analytical Tools and Data Processing

Monthly prices of dry beans and dry peas were deflated to remove the effect of inflation, using a monthly Consumer Price Index (CPI) (Figure 6 and Appendix 1) constructed from an annual World Bank CPI. The monthly CPI was computed by breaking the annual CPI into monthly segments, centering the average annual CPI on July, thereby spreading the inflation linearly over the year.

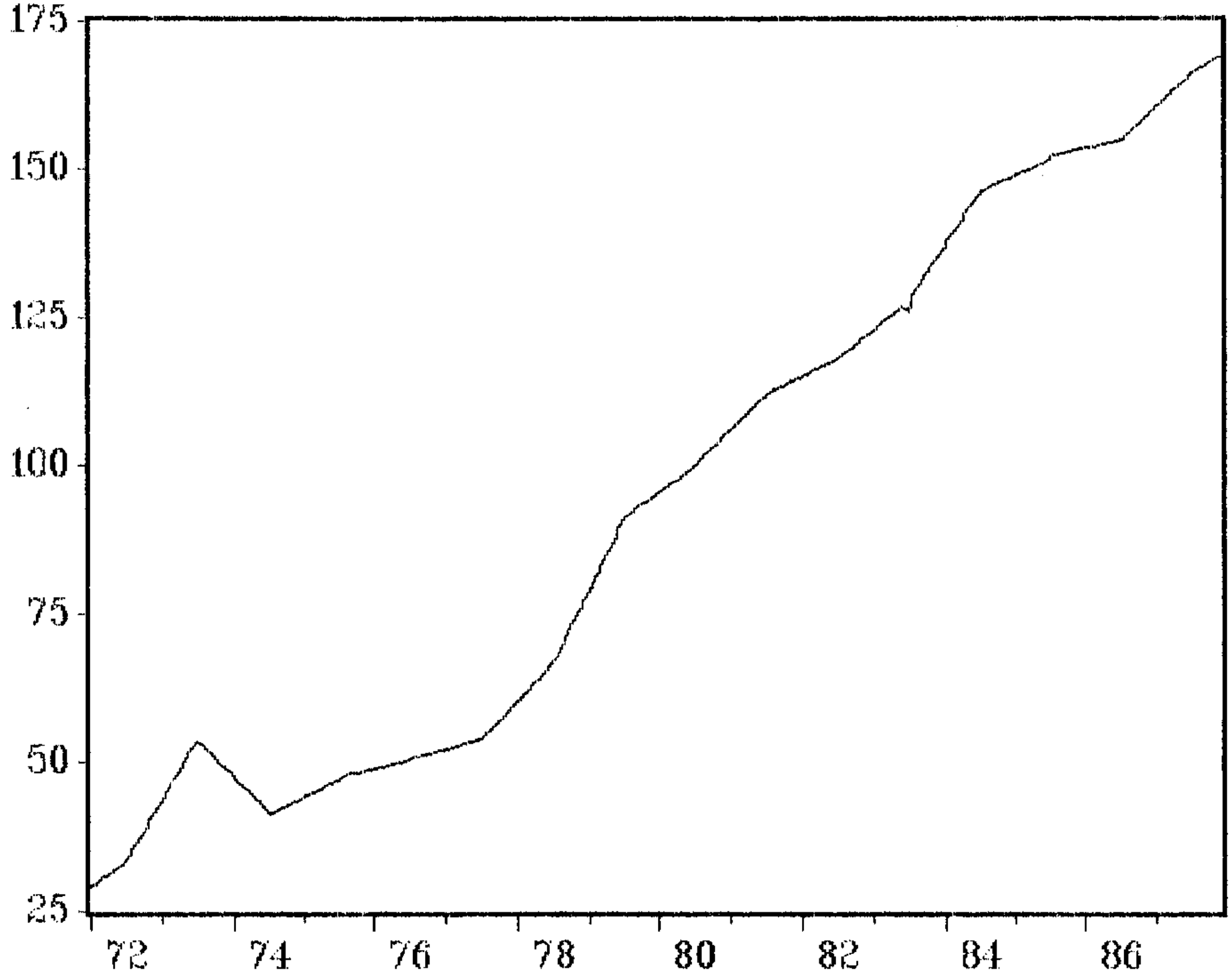
A year starts in July and ends in June of the following year. Monthly values of the CPI were computed as follows: first, a monthly inflation rate (p) was computed, where

$$p = CPI_{July\ (t)} - CPI_{July\ (t-1)}.$$

Then, the value of p was added to the value of the July CPI in year t through June of the following year (year t+1).

The values of CPI for the first six months of June 1972 and of the last five months of 1987 were obtained by using the annual average CPI growth rates in Burundi estimated by UNCTAD (1988).

Figure 6. Monthly Consumer Price Index (CPI1), Burundi, 1972–1987.



Source: Constructed from World Bank Annual Data.

For some months, nominal dry pea prices appear to have been either misreported (mixture of fresh and dry pea prices) or they were not reported at all. To handle the first problem, abnormal prices were replaced by dry pea prices in the nearby cities, Gitega and Ngozi, and then deflated. To estimate unreported monthly data, an average of the monthly prices of the previous year and the following year was computed, and then deflated. These techniques generated the deflated pea price series shown in Appendix 1.

3.3. Model Specification

This study attempts to test the hypotheses formulated in Chapter One, with models using both annual and monthly data.

3.3.1. Annual data model

In the annual data model, the annual average real price of dry beans is used as a dependent variable. Independent variables are lagged bean prices, the prices of a substitute for beans (peas), the annual average production of beans and peas, and a time trend. Annual prices of both beans and peas are computed as an average of monthly prices. The resulting model estimates the relationships between dry bean prices and bean production.

The annual model constitutes a predictive framework around which annual price uncertainty can be measured. The variance of the error term indicates the level of price uncertainty. The error term is the difference between observed and predicted real prices.

The following equation illustrates the annual model which can be interpreted as a reduced form.

$$RPB1_t = a + b_1 RPB1_{t-1} + b_2 QB_{t-1} + b_3 \ RPP2_{t-1} + b_4 \ QP_{t-1} + b_5 \ Trend + E_t . \quad (1)$$

Where: - RPB1 is the annual average retail real price of beans;

- a is the intercept;
- b_i's are the slope coefficients;
- QB is the annual average quantity of beans;
- QP is the annual average quantity of peas;
- RPP2 is the annual average retail real price of peas;
- Trend stands for time; and
- E represents the error term.

The Ordinary Least Square (OLS) technique is used to estimate the parameters.

The Durbin-Watson statistic cannot be used to test for autocorrelation in the residuals when there is a lagged endogenous variable in the model. Although the H-statistic can endogenous variable in the model. Although the H-statistic can be used to test for the first order correlation, Q-statistic is preferred to the H-statistic because it can be used to test for any order of serial correlation in the residuals. The value of the Q-statistic is compared to the critical value of the X^2-distribution at α level of significance and k-degrees of freedom, where k is the number of lags (representing the order of serial correlation).

If the value of Q-statistic is lower than the critical value of the X^2-distribution, then the hypothesis that there is no serial autocorrelation is accepted. Otherwise, it is rejected. The latter case indicates that there is a problem of model specification. Therefore, the model has to be respecified.

A weakness of the annual model is that it does not provide any information on the conditions within a year. It is difficult to break average annual crop production into monthly data because there are specific bean and pea harvest periods. For instance, beans are harvested three times a year in Burundi. The first harvest takes place in January and in the first week of February. The second harvest occurs at the end of May and the entire month of June. The harvest for marsh (lowland) season occurs mainly in November. Therefore, slack periods occur during about two third of the year.

3.3.2. Monthly data model

To handle the problem of not capturing information within developed.

In the monthly data model, monthly real bean price is a dependent variable. Lagged bean and pea prices are used as independent variables.

Equation 2 refers to a regression of bean prices against lagged bean prices. The purpose of using this model is to check if past bean prices can be used to predict actual prices of beans. Equation 3 consists of a regression of bean prices against lagged bean and pea prices to determine whether or not the inclusion of pea prices better predicts bean prices. In other words, do bean and pea prices together better predict the current prices of beans than when each product considered separately?

The equations are written:

$$RPB20_t = a_1 + b\ RPB20_{t-1} + e_t \quad (2)$$

$$RPB20_t = a_2 + b_1 RPB20_{t-1} + b_2 RPP20_{t-1} + v_t \quad (3)$$

Where: - RPB20 is the monthly retail real price of beans;

- RPP20 is the monthly retail real price for peas;
- a_1 and a_2 are the intercepts;
- b, b_1, and b_2 are the slope coefficients; and
- e and v are the error terms.

A Unit Root test, also called the *Dickey-Fuller* test, is used to check if the coefficient b (Equation 2) is unity.

A T-statistic of the coefficient b is computed for that purpose. If b=1, equation 2 can be written:

$$RPB20_t - RPB20_{t-1} = a_t + e_t. \qquad (4)$$

The T-statistic of b is the same as the standard T-statistic from the tables. However, it has different distribution. T-statistic is equal to (b-1)/standard deviation of b. So, one needs to compare the value of the calculated T-statistic with critical values provided by Dickey and Fuller (1986). If the value of the calculated T-statistic is less than the critical value, the hypothesis of nonstationary time series is rejected. The series can be considered stationary.

In addition, seasonality was accounted for by adding dummy variables. July was considered as the beginning of the market year.

Equations 2 and 3 were therefore rewritten:

$$RPB20_t = a_1 + b\ RPB20_{t-1} + d_1 X_1 + d_2 X_2 + d_3 X_3 + d_4 X_4 + d_5 X_5 + d_6 X_6 + d_8 X_8 + d_9 X_9 + d_{10} X_{10} + d_{11} X_{11} + d_{12} X_{12} + e_t. \qquad (5)$$

$$RPB20_t = a_2 + b_1 RPB20_{t-1} + b_2 RPP20_{t-1} + q_1 X_1 + q_2 X_2 + q_3 X_3 + q_4 X_4 + q_5 X_5 + q_6 X_6 + q_8 X_8 + q_9 X_9 + q_{10} X_{10} + q_{11} X_{11} + q_{12} X_{12} + v_t. \qquad (6)$$

$X_1, \ldots X_{12}$ are the dummy variables associated with each month.

Two periods are considered. The first period, 1972-1987, represents the years prior to the creation of the marketing board (SOBECOV). The second period, 1979-1987, represents the years when the government of Burundi attempted to stabilize prices through the Board. Comparing the variances of the error term for the two periods will indicate whether or not SOBECOV played a role in reducing bean price uncertainty.

A test for different variances in the two periods is conducted by estimating the equation:

$$U^2_t = \alpha_1 + \alpha_2 D_t \qquad (7)$$

Where: - U represents the residuals from the prediction model discussed earlier;

- α_1 is a constant;
- α_2 is a slope coefficient; and
- D is a dummy variable whose value is 0 in the first period and 1 in the second period.

The assumption behind the regression of the squared residuals against D_t is that if $\alpha_2 = 0$ then the variance is constant for the entire period of the study. If α_2 is negative (< 0), it means that the variance in the second period is lower than the variance in the first period. This would indicate that the reduction of the level of uncertainty in the second period was associated with the existence of the Board.

CHAPTER IV: RESULTS AND DISCUSSION.

4.1. Results

Chapter Three presented two types of models. The first model used average annual data on both prices and quantities of beans and peas. Time was also incorporated into this model with a trend variable. The second model used only monthly price data on beans and peas. The analysis of both models was carried out in three steps.

First, the series were tested for stationarity, using the Dickey-Fuller test (Unit Root Test) to determine how well the models predicted the actual bean prices. For the annual data model, the value of the T-statistic was compared with the critical value of τ_τ-distribution (because of time factor). For the monthly data model, the value of the T-statistic was compared with the critical value of τ_μ -distribution.

Second, the residuals were tested for serial correlation for both models to determine if the current value of the error term was, or was not, correlated with its own past values. The value of Q-statistic was compared with the critical value of χ^2-distribution. If residuals were found correlated, more lags were added to the independent variable used in the test.

Third, the level of uncertainty was computed. The square of residuals was run against a dummy variable whose values are zero in period one and one in the period two. The hypothesis was that the variance was constant for the entire period (1972-1987). The results from the analysis are presented below for both annual and monthly data.

4.1.1. Annual data

Test for nonstationarity

In the annual model, bean prices were regressed against lagged bean prices and time. The equation is formulated as:

$$RPB1_t = b_1\ RPB1_{t-1} + b_2\ TREND + E_t \qquad (8)$$

The test for stationarity, using the Dickey-Fuller test, did not reject the null hypothesis (nonstationary time series). The value of T- statistic of b_1 (Equation 8) was (0.46 - 1) / 0.25 = -2.16. This value is greater than - 3.60, the critical value of the τ_τ -distribution, with 15 observations, at the 0.05 level of significance. Thus, the series was not stationary. Therefore, the data were differenced to make the series stationary. The value of T-statistic of differenced data was (-0.47 - 1)/0.17 = -8.65. This value is less than the critical value of the distribution, indicating that the differenced series was now stationary.

Test for serial correlation of residuals

The test for serial correlation in model (8) before differencing indicated no serial correlation of the residuals (Table 4).

Table 4. Comparison of the values of Q-statistic with the critical values of X^2-distribution[1], using equation 8.

Order serial correlation	Q-statistic	X^2-distribution
1	0.005	3.84
2	1.241	5.99
3	1.691	7.81

After differencing the data and respecifying the model (Equation 1), further tests for serial correlation of the expanded equation were undertaken. The results in Table 5 below indicate that there was no residual serial correlation.

Table 5. Comparison of the values of Q-statistic with the critical values of X^2-distribution[2], after differencing and adding variables from equation 1.

Order serial correlation	Q-statistic	X^2-distribution
1	1.121	3.84
2	2.529	5.99
3	3.832	7.81

[1]K-degrees of freedom, 0.05 level of significance, 15 observations.

[2]K-degrees of freedom, 0.05 level of significance, 14 observations.

The final estimated equation, using differenced series of average annual bean prices (DRPB1), is:

$$DRPB1_t = 87.26 - 0.47\ QB_{t-1} + 2.80\ QP_{t-1} - 0.42\ RPP2_{t-1} - 0.28\ Trend$$
$$(27.24) \quad (0.17) \quad (0.91) \quad (0.17) \quad (0.50) \qquad (9)$$

Level of uncertainty

The estimate for the test of constant variance, using differenced data (Equation 9), gave:

$$U^2_t = 9.87 + 28.59\ D_t \qquad (10)$$
$$(16.18) \quad (20.18)$$
$$t = 0.61 \quad t = 1.42$$

Thus, α_2 is found to be is positive. However, it is not statistically different from zero (T-statistic). This means that the variance was constant in both the period including SOBECOV (1979-1987) and in the period prior to the existence of SOBECOV (1972-1978).

4.1.2. Monthly data

With this model, two types of analysis were performed. The first analysis regressed bean prices against lagged bean prices. The second analysis regressed bean prices against both bean and pea prices to see if adding pea prices would better predict bean prices.

A. Bean prices against lagged bean prices

The basic equation for this model is Equation 2, which was formulated as following:

$$RPB20_t = a + b\ RPB20_{t-1} + E_t.$$

Test for nonstationarity

The test for stationarity of the series in which bean prices were regressed against lagged bean prices (Equation 2) and seasonal dummy variables, using the Dickey-Fuller test, indicated a T-statistic value of -3.3. The critical value of the τ_μ - distribution, with 180 observations at 0.05 level of significance is -2.88. Since the value of the T-statistic of b was less than the critical value, the hypothesis of non- stationary time series (null hypothesis) was rejected. The series was stationary.

Test for serial correlation of residuals

The test for serial correlation of residuals, using equation 2 (bean prices regressed against lagged bean prices), looked at first, second, and higher order serial correlation to check if the value of the current error term was correlated with its own values of 1, 2, 5, ..., n periods ago. The results shown in Table 6 indicate that the values of the Q-statistic are all less than the critical values of the X^2-distribution. Thus, there is no evidence of serial correlation. The model is well specified and can therefore be used to forecast bean prices.

Table 6. Comparison of the values of Q-statistic with the critical values of X^2-distribution[3], using equation 2.

Order serial correlation	Q-statistic	X^2-distribution
1	1.377	3.84
2	2.587	5.99
5	3.980	11.07
10	7.533	18.31
20	24.388	31.41
33	48.816	~55

Next, dummy variables are added (Equation 5) to account for seasonality. The estimated equation became:

$$
\begin{aligned}
RPB20_t = {} & \underset{(1.8)}{3.64} + \underset{(0.03)}{0.92}\, RPB20_{t-1} - \underset{(1.74)}{2.77}\, X_1 - \underset{(1.74)}{0.53}\, X_2 + \underset{(1.74)}{1.03}\, X_3 + \underset{(1.74)}{0.88}\, X_4 \\
& + \underset{(1.74)}{0.24}\, X_5 - \underset{(1.74)}{2.98}\, X_6 + \underset{(1.74)}{1.20}\, X_8 + \underset{(1.74)}{2.19}\, X_9 + \underset{(1.74)}{2.44}\, X_{10} + \underset{(1.74)}{3.88}\, X_{11} \\
& - \underset{(1.76)}{1.76}\, X_{12} \qquad (11)
\end{aligned}
$$

Where: $RPB20_t$ represents actual monthly real bean prices;

$RPB20_{t-1}$ represents monthly real bean prices for the previous period;

[3]K-degrees of freedom, 0.05 level of significance, 180 observations.

X_1 .... X_{12} are the seasonal dummy variables, and the values in parentheses are the standard errors.

Test for serial correlation of residuals (with dummy variables)

The addition of the seasonal dummy variables required a retest for serial correlation of residuals, using equation 11. This test indicated the presence of serial correlation at the first, second and fifth orders (Table 7).

Table 7. Comparison of the values of Q-statistic with the critical values of X^2-distribution[4], using equation 11.

Order serial correlation	Q-statistic	X^2-distribution
1	5.683	3.84
2	9.107	5.99
5	11.392	11.07
10	13.525	18.31
20	22.854	31.41
36	35.616	~ 55

To correct for serial correlation, introduced by the seasonal dummy variables, one more lag was added to the basic equation 2, which is rewritten:

$$RPB20_t = a + b\ RPB20_{t-1} + m\ RPB20_{t-2} + E_t \qquad (12)$$

Where $RPB20_{t-2}$ represents monthly real bean prices two periods ago.

[4]K-degrees of freedom, 0.05 level of significance, 180 observations.

This model with one additional lag was tested for serial correlation, using equation 12. The results (Table 8) indicate that there is no serial correlation since the values of Q-statistic are all less than the critical value of the X^2-distribution.

Table 8. Comparison of the values Q-statistic with the critical values of X^2-distribution[5], using equation 12.

Order serial correlation	Q-statistic	X^2-distribution
1	0.003	3.84
2	0.689	5.99
5	2.049	11.07
10	5.765	18.31
20	25.674	31.41
33	44.437	48

When dummy variables were added to equation 12, it was necessary to retest for serial correlation. Table 9 below indicate no serial correlation.

[5]K-degrees of freedom, 0.05 level of significance, 168 observations.

Table 9. Comparison of the values of Q-statistic with the critical values of X^2-distribution[6], adding dummy variables to equation 12.

Order serial correlation	Q-statistic	X^2-distribution
1	0.059	3.84
2	1.567	5.99
5	3.508	11.07
10	5.818	18.31
20	14.057	31.41
33	23.531	~ 48

The estimated equation, using equation 12 (with dummy variables) is:

$$RPB20_t = 3.43 + 0.73\ RPB20_{t-1} + 0.18\ RPB20_{t-2} - 2.75\ X_1 - 0.85\ X_2$$
$$(2.04)\quad (0.08)\qquad\qquad (0.08)\qquad\qquad (1.82)\qquad (1.81)$$
$$+ 1.21\ X_3 + 1.63\ X_4 + 0.84\ X_5 - 2.77\ X_6 + 1.66\ X_8 + 2.84\ X_9$$
$$(1.82)\quad (1.84)\quad (1.84)\quad (1.83)\quad (1.84)\quad (1.84)$$
$$+ 3.55\ X_{10} + 4.83\ X_{11} - 0.75\ X_{12}$$
$$(1.86)\quad (1.87)\quad (1.90) \qquad (13)$$

[6]K-degrees of freedom, 0.05 level of significance, 168 observations.

The level of uncertainty

The equation for testing for constant variance was estimated. The results are:

$$U^2_t = 33.82 - 19.78\ D_t \qquad (14)$$

$$(6.304) \quad (7.862)$$

$$t = 5.36 \quad t = -2.51$$

α_2 is both less than zero and is significantly different from zero (statistically). This means that the variance in the second period is lower than the variance in the first period, indicating that price uncertainty was reduced following the introduction of SOBECOV.

B. Bean prices against lagged bean and pea prices

The basic equation for this model is also equation 2. Thereafter, the equation was expanded by including pea prices and seasonal dummy variables.

Test for nonstationarity

The test for stationarity was not necessary, since equation 2 indicated that the series was stationary.

Test for serial correlation of residuals

The basic equation used to test for serial correlation was equation 13 to which lagged monthly real pea prices were added. The test for serial correlation of residuals indicated that the values of the Q-statistic are less than the critical values of the X^2-distribution (Table 10). Consequently, there is no serial correlation of residuals.

Table 10. Comparison of the values of Q-statistic with the critical values of X^2-distribution[7], using equation 6.

Order serial correlation	Q-statistic	X^2-distribution
1	0.080	3.84
2	1.993	5.99
5	4.064	11.07
10	6.252	18.31
20	14.079	31.41
33	23.701	¯48

[7]K-degrees of freedom, 0.05 level of significance, 168 observations.

The estimated equation is:

$$RPB20_t = 2.84 + 0.72\ RPB20_{t-1} + 0.17\ RPB20_{t-2} + 0.02\ RPP20_{t-1}$$
$$(2.20)\quad (0.08)\quad (0.08)\quad (0.03)$$
$$- 2.41\ X_1 - 0.53\ X_2 + 1.41\ X_3 + 1.77\ X_4 + 0.92\ X_5$$
$$(1.89)\quad (1.87)\quad (1.85)\quad (1.86)\quad (1.85)$$
$$- 2.63\ X_6 + 1.73\ X_8 + 2.96\ X9 + 3.71\ X_{10} + 5.07\ X_{11}$$
$$(1.85)\quad (1.84)\quad (1.86)\quad (1.88)\quad (1.90)$$
$$- 0.48\ X_{12}$$
$$(1.94) \qquad (15)$$

Where $RPP20_{t-1}$ represents monthly real pea prices for the previous period.

The level of uncertainty

The test for the level of uncertainty indicated the following results:

$$U^2_t = 33.82 - 19.89\ D_t \qquad (16)$$
$$(6.25)\quad (7.80)$$
$$t = 5.41 \quad t = -2.55$$

α_2 is both less than zero and is significantly different from zero (statistically). This means that the variance of the error term in the second period is lower than the variance in the first period, indicating that price uncertainty was reduced following the establishment of SOBECOV.

The goodness of fit ($\bar{R}^2$) of the two regressions [Equations 13 (without pea prices) and 15 (with pea prices)] is the same (0.82). Both equations 13 and 15 predict actual bean prices equally well. This indicates that adding pea prices does not improve predicting bean prices in Burundi.

4.2. Discussion

4.2.1. Price uncertainty

The annual data model indicated that the variance of the error term was constant over the period 1972-1987 (Equation 10). On the other hand, the monthly data model showed that bean prices in the period including SOBECOV (1979-1987) were more predictable than bean prices prior to the Board (1972-1978) (Equations 14 and 16).

4.2.2. Crop production

SOBECOV appears to have had an impact on increasing bean production. Figure 1 and Table 2 show that bean production rose yearly from an average of 280 thousand metric tons in the pre-SOBECOV period to an average of 290 thousand metric tons in the second period during which SOBECOV operated.

In contrast, pea production (Figure 3 and Table 3), decreased slightly in the period including SOBECOV, from 29.5

thousand metric tons per year (1972-1978) to 29 thousand metric tons per year (1979-1987). This may be explained by the fact that SOBECOV largely bought beans to constitute a security stock because beans are the staple food.

The above results suggest that the presence of SOBECOV (through its reduction in price uncertainty) may have been one of the factors which contributed to the increase in bean production during the 1979-1987 period.

4.2.3. Production components: area and yield

During the period studied, the area harvested for beans also increased sharply by 31 percent, from an average of 485,400 hectares (1972-1978) to 633,900 hectares (1979-1987). The average yearly increase of the area harvested was therefore 16,500 hectares. On the other hand, bean yield decreased by 21 percent, from an average of 576 kg/ha in the first period to 457 kg/ha in the second period.

Similarly, the area harvested for peas increased by 8 percent, from 42,760 hectares (1972-1978) to 46,320 hectares (1979-1987), but pea yields decreased by 9 percent,from 690 kg/ha in the first period to 621 kg/ha in the second period.

The decrease in both bean and pea yields is consistent with the extensive agricultural focus of the *Fourth Five Year Plan* (1983-1987), which prescribed a spontaneous land settlement to increase the production of beans, maize and peanuts. In actual fact, the government of Burundi put greater emphasis on bean production than on pea production, accounting for the more rapid increase in bean area harvested (31%) compared to the increase in area harvested for peas (8%). People increased bean production by increasing the area harvested (new lands) instead of adopting new technology. The Plan also proposed that the government reorganize the marketing of beans, maize, cassava and sorghum. In fact, one of SOBECOV's programs was to assemble beans throughout the country to develop a security stock in order to stabilize bean prices. Thus, relatively stable prices appear to have contributed to the increase in bean area harvested during 1979-1987.

Around 1982, however, SOBECOV closed four of its six assembly stations, probably because of problems in managing the buffer stock. As a result, it was no longer able to release enough beans to supply the market in subsequent bean shortage periods.

In conclusion, this study indicates that monthly bean prices were more uncertain in Burundi in the period prior to SOBECOV (1972-1978) than in the period including SOBECOV (1979-1987). The results also suggest that price uncertainty contributes to lower bean production. This implies that the creation of SOBECOV may have been one of the factors which reduced price uncertainty in the period 1979-1987 and consequently, that bean price stabilization induced increased bean production.

CHAPTER V: SUMMARY AND POLICY IMPLICATIONS

5.1. Summary

Burundi has one of the highest population densities in Africa and the rate of population increase exceeds annual food production growth. Temporarly migration has served as a short run solution to the land constraints. Yet, in the long run, Burundi must increase yields to feed its people.

The government of Burundi has proposed various means to increase production and generate a larger marketed surpluses of beans, maize, cassava, sweet potatoes, and peanuts. However, the author asserted that as long as farmers are not assured stable prices, they will not commit their resources to produce surpluses. Consequently, bean price uncertainty was likely to handicap investment in improved farm technology to increase production.

The objectives of this study were to analyse the behavior of dry bean production in Burundi under uncertain prices and to assess the degree of bean price uncertainty for the period 1972-1987. The study focused on beans because they are the staple food in Burundi. In addition, they are the major source of proteins and energy for the rural population and are a source of cash income to farmers.

The hypotheses tested were that dry bean prices in Burundi are uncertain; and that bean production per capita has fallen because dry bean prices are uncertain. The assumptions underlying the hypotheses were that farmers'decisions to produce beans are made ex ante and that farmers are averse to risk.

Findings in this study showed that the creation of the marketing board (SOBECOV) may have contributed to reducing bean price uncertainty in the period 1979-1987. Also, the study indicated that bean production increased in that period, although yields declined.

5.2. Policy Implication For Burundi

While stable prices and guaranteed markets would likely to stimulate production, infrastructure (roads, transportation facilities) and efficient institutions to coordinate bean production and input and output marketing are also required to enable farmers to generate surpluses in Burundi. Thus, price stabilization is only one element of an improved marketing system.

Agricultural price policy cannot be determined by reference to agriculture alone because agriculture is affected by other segments of the national economy and macroeconomic factors like interest rates, wage rates, and foreign exchange rates. Also, the government can not set policies designed to affect a single crop like beans, independent of other commodities, since the relative prices for commodities that are substitutes and complements can affect farmers' response to price policy for a specific commodity. In the case of beans in Burundi, price policy should take into account pea prices (substitute) and major bean complements like sweet potatoes, bananas, and cassava.

The government of Burundi should also consider various opportunities that farmers can use to increase production, as well as to improve their access to marketed beans. Strenghening institutions like credit cooperatives (COOPEC) represents a means to increase investment in bean production.

In a country where the population growth rate exceeds production growth rate, price policy alone can not be relied on to increase bean production. New bean production technological represents a potential remedy to low bean production in Burundi. Chapter Two discussed the constraints to technological change in bean production via new bean varieties. Farmers did not accept the recommended intensive technology because it was inappropriate for the farming system and eating habits of Burundians since. It required planting in pure stands and required adoption of black-seeded beans, whereas consumers prefer light-colored beans. Consequently, research is needed to identify more appropriate varieties. Also, research is needed to identify ways to encourage farmers to more intensively use organic and/or chemical fertilizers. However, chemical fertilizers must be imported and distributed to farmers on a regular basis, at the right time (prior to planting), and at an affordable price, given a large number of low-income farmers. Also, farmers must be taught how to apply chemical fertilizers correctly. A public institutional organization is needed, at least in short run, to bear the responsibility and to educate farmers to correctly use new inputs like fertilizers.

In summary, to improve food security in Burundi, the government needs to both improve bean marketing and increase bean production so that the rural population have better access to the country's staple crops. In addition, SOBECOV must be reorganized to better perform its exchange (buying and selling), physical (storage and transportation) and facilitating functions (standardization, financing, risk bearing, and market information. Also, biological research must be carried out to speed up technological change in bean production in order to increase bean yields.

5.3. Limitations of the Analysis

First, data on beans and peas used to assess the level of price uncertainty in Burundi and its consequences on bean production reflect only the market conditions in the capital city, Bujumbura. Indeed, the behavior of bean prices in Bujumbura may differ from the rest of the country. Second, the time series analysed were composed of aggregate data. They do not reflect the conditions of households, in terms of production and marketing of beans. For example, aggregate data do not reflect differences between wealthy versus poor households. They also do not take into account regional variations across the country, in terms of resource endowment. Also, they do not reflect rural versus urban conditions. Cross-sectional data are required to analyse the differential impact of alternative pricing policies at the household level.

Consequently, price policy - based on the findings of this study - should be implemented with caution, since the market conditions in one location of the country may not be characteristic of the entire country. Yet, the results obtained in this study constitute a basis on which hypotheses can be formulated to better understand bean subsector in Burundi, and thus, to identify probable policy impacts.

5.4. Future Research Needs

The establishment of SOBECOV appears to have contributed to increasing staple food production in Burundi. To insure future food security, an effective marketing system will be required to stimulate production, encouraging farmers to use land-saving technology, and to distribute food to different consumers in the country at an affordable cost. Therefore, the issues of a continuous flow of food (food availability) and the access to that food, via distributional mechanisms, raise the question of whether SOBECOV alone can manage to accomplish all the tasks necessary to achieve food security.

So far, SOBECOV's program has been limited to assembling and storing beans. This study indicated that although SOBECOV may have contributed to increase bean production, it failed to stabilize bean prices. Scope may exist for the private sector to help the marketing board to realize some of its functions, such as assembly and distribution of both beans and inputs used to produce beans.

In order to assess this strategy, research is needed to address four issues. First, what are consequences associated with this partial privatization of the economy (i.e., impact of free market on prices of agricultural commodities, production and intraregional trade) in Burundi. A second issue is whether or not the private sector in Burundi has the capacity to assume some of the functions of the board. A third issue is what type of local facilitating local institutions are needed (i.e., credit system, farmers' association) to insure a smooth introduction of market liberalization. Fourth, market liberalization requires the development of an information system on prices of both inputs and outputs. Thus research is needed to identify the institution responsible for the collection and diffusion of information to both producers and consumers as well as the appropriate methods to disseminate it.

BIBLIOGRAPHY

Africa, South of Sahara, Burundi. (1988). Europa Publications Limited, London, 18th edition, 305.

Anonymous. (1982). Les Effets des Facteurs Démographiques sur le Burundi, 21.

Arnould, E. (1982). Draft Environmental Profile of Burundi. MAB, 9-17.

Berti, F. (1985). Synthèse de Travaux Réalisés sur Phaseolus au Zaire, Rwanda et Burundi, de 1945 à nos Jours. CIAT, 27-36.

Dickey, D. A., et al.. (1986). "Unit Roots in Time Series Model: Tests and Implications" in The American Statistician. 40(1), 12-26.

FAO. (1987). Agricultural Price Policy: Issues and Proposal. Rome, 1-116.

FAO. (1987-1988). The State of Food and Agriculture. Rome, 150.

Gajardo, T. (1986). "L'Expérience de la Planification Agricole pour l'Elaboration du Plan Quinquinnal 1983-1987 au Burundi" in Cahiers du CURDES. Bujumbura, 19-21.

Hebert, D. (1984). "Producer Preference for Price Stability" in AJAE. 66(1-2), 88-90.

IBRD. (1989). World Development Report, 164-227.

Jayne, T. (1987). A Comparative Analysis of Grain Marketing in three Sub-Saharan Countries: Implications for Food Security. MSU, M.S. Thesis, Chapter 3.

Kuntz, P.S. (1984). Country Orientation Notebooks for Africa, Burundi. n° 6, University of Florida, Center for African Studies, Sections VI and VIII.

Lindon, R.J. and P.J.Barry. (1987). The Competitive Firm's Response to Risk. New York, MacMillan, 12-14.

Loveridge, S. (1988). Uses of Farm and Market Survey Data to Inform Food Security Policy in Rwanda. MSU, Ph.D. Dissertation, 13 and 245.

Shaffer,J., H.Riley, J.Staatz, M.Weber. (1985). "Designing Marketing Systems to Promote Development in Less Developed Countries" in ICRISAT, Agricultural Markets in the Semi-Arid Tropics., 306-317.

UNCTAD. 1988. Commodity Yearbook, 57.

USAID Field Mission in Burundi, 1981(?), 9-58.

Verbal Communication with Credentials of the Individual who Collected the Data: **Shahuri Charles**, Vice-Director of **SNES**, December 1987.

World Bank. (1987). World Tables, 76-77.

Population Reference Bureau. (1988). World Population Data Sheet (Broadside)

APPENDICES

APPENDIX 1

obs	RPB	RPB20	RPP	RPP20	CPI1
1972.01	14.60000	50.51903	19.00000	65.74394	28.90000
1972.02	13.00000	43.91892	19.20000	64.86487	29.60000
1972.03	13.70000	45.06579	20.60000	67.76316	30.40000
1972.04	9.800000	31.51125	22.00000	70.73955	31.10000
1972.05	14.70000	46.22641	21.20000	66.66667	31.80000
1972.06	13.10000	40.18405	21.00000	64.41718	32.60000
1972.07	12.90000	38.73874	22.90000	68.76877	33.30000
1972.08	12.80000	36.57143	20.90000	59.71428	35.00000
1972.09	13.10000	35.69482	17.50000	47.68392	36.70000
1972.10	13.70000	35.67708	18.50000	48.17708	38.40000
1972.11	15.20000	37.90524	19.00000	47.38155	40.10000
1972.12	13.60000	32.53589	19.20000	45.93302	41.80000
1973.01	12.20000	28.04598	18.50000	42.52874	43.50000
1973.02	13.40000	29.64602	18.30000	40.48673	45.20000
1973.03	14.80000	31.55650	19.50000	41.57782	46.90000
1973.04	14.40000	29.62963	19.90000	40.94650	48.60000
1973.05	14.80000	29.42346	19.10000	37.97217	50.30000
1973.06	15.20000	29.23077	21.00000	40.38462	52.00000
1973.07	13.80000	25.89118	18.80000	35.27205	53.30000
1973.08	14.40000	27.32448	18.80000	35.67362	52.70000
1973.09	15.10000	29.26357	18.90000	36.62791	51.60000
1973.10	13.90000	27.47036	19.40000	38.33992	50.60000
1973.11	15.10000	30.44355	19.70000	39.71774	49.60000
1973.12	14.30000	29.42387	21.30000	43.82716	48.60000
1974.01	13.10000	27.57895	18.60000	39.15789	47.50000
1974.02	13.90000	29.89247	19.70000	42.36559	46.50000
1974.03	14.30000	31.42857	20.10000	44.17582	45.50000
1974.04	15.20000	34.23423	21.20000	47.74775	44.40000
1974.05	15.50000	35.71428	20.40000	47.00460	43.40000
1974.06	15.70000	37.02830	19.50000	45.99057	42.40000
1974.07	16.50000	40.34230	19.80000	48.41076	40.90000
1974.08	23.40000	56.52174	37.60000	90.82125	41.40000
1974.09	25.10000	59.90453	46.80000	111.6945	41.90000
1974.10	24.90000	58.72641	46.80000	110.3774	42.40000
1974.11	35.00000	81.58508	47.60000	110.9557	42.90000
1974.12	31.20000	71.88940	40.00000	92.16589	43.40000
1975.01	30.00000	68.33713	40.00000	91.11617	43.90000
1975.02	28.40000	63.96396	50.00000	112.6126	44.40000
1975.03	31.90000	71.04677	53.40000	118.9310	44.90000
1975.04	31.60000	69.60352	64.60000	142.2907	45.40000
1975.05	30.30000	65.86956	64.60000	140.4348	46.00000
1975.06	28.70000	61.72043	64.60000	138.9247	46.50000
1975.07	28.60000	60.72187	48.40000	102.7601	47.10000
1975.08	26.60000	55.76520	48.40000	101.4675	47.70000
1975.09	27.70000	57.82881	48.40000	101.0438	47.90000
1975.10	31.70000	66.04167	43.00000	89.58334	48.00000
1975.11	29.60000	61.41079	43.00000	89.21162	48.20000
1975.12	28.90000	59.58763	43.00000	88.65979	48.50000
1976.01	26.50000	54.30328	39.80000	81.55737	48.80000
1976.02	29.70000	60.61225	43.20000	88.16327	49.00000

obs	RPB	RPB20	RPP	RPP20	CPI1
1976.03	31.20000	63.28601	45.70000	92.69777	49.30000
1976.04	33.40000	67.47475	50.60000	102.2222	49.50000
1976.05	28.70000	57.63052	50.30000	101.0040	49.80000
1976.06	26.80000	53.49302	50.80000	101.3972	50.10000
1976.07	28.30000	56.15079	53.80000	106.7460	50.40000
1976.08	29.70000	58.57988	39.10000	77.12031	50.70000
1976.09	29.80000	58.54617	34.80000	68.36935	50.90000
1976.10	28.80000	56.25000	36.20000	70.70313	51.20000
1976.11	38.10000	73.98058	36.00000	69.90292	51.50000
1976.12	26.50000	51.15830	38.10000	73.55212	51.80000
1977.01	26.00000	49.90403	39.60000	76.00768	52.10000
1977.02	28.10000	53.72849	36.30000	69.40727	52.30000
1977.03	28.00000	53.23194	38.00000	72.24335	52.60000
1977.04	26.40000	49.90548	36.60000	69.18714	52.90000
1977.05	25.90000	48.68421	36.00000	67.66917	53.20000
1977.06	23.60000	44.11215	36.90000	68.97196	53.50000
1977.07	26.80000	49.81413	36.50000	67.84386	53.80000
1977.08	27.10000	49.36248	36.70000	66.84882	54.90000
1977.09	36.80000	65.83184	36.80000	65.83184	55.90000
1977.10	34.50000	60.52632	41.40000	72.63158	57.00000
1977.11	40.00000	68.96552	44.40000	76.55173	58.00000
1977.12	34.60000	58.44594	41.60000	70.27026	59.20000
1978.01	33.30000	55.22388	50.00000	82.91874	60.30000
1978.02	33.30000	54.23452	48.80000	79.47882	61.40000
1978.03	32.30000	51.76282	53.90000	86.37820	62.40000
1978.04	33.30000	52.44095	54.70000	86.14173	63.50000
1978.05	33.70000	52.16719	50.00000	77.39938	64.60000
1978.06	32.90000	50.07611	72.00000	109.5890	65.70000
1978.07	34.30000	51.34730	50.00000	74.85030	66.80000
1978.08	39.50000	57.41279	47.00000	68.31395	68.80000
1978.09	42.90000	60.50776	48.50000	68.40620	70.90000
1978.10	52.00000	71.33059	52.00000	71.33059	72.90000
1978.11	50.00000	66.66666	51.10000	68.13333	75.00000
1978.12	54.30000	70.51948	55.80000	72.46753	77.00000
1979.01	48.60000	61.51899	60.30000	76.32911	79.00000
1979.02	46.50000	57.40741	61.20000	75.55556	81.00000
1979.03	48.50000	58.36342	69.80000	83.99519	83.10000
1979.04	49.10000	57.62911	72.70000	85.32864	85.20000
1979.05	46.70000	53.55505	64.50000	73.96790	87.20000
1979.06	42.50000	47.64574	80.00000	89.68610	89.20000
1979.07	46.60000	51.04052	88.90000	97.37130	91.30000
1979.08	45.70000	49.67391	100.0000	108.6957	92.00000
1979.09	47.60000	51.34843	87.90000	94.82201	92.70000
1979.10	52.80000	56.53105	81.70000	87.47323	93.40000
1979.11	55.90000	59.40489	87.00000	92.45483	94.10000
1979.12	56.90000	60.02110	79.00000	83.33333	94.80000
1980.01	56.40000	59.05759	68.60000	71.83246	95.50000
1980.02	50.20000	52.18295	70.30000	73.07693	96.20000
1980.03	48.10000	49.63880	70.00000	72.23942	96.90000
1980.04	46.60000	47.74590	70.00000	71.72131	97.60000

APPENDIX 1

obs	RPB	RPB20	RPP	RPP20	CPI1
1980.05	45.50000	46.28688	70.00000	71.21058	98.30000
1980.06	39.50000	39.89899	68.80000	69.49495	99.00000
1980.07	38.90000	38.90000	70.00000	70.00000	100.0000
1980.08	39.10000	38.71287	68.80000	68.11881	101.0000
1980.09	39.00000	38.23529	65.90000	64.60784	102.0000
1980.10	37.60000	36.50485	58.10000	56.40776	103.0000
1980.11	37.00000	35.57692	57.00000	54.80769	104.0000
1980.12	37.50000	35.71429	55.00000	52.38095	105.0000
1981.01	33.80000	31.88679	60.00000	56.60378	106.0000
1981.02	32.20000	30.09346	60.00000	56.07477	107.0000
1981.03	34.30000	31.75926	63.70000	58.98148	108.0000
1981.04	36.30000	33.30275	69.40000	63.66973	109.0000
1981.05	37.50000	34.09091	70.00000	63.63636	110.0000
1981.06	34.50000	31.08108	69.80000	62.88289	111.0000
1981.07	34.20000	30.53572	65.40000	58.39286	112.0000
1981.08	37.60000	33.42222	61.00000	54.22222	112.5000
1981.09	39.30000	34.77876	60.00000	53.09734	113.0000
1981.10	41.00000	36.12335	69.50000	61.23348	113.5000
1981.11	39.80000	34.91228	74.60000	65.43860	114.0000
1981.12	36.30000	31.70306	70.00000	61.13537	114.5000
1982.01	39.40000	34.26087	70.00000	60.86956	115.0000
1982.02	40.00000	34.63203	70.40000	60.95238	115.5000
1982.03	43.00000	37.06897	70.10000	60.43103	116.0000
1982.04	54.60000	46.86695	77.30000	66.35194	116.5000
1982.05	68.80000	58.80342	81.30000	69.48718	117.0000
1982.06	59.10000	50.29787	98.00000	83.40426	117.5000
1982.07	48.40000	41.01695	80.40000	68.13560	118.0000
1982.08	42.90000	36.11111	78.10000	65.74074	118.8000
1982.09	42.70000	35.70234	77.70000	64.96655	119.6000
1982.10	44.60000	37.04319	75.60000	62.79070	120.4000
1982.11	50.70000	41.83168	77.40000	63.86139	121.2000
1982.12	48.90000	40.08197	100.6000	82.45902	122.0000
1983.01	48.50000	39.49511	80.00000	65.14658	122.8000
1983.02	45.20000	36.56958	80.00000	64.72492	123.6000
1983.03	45.70000	36.73634	80.00000	64.30868	124.4000
1983.04	48.20000	38.49841	80.10000	63.97763	125.2000
1983.05	49.30000	39.12698	82.10000	65.15873	126.0000
1983.06	48.30000	38.09148	82.70000	65.22082	126.8000
1983.07	47.00000	37.30159	87.90000	69.76191	126.0000
1983.08	46.70000	36.06178	83.00000	64.09267	129.5000
1983.09	47.80000	36.48855	80.20000	61.22137	131.0000
1983.10	53.50000	40.37736	76.60000	57.81132	132.5000
1983.11	56.50000	42.16418	80.00000	59.70149	134.0000
1983.12	60.60000	44.72325	80.70000	59.55719	135.5000
1984.01	58.90000	42.99270	85.00000	62.04380	137.0000
1984.02	60.00000	43.32130	90.00000	64.98195	138.5000
1984.03	61.00000	43.57143	89.00000	63.57143	140.0000
1984.04	61.20000	43.25089	88.80000	62.75619	141.5000
1984.05	62.90000	43.98602	88.60000	61.95804	143.0000
1984.06	64.30000	44.49827	90.50000	62.62976	144.5000

APPENDIX I

obs	RPB	RPB20	RPP	RPP20	CPI1
1984.07	65.80000	45.06850	95.10000	65.13699	146.0000
1984.08	67.40000	46.00683	96.20000	65.66553	146.5000
1984.09	71.50000	48.67257	99.80000	67.93738	146.9000
1984.10	88.80000	60.24424	100.0000	67.84261	147.4000
1984.11	91.90000	62.13658	100.5000	67.95132	147.9000
1984.12	107.5000	72.48820	114.8000	77.41065	148.3000
1985.01	81.70000	54.90591	116.6000	78.36021	148.8000
1985.02	81.70000	54.75871	116.6000	78.15013	149.2000
1985.03	81.70000	54.57582	116.6000	77.88911	149.7000
1985.04	80.50000	53.63091	117.2000	78.08128	150.1000
1985.05	76.20000	50.59761	116.9000	77.62284	150.6000
1985.06	67.00000	44.34150	115.9000	76.70417	151.1000
1985.07	70.00000	46.05263	109.2000	71.84210	152.0000
1985.08	72.70000	47.76610	99.80000	65.57162	152.2000
1985.09	72.10000	47.27869	103.5000	67.86885	152.5000
1985.10	76.00000	49.77079	108.8000	71.25082	152.7000
1985.11	75.70000	49.50948	134.9000	88.22760	152.9000
1985.12	74.90000	48.89034	113.5000	74.08617	153.2000
1986.01	71.90000	46.87093	107.9000	70.33899	153.4000
1986.02	65.70000	42.77343	113.2000	73.69791	153.6000
1986.03	65.40000	42.52276	118.8000	77.24317	153.8000
1986.04	64.80000	42.05062	115.5000	74.95132	154.1000
1986.05	63.50000	41.15360	116.0000	75.17822	154.3000
1986.06	61.90000	40.06473	116.4000	75.33981	154.5000
1986.07	62.10000	40.11628	116.7000	75.38760	154.8000
1986.08	60.90000	39.11368	106.7000	68.52922	155.7000
1986.09	61.30000	39.11934	105.1000	67.07084	156.7000
1986.10	60.70000	38.51523	106.5000	67.57614	157.6000
1986.11	60.50000	38.14628	107.3000	67.65447	158.6000
1986.12	53.60000	33.60502	112.7000	70.65830	159.5000
1987.01	60.00000	37.40649	90.70000	56.54614	160.4000
1987.02	59.10000	36.61710	100.0000	61.95787	161.4000
1987.03	60.00000	36.96858	100.0000	61.61429	162.3000
1987.04	60.30000	36.92590	106.3000	65.09492	163.3000
1987.05	74.50000	45.37150	104.2000	63.45919	164.2000
1987.06	69.20000	41.91399	105.0000	63.59782	165.1000
1987.07	64.80000	39.01264	103.0000	62.01083	166.1000
1987.08	65.60000	39.35213	100.0000	59.98800	166.7000
1987.09	65.00000	38.85236	104.1000	62.22355	167.3000
1987.10	66.00000	39.30911	106.1000	63.19238	167.9000
1987.11	66.20000	39.28783	106.3000	63.08606	168.5000
1987.12	67.70000	40.03548	107.8000	63.74926	169.1000

APPENDIX 2

obs	RPB1	RPP2	QB	QP	POP	QBCAP
1972	39.55000	59.82000	256.3000	27.70000	3.407000	75.22747
1973	28.95000	39.45000	291.3000	31.40000	3.576000	81.45973
1974	47.07000	69.24000	232.9000	25.20000	3.647000	63.86071
1975	63.49000	109.7500	294.0000	31.80000	3.720000	79.03226
1976	59.29000	86.13000	300.6000	32.40000	3.794000	79.23037
1977	54.37000	70.29000	307.0000	33.00000	3.870000	79.32817
1978	57.82000	78.78000	276.3000	25.00000	3.948000	69.98480
1979	55.35000	87.42000	273.7000	28.00000	4.022000	68.05073
1980	43.21000	66.33000	290.0000	26.00000	4.114000	70.49101
1981	32.81000	59.60000	294.0000	30.00000	4.229000	69.51998
1982	41.14000	67.45000	290.0000	29.00000	4.310000	67.28539
1983	38.80000	63.39000	280.0000	30.00000	4.420000	63.34842
1984	58.31000	65.82000	241.0000	18.00000	4.540000	53.08370
1985	50.17000	75.47000	301.0000	32.00000	4.720000	63.77119
1986	40.34000	71.97000	313.0000	33.00000	4.850000	64.53609
1987	39.26000	62.21000	324.9000	32.80000	5.000000	64.98000

obs	TREND	QPCAP	GNP
1972	1.000000	8.130320	70.00000
1973	2.000000	8.780761	80.00000
1974	3.000000	6.909789	90.00000
1975	4.000000	8.548387	100.0000
1976	5.000000	8.539801	120.0000
1977	6.000000	8.527132	130.0000
1978	7.000000	6.332320	140.0000
1979	8.000000	6.961711	180.0000
1980	9.000000	6.319883	210.0000
1981	10.00000	7.093875	230.0000
1982	11.00000	6.728539	240.0000
1983	12.00000	6.787330	240.0000
1984	13.00000	3.964758	270.0000
1985	14.00000	6.779661	230.0000
1986	15.00000	6.804124	240.0000
1987	16.00000	6.560000	250.0000

APPENDIX 3

LS // Dependent Variable is RPB20
Date: 3-09-1990 / Time: 14:58
SMPL range: 1973.01 - 1987.12
Number of observations: 180

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	4.4586063	1.5084547	2.9557442	0.003
RPB20(-1)	0.9055011	0.0312635	28.963540	0.000

R-squared	0.824956	Mean of dependent var	46.78233
Adjusted R-squared	0.823973	S.D. of dependent var	11.96957
S.E. of regression	5.021908	Sum of squared resid	4489.082
Durbin-Watson stat	2.167274	F-statistic	838.8866
Log likelihood	-544.8891		

IDENT RESID
Date: 3-09-1990 / Time: 14:58
SMPL range: 1973.01 - 1987.12
Number of observations: 180

Autocorrelations	Partial Autocorrelations		ac	pac
.*| .	.*| .	1	-0.087	-0.087

Q-Statistic (1 lags) 1.377 S.E. of Correlations 0.075

IDENT RESID
Date: 3-09-1990 / Time: 14:58
SMPL range: 1973.01 - 1987.12
Number of observations: 180

Autocorrelations	Partial Autocorrelations		ac	pac
.*| .	.*| .	1	-0.087	-0.087
. |*.	. |*.	2	0.082	0.075

Q-Statistic (2 lags) 2.587 S.E. of Correlations 0.075

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 14:59
SMPL range: 1973.01 - 1987.12
Number of observations: 180
=========================================================================
       Autocorrelations         Partial Autocorrelations        ac     pac
=========================================================================
¦                .*¦ .      ¦               .*¦ .         ¦  1 -0.087 -0.087
¦                . ¦*.      ¦               . ¦*.         ¦  2  0.082  0.075
¦                .*¦ .      ¦               .*¦ .         ¦  3 -0.067 -0.054
¦                . ¦*.      ¦               . ¦ .         ¦  4  0.044  0.029
¦                . ¦ .      ¦               . ¦ .         ¦  5 -0.037 -0.023
=========================================================================
 Q-Statistic (5 lags)     3.980            S.E. of Correlations  0.075
=========================================================================
```

```
IDENT RESID
Date: 3-09-1990 / Time: 14:59
SMPL range: 1973.01 - 1987.12
Number of observations: 180
=========================================================================
       Autocorrelations         Partial Autocorrelations        ac     pac
=========================================================================
¦                .*¦ .      ¦               .*¦ .         ¦  1 -0.087 -0.087
¦                . ¦*.      ¦               . ¦*.         ¦  2  0.082  0.075
¦                .*¦ .      ¦               .*¦ .         ¦  3 -0.067 -0.054
¦                . ¦*.      ¦               . ¦ .         ¦  4  0.044  0.029
¦                . ¦ .      ¦               . ¦ .         ¦  5 -0.037 -0.023
¦                . ¦ .      ¦               . ¦ .         ¦  6  0.027  0.014
¦                . ¦*.      ¦               . ¦*.         ¦  7  0.061  0.074
¦                .*¦ .      ¦               . ¦ .         ¦  8 -0.039 -0.038
¦                .*¦ .      ¦               **¦ .         ¦  9 -0.115 -0.129
¦                . ¦ .      ¦               . ¦ .         ¦ 10 -0.023 -0.031
=========================================================================
 Q-Statistic (10 lags)     7.533           S.E. of Correlations  0.075
=========================================================================
```

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 15:00
SMPL range: 1973.01 - 1987.12
Number of observations: 180
==========================================================================
      Autocorrelations            Partial Autocorrelations      ac     pac
==========================================================================
|               .*| .       |          .*| .       |  1 -0.087 -0.087
|               . |*.       |          . |*.       |  2  0.082  0.075
|               .*| .       |          .*| .       |  3 -0.067 -0.054
|               . |*.       |          . | .       |  4  0.044  0.029
|               . | .       |          . | .       |  5 -0.037 -0.023
|               . | .       |          . | .       |  6  0.027  0.014
|               . |*.       |          . |*.       |  7  0.061  0.074
|               .*| .       |          . | .       |  8 -0.039 -0.038
|               .*| .       |          **| .       |  9 -0.115 -0.129
|               . | .       |          . | .       | 10 -0.023 -0.031
|               . |*.       |          . |*.       | 11  0.085  0.096
|               . |**       |          . |**       | 12  0.159  0.179
|               . |**       |          . |**       | 13  0.152  0.180
|               .*| .       |          **| .       | 14 -0.110 -0.119
|               .*| .       |          .*| .       | 15 -0.050 -0.100
|               **| .       |          **| .       | 16 -0.125 -0.116
|               . |*.       |          . |*.       | 17  0.079  0.062
|               . | .       |          . | .       | 18 -0.031 -0.002
|               . | .       |          . | .       | 19  0.016 -0.036
|               . | .       |          . | .       | 20 -0.009  0.012
==========================================================================
 Q-Statistic (20 lags)   24.388          S.E. of Correlations  0.075
==========================================================================
```

```
IDENT RESID
Date: 3-09-1990 / Time: 15:00
SMPL range: 1973.01 - 1987.12
Number of observations: 180
==============================================================================
     Autocorrelations              Partial Autocorrelations           ac     pac
==============================================================================
 |          .*| .          |          .*| .          |  1 -0.087 -0.087
 |          . |*.          |          . |*.          |  2  0.082  0.075
 |          .*| .          |          .*| .          |  3 -0.067 -0.054
 |          . |*.          |          . | .          |  4  0.044  0.029
 |          . | .          |          . | .          |  5 -0.037 -0.023
 |          . | .          |          . | .          |  6  0.027  0.014
 |          . |*.          |          . |*.          |  7  0.061  0.074
 |          .*| .          |          . | .          |  8 -0.039 -0.038
 |          .*| .          |          **| .          |  9 -0.115 -0.129
 |          . | .          |          . | .          | 10 -0.023 -0.031
 |          . |*.          |          . |*.          | 11  0.085  0.096
 |          . |**          |          . |**          | 12  0.159  0.179
 |          . |**          |          . |**          | 13  0.152  0.180
 |          .*| .          |          **| .          | 14 -0.110 -0.119
 |          .*| .          |          .*| .          | 15 -0.050 -0.100
 |          **| .          |          **| .          | 16 -0.125 -0.116
 |          . |*.          |          . |*.          | 17  0.079  0.062
 |          . | .          |          . | .          | 18 -0.031 -0.002
 |          . | .          |          . | .          | 19  0.016 -0.036
 |          . | .          |          . | .          | 20 -0.009  0.012
 |          .*| .          |          .*| .          | 21 -0.098 -0.042
 |          **| .          |          .*| .          | 22 -0.118 -0.094
 |          . |*.          |          . | .          | 23  0.076  0.030
 |          . |*.          |          . |*.          | 24  0.114  0.054
 |          . | .          |          . | .          | 25  0.018 -0.028
 |          .*| .          |          .*| .          | 26 -0.071 -0.055
 |          .*| .          |          . | .          | 27 -0.051 -0.005
 |          .*| .          |          .*| .          | 28 -0.086 -0.043
 |          . |*.          |          . |*.          | 29  0.046  0.068
 |          . |**          |          . |**          | 30  0.145  0.131
 |          . | .          |          . | .          | 31 -0.005 -0.020
 |          . | .          |          . | .          | 32  0.031  0.019
 |          **| .          |          **| .          | 33 -0.186 -0.144
 |          . |*.          |          . |*.          | 34  0.045  0.045
 |          . | .          |          . | .          | 35 -0.034  0.009
 |          . |**          |          . | .          | 36  0.127  0.036
==============================================================================
 Q-Statistic (36 lags)   48.816           S.E. of Correlations   0.075
==============================================================================
```

LS // Dependent Variable is RPB20
Date: 3-09-1990 / Time: 15:04
SMPL range: 1973.01 - 1987.12
Number of observations: 180

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	3.6398879	1.8000066	2.0221526	0.043
RPB20(-1)	0.9161732	0.0302220	30.314775	0.000
X1	-2.7666372	1.7446460	-1.5857872	0.113
X2	-0.5308567	1.7374721	-0.3055339	0.760
X3	1.0349709	1.7366066	0.5959731	0.551
X4	0.8806049	1.7376303	0.5067849	0.612
X5	0.2412693	1.7386437	0.1387687	0.890
X6	-2.9786676	1.7385597	-1.7132961	0.087
X8	1.2027705	1.7357582	0.6929367	0.488
X9	2.1891304	1.7361242	1.2609296	0.207
X10	2.4455796	1.7385480	1.4066794	0.160
X11	3.8834946	1.7434644	2.2274585	0.026
X12	-1.7629051	1.7561761	-1.0038316	0.315

R-squared	0.852855	Mean of dependent var	46.78233
Adjusted R-squared	0.842282	S.D. of dependent var	11.96957
S.E. of regression	4.753570	Sum of squared resid	3773.603
Durbin-Watson stat	2.352300	F-statistic	80.66112
Log likelihood	-529.2635		

IDENT RESID
Date: 3-09-1990 / Time: 15:05
SMPL range: 1973.01 - 1987.12
Number of observations: 180

Autocorrelations	Partial Autocorrelations		ac	pac
**| .	**| .	1	-0.178	-0.178

Q-Statistic (1 lags) 5.683 S.E. of Correlations 0.075

IDENT RESID
Date: 3-09-1990 / Time: 15:05
SMPL range: 1973.01 - 1987.12
Number of observations: 180

Autocorrelations	Partial Autocorrelations		ac	pac
**| .	**| .	1	-0.178	-0.178
. |**	. |*.	2	0.138	0.110

Q-Statistic (2 lags) 9.107 S.E. of Correlations 0.075

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 15:06
SMPL range: 1973.01 - 1987.12
Number of observations: 180
==========================================================================
       Autocorrelations          Partial Autocorrelations       ac     pac
==========================================================================
 :             **: .          :              **: .        :  1 -0.178 -0.178
 :             . :**          :              . :*.        :  2  0.138  0.110
 :             . : .          :              . :*.        :  3  0.001  0.044
 :             . :*.          :              . :*.        :  4  0.097  0.094
 :             .*: .          :              . : .        :  5 -0.056 -0.034
==========================================================================
 Q-Statistic (5 lags)   11.392             S.E. of Correlations   0.075
==========================================================================
```

```
IDENT RESID
Date: 3-09-1990 / Time: 15:06
SMPL range: 1973.01 - 1987.12
Number of observations: 180
==========================================================================
       Autocorrelations          Partial Autocorrelations       ac     pac
==========================================================================
 :             **: .          :              **: .        :  1 -0.178 -0.178
 :             . :**          :              . :*.        :  2  0.138  0.110
 :             . : .          :              . :*.        :  3  0.001  0.044
 :             . :*.          :              . :*.        :  4  0.097  0.094
 :             .*: .          :              . : .        :  5 -0.056 -0.034
 :             .*: .          :              .*: .        :  6 -0.050 -0.094
 :             . :*.          :              . :*.        :  7  0.074  0.059
 :             . : .          :              . : .        :  8 -0.012  0.024
 :             .*: .          :              .*: .        :  9 -0.055 -0.061
 :             . : .          :              . : .        : 10  0.024  0.010
==========================================================================
 Q-Statistic (10 lags)   13.525            S.E. of Correlations   0.075
==========================================================================
```

```
IDENT RESID
Date: 3-09-1990 / Time: 15:07
SMPL range: 1973.01 - 1987.12
Number of observations: 180
==========================================================================
     Autocorrelations          Partial Autocorrelations         ac     pac
==========================================================================
 |            **| .          |            **| .          |  1 -0.178 -0.178
 |             . |**         |             . |*.         |  2  0.138  0.110
 |             . | .         |             . |*.         |  3  0.001  0.044
 |             . |*.         |             . |*.         |  4  0.097  0.094
 |             .*| .         |             . | .         |  5 -0.056 -0.034
 |             .*| .         |             .*| .         |  6 -0.050 -0.094
 |             . |*.         |             . |*.         |  7  0.074  0.059
 |             . | .         |             . | .         |  8 -0.012  0.024
 |             .*| .         |             .*| .         |  9 -0.055 -0.061
 |             . | .         |             . | .         | 10  0.024  0.010
 |             . | .         |             . |*.         | 11  0.036  0.040
 |             . | .         |             . | .         | 12 -0.009  0.006
 |             . |*.         |             . |**         | 13  0.113  0.131
 |             .*| .         |             .*| .         | 14 -0.087 -0.072
 |             . | .         |             . | .         | 15  0.035 -0.037
 |             .*| .         |             .*| .         | 16 -0.094 -0.072
 |             . |*.         |             . |*.         | 17  0.095  0.062
 |             .*| .         |             . | .         | 18 -0.097 -0.038
 |             . | .         |             . | .         | 19  0.027  0.002
 |             . | .         |             . | .         | 20  0.030  0.038
==========================================================================
 Q-Statistic (20 lags)    22.854           S.E. of Correlations   0.075
==========================================================================
```

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 15:08
SMPL range: 1973.01 - 1987.12
Number of observations: 180
==========================================================================
      Autocorrelations          Partial Autocorrelations        ac     pac
==========================================================================
¦           **¦ .        ¦          **¦ .         ¦  1 -0.178 -0.178
¦            . ¦**       ¦           . ¦*.        ¦  2  0.138  0.110
¦            . ¦ .       ¦           . ¦*.        ¦  3  0.001  0.044
¦            . ¦*.       ¦           . ¦*.        ¦  4  0.097  0.094
¦            .*¦ .       ¦           . ¦ .        ¦  5 -0.056 -0.034
¦            .*¦ .       ¦           .*¦ .        ¦  6 -0.050 -0.094
¦            . ¦*.       ¦           . ¦*.        ¦  7  0.074  0.059
¦            . ¦ .       ¦           . ¦ .        ¦  8 -0.012  0.024
¦            .*¦ .       ¦           .*¦ .        ¦  9 -0.055 -0.061
¦            . ¦ .       ¦           . ¦ .        ¦ 10  0.024  0.010
¦            . ¦ .       ¦           . ¦*.        ¦ 11  0.036  0.040
¦            . ¦ .       ¦           . ¦ .        ¦ 12 -0.009  0.006
¦            . ¦*.       ¦           . ¦**        ¦ 13  0.113  0.131
¦            .*¦ .       ¦           .*¦ .        ¦ 14 -0.087 -0.072
¦            . ¦ .       ¦           . ¦ .        ¦ 15  0.035 -0.037
¦            .*¦ .       ¦           .*¦ .        ¦ 16 -0.094 -0.072
¦            . ¦*.       ¦           . ¦*.        ¦ 17  0.095  0.062
¦            .*¦ .       ¦           . ¦ .        ¦ 18 -0.097 -0.038
¦            . ¦ .       ¦           . ¦ .        ¦ 19  0.027  0.002
¦            . ¦ .       ¦           . ¦ .        ¦ 20  0.030  0.038
¦            . ¦ .       ¦           . ¦ .        ¦ 21 -0.009 -0.006
¦            .*¦ .       ¦           .*¦ .        ¦ 22 -0.069 -0.064
¦            . ¦ .       ¦           . ¦ .        ¦ 23  0.021 -0.003
¦            . ¦ .       ¦           .*¦ .        ¦ 24 -0.033 -0.050
¦            .*¦ .       ¦           .*¦ .        ¦ 25 -0.045 -0.049
¦            .*¦ .       ¦           . ¦ .        ¦ 26 -0.041 -0.032
¦            . ¦ .       ¦           . ¦ .        ¦ 27  0.027  0.029
¦            . ¦ .       ¦           . ¦ .        ¦ 28 -0.035 -0.018
¦            . ¦*.       ¦           . ¦*.        ¦ 29  0.041  0.076
¦            . ¦*.       ¦           . ¦*.        ¦ 30  0.110  0.113
¦            . ¦ .       ¦           . ¦ .        ¦ 31 -0.008  0.018
¦            . ¦*.       ¦           . ¦*.        ¦ 32  0.081  0.051
¦           **¦ .        ¦          **¦ .         ¦ 33 -0.135 -0.148
¦            . ¦*.       ¦           . ¦ .        ¦ 34  0.104  0.017
¦            .*¦ .       ¦           . ¦ .        ¦ 35 -0.097 -0.010
¦            . ¦ .       ¦           . ¦ .        ¦ 36 -0.002 -0.031
==========================================================================
 Q-Statistic (36 lags)   35.616          S.E. of Correlations   0.075
==========================================================================
```

LS // Dependent Variable is RPB20
Date: 3-09-1990 / Time: 15:12
SMPL range: 1974.01 - 1987.12
Number of observations: 168

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	5.0975043	1.7543624	2.9056165	0.004
RPB20(-1)	0.8118287	0.0774943	10.475978	0.000
RPB20(-2)	0.0833658	0.0770859	1.0814669	0.279

R-squared	0.798032	Mean of dependent var	48.05636
Adjusted R-squared	0.795584	S.D. of dependent var	11.35424
S.E. of regression	5.133529	Sum of squared resid	4348.265
Durbin-Watson stat	1.988334	F-statistic	325.9798
Log likelihood	-511.6814		

IDENT RESID
Date: 3-09-1990 / Time: 15:16
SMPL range: 1974.01 - 1987.12
Number of observations: 168

Autocorrelations	Partial Autocorrelations		ac	pac
. | .	. | .	1	0.004	0.004

Q-Statistic (1 lags) 0.003 S.E. of Correlations 0.077

IDENT RESID
Date: 3-09-1990 / Time: 15:16
SMPL range: 1974.01 - 1987.12
Number of observations: 168

Autocorrelations	Partial Autocorrelations		ac	pac
. | .	. | .	1	0.004	0.004
. |*.	. |*.	2	0.064	0.064

Q-Statistic (2 lags) 0.689 S.E. of Correlations 0.077

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 15:16
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
      Autocorrelations        Partial Autocorrelations          ac      pac
==========================================================================
¦            . ¦ .        ¦            . ¦ .          ¦  1  0.004   0.004
¦            . ¦*.        ¦            . ¦*.          ¦  2  0.064   0.064
¦            .*¦ .        ¦            .*¦ .          ¦  3 -0.074  -0.074
¦            . ¦ .        ¦            . ¦ .          ¦  4  0.031   0.028
¦            .*¦ .        ¦            . ¦ .          ¦  5 -0.041  -0.033
==========================================================================
 Q-Statistic (5 lags)     2.049           S.E. of Correlations   0.077
==========================================================================
```

```
IDENT RESID
Date: 3-09-1990 / Time: 15:17
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
      Autocorrelations        Partial Autocorrelations          ac      pac
==========================================================================
¦            . ¦ .        ¦            . ¦ .          ¦  1  0.004   0.004
¦            . ¦*.        ¦            . ¦*.          ¦  2  0.064   0.064
¦            .*¦ .        ¦            .*¦ .          ¦  3 -0.074  -0.074
¦            . ¦ .        ¦            . ¦ .          ¦  4  0.031   0.028
¦            .*¦ .        ¦            . ¦ .          ¦  5 -0.041  -0.033
¦            . ¦ .        ¦            . ¦ .          ¦  6  0.016   0.008
¦            . ¦*.        ¦            . ¦*.          ¦  7  0.060   0.070
¦            .*¦ .        ¦            .*¦ .          ¦  8 -0.041  -0.051
¦            **¦ .        ¦            **¦ .          ¦  9 -0.128  -0.133
¦            . ¦ .        ¦            . ¦ .          ¦ 10 -0.012   0.004
==========================================================================
 Q-Statistic (10 lags)    5.765           S.E. of Correlations   0.077
==========================================================================
```

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 15:17
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
      Autocorrelations        Partial Autocorrelations        ac      pac
==========================================================================
 |          . | .          |          . | .          |  1  0.004   0.004
 |          . |*.          |          . |*.          |  2  0.064   0.064
 |          .*| .          |          .*| .          |  3 -0.074  -0.074
 |          . | .          |          . | .          |  4  0.031   0.028
 |          .*| .          |          . | .          |  5 -0.041  -0.033
 |          . | .          |          . | .          |  6  0.016   0.008
 |          . |*.          |          . |*.          |  7  0.060   0.070
 |          .*| .          |          .*| .          |  8 -0.041  -0.051
 |          **| .          |          **| .          |  9 -0.128  -0.133
 |          . | .          |          . | .          | 10 -0.012   0.004
 |          . |**          |          . |**          | 11  0.119   0.131
 |          . |**          |          . |**          | 12  0.186   0.183
 |          . |***         |          . |***         | 13  0.205   0.206
 |          .*| .          |          **| .          | 14 -0.093  -0.123
 |          .*| .          |          .*| .          | 15 -0.049  -0.077
 |          .*| .          |          .*| .          | 16 -0.086  -0.047
 |          . |*.          |          . |*.          | 17  0.084   0.084
 |          . | .          |          . | .          | 18 -0.009  -0.001
 |          . |*.          |          . | .          | 19  0.050   0.009
 |          . | .          |          . | .          | 20 -0.010   0.010
==========================================================================
 Q-Statistic (20 lags)   25.674             S.E. of Correlations   0.077
==========================================================================
```

APPENDIX 3

IDENT RESID
Date: 3-09-1990 / Time: 15:18
SMPL range: 1974.01 - 1987.12
Number of observations: 168

Autocorrelations	Partial Autocorrelations		ac	pac
. ¦ .	. ¦ .	1	0.004	0.004
. ¦*.	. ¦*.	2	0.064	0.064
.*¦ .	.*¦ .	3	-0.074	-0.074
. ¦ .	. ¦ .	4	0.031	0.028
.*¦ .	. ¦ .	5	-0.041	-0.033
. ¦ .	. ¦ .	6	0.016	0.008
. ¦*.	. ¦*.	7	0.060	0.070
.*¦ .	.*¦ .	8	-0.041	-0.051
**¦ .	**¦ .	9	-0.128	-0.133
. ¦ .	. ¦ .	10	-0.012	0.004
. ¦**	. ¦**	11	0.119	0.131
. ¦**	. ¦**	12	0.186	0.183
. ¦***	. ¦***	13	0.205	0.206
.*¦ .	**¦ .	14	-0.093	-0.123
.*¦ .	.*¦ .	15	-0.049	-0.077
.*¦ .	.*¦ .	16	-0.086	-0.047
. ¦*.	. ¦*.	17	0.084	0.084
. ¦ .	. ¦ .	18	-0.009	-0.001
. ¦*.	. ¦ .	19	0.050	0.009
. ¦ .	. ¦ .	20	-0.010	0.010
.*¦ .	.*¦ .	21	-0.104	-0.053
.*¦ .	.*¦ .	22	-0.090	-0.049
. ¦*.	. ¦ .	23	0.075	0.025
. ¦**	. ¦*.	24	0.131	0.040
. ¦ .	.*¦ .	25	0.011	-0.056
.*¦ .	.*¦ .	26	-0.059	-0.058
.*¦ .	. ¦ .	27	-0.057	0.009
.*¦ .	.*¦ .	28	-0.083	-0.047
. ¦*.	. ¦*.	29	0.053	0.071
. ¦**	. ¦**	30	0.161	0.123
. ¦ .	. ¦ .	31	0.008	-0.034
. ¦ .	. ¦ .	32	0.024	0.026
**¦ .	.*¦ .	33	-0.164	-0.111

Q-Statistic (33 lags) 44.437 S.E. of Correlations 0.077

APPENDIX 3

LS // Dependent Variable is RPB20
Date: 3-12-1990 / Time: 12:22
SMPL range: 1974.01 - 1987.12
Number of observations: 168

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	3.4260803	2.0450711	1.6752866	0.094
RPB20(-1)	0.7280993	0.0791979	9.1934188	0.000
RPB20(-2)	0.1856214	0.0785704	2.3624854	0.018
X1	-2.7507143	1.8245900	-1.5075795	0.132
X2	-0.8510489	1.8159581	-0.4686501	0.639
X3	1.2109661	1.8243577	0.6637767	0.507
X4	1.6301047	1.8434287	0.8842786	0.377
X5	0.8413999	1.8444319	0.4561838	0.648
X6	-2.7690675	1.8339887	-1.5098608	0.131
X8	1.6568559	1.8365626	0.9021505	0.367
X9	2.8479676	1.8488304	1.5404158	0.123
X10	3.5524327	1.8638732	1.9059412	0.057
X11	4.8351694	1.8732832	2.5811203	0.010
X12	-0.7519233	1.9022424	-0.3952826	0.693

R-squared	0.835324	Mean of dependent var	48.05636
Adjusted R-squared	0.821423	S.D. of dependent var	11.35424
S.E. of regression	4.798116	Sum of squared resid	3545.375
Durbin-Watson stat	1.961929	F-statistic	60.09009
Log likelihood	-494.5342		

IDENT RESID
Date: 3-12-1990 / Time: 12:23
SMPL range: 1974.01 - 1987.12
Number of observations: 168

Autocorrelations	Partial Autocorrelations		ac	pac
: . : .	: . : .	1	0.019	0.019

Q-Statistic (1 lags)	0.059	S.E. of Correlations	0.077

APPENDIX 3

```
IDENT RESID
Date: 3-12-1990 / Time: 12:23
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
        Autocorrelations          Partial Autocorrelations        ac     pac
==========================================================================
 :            . : .          :            . : .          :  1  0.019  0.019
 :            . :*.          :            . :*.          :  2  0.095  0.094
==========================================================================
 Q-Statistic (2 lags)     1.567              S.E. of Correlations  0.077
==========================================================================
```

```
IDENT RESID
Date: 3-12-1990 / Time: 12:23
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
        Autocorrelations          Partial Autocorrelations        ac     pac
==========================================================================
 :            . : .          :            . : .          :  1  0.019  0.019
 :            . :*.          :            . :*.          :  2  0.095  0.094
 :            . : .          :            . : .          :  3  0.023  0.020
 :            . :*.          :            . :*.          :  4  0.082  0.073
 :            .*: .          :            .*: .          :  5 -0.066 -0.073
==========================================================================
 Q-Statistic (5 lags)     3.508              S.E. of Correlations  0.077
==========================================================================
```

```
IDENT RESID
Date: 3-12-1990 / Time: 12:24
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
        Autocorrelations          Partial Autocorrelations        ac     pac
==========================================================================
 :            . : .          :            . : .          :  1  0.019  0.019
 :            . :*.          :            . :*.          :  2  0.095  0.094
 :            . : .          :            . : .          :  3  0.023  0.020
 :            . :*.          :            . :*.          :  4  0.082  0.073
 :            .*: .          :            .*: .          :  5 -0.066 -0.073
 :            .*: .          :            .*: .          :  6 -0.070 -0.084
 :            . :*.          :            . :*.          :  7  0.063  0.077
 :            . : .          :            . : .          :  8 -0.008  0.001
 :            .*: .          :            .*: .          :  9 -0.046 -0.046
 :            . :*.          :            . :*.          : 10  0.050  0.059
==========================================================================
 Q-Statistic (10 lags)    5.818              S.E. of Correlations  0.077
==========================================================================
```

IDENT RESID
Date: 3-12-1990 / Time: 12:24
SMPL range: 1974.01 - 1987.12
Number of observations: 168

Autocorrelations	Partial Autocorrelations		ac	pac
. ¦ .	. ¦ .	1	0.019	0.019
. ¦*.	. ¦*.	2	0.095	0.094
. ¦ .	. ¦ .	3	0.023	0.020
. ¦*.	. ¦*.	4	0.082	0.073
.*¦ .	.*¦ .	5	-0.066	-0.073
.*¦ .	.*¦ .	6	-0.070	-0.084
. ¦*.	. ¦*.	7	0.063	0.077
. ¦ .	. ¦ .	8	-0.008	0.001
.*¦ .	.*¦ .	9	-0.046	-0.046
. ¦*.	. ¦*.	10	0.050	0.059
. ¦*.	. ¦*.	11	0.061	0.048
. ¦*.	. ¦*.	12	0.044	0.039
. ¦**	. ¦**	13	0.156	0.166
.*¦ .	.*¦ .	14	-0.056	-0.099
. ¦ .	. ¦ .	15	0.019	-0.021
. ¦ .	. ¦ .	16	-0.030	-0.003
. ¦*.	. ¦*.	17	0.072	0.057
.*¦ .	.*¦ .	18	-0.071	-0.041
. ¦*.	. ¦*.	19	0.045	0.056
. ¦*.	. ¦ .	20	0.048	0.024

Q-Statistic (20 lags) 14.057 S.E. of Correlations 0.077

APPENDIX 3

```
IDENT RESID
Date: 3-12-1990 / Time: 12:25
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
       Autocorrelations          Partial Autocorrelations        ac     pac
==========================================================================
¦            . ¦ .          ¦            . ¦ .          ¦  1  0.019  0.019
¦            . ¦*.          ¦            . ¦*.          ¦  2  0.095  0.094
¦            . ¦ .          ¦            . ¦ .          ¦  3  0.023  0.020
¦            . ¦*.          ¦            . ¦*.          ¦  4  0.082  0.073
¦            .*¦ .          ¦            .*¦ .          ¦  5 -0.066 -0.073
¦            .*¦ .          ¦            .*¦ .          ¦  6 -0.070 -0.084
¦            . ¦*.          ¦            . ¦*.          ¦  7  0.063  0.077
¦            . ¦ .          ¦            . ¦ .          ¦  8 -0.008  0.001
¦            .*¦ .          ¦            .*¦ .          ¦  9 -0.046 -0.046
¦            . ¦*.          ¦            . ¦*.          ¦ 10  0.050  0.059
¦            . ¦*.          ¦            . ¦*.          ¦ 11  0.061  0.048
¦            . ¦*.          ¦            . ¦*.          ¦ 12  0.044  0.039
¦            . ¦**          ¦            . ¦**          ¦ 13  0.156  0.166
¦            .*¦ .          ¦            .*¦ .          ¦ 14 -0.056 -0.099
¦            . ¦ .          ¦            . ¦ .          ¦ 15  0.019 -0.021
¦            . ¦ .          ¦            . ¦ .          ¦ 16 -0.030 -0.003
¦            . ¦*.          ¦            . ¦*.          ¦ 17  0.072  0.057
¦            .*¦ .          ¦            .*¦ .          ¦ 18 -0.071 -0.041
¦            . ¦*.          ¦            . ¦*.          ¦ 19  0.045  0.056
¦            . ¦*.          ¦            . ¦ .          ¦ 20  0.048  0.024
¦            . ¦ .          ¦            .*¦ .          ¦ 21 -0.031 -0.045
¦            .*¦ .          ¦            .*¦ .          ¦ 22 -0.066 -0.051
¦            . ¦ .          ¦            . ¦ .          ¦ 23  0.013 -0.010
¦            .*¦ .          ¦            .*¦ .          ¦ 24 -0.040 -0.063
¦            .*¦ .          ¦            .*¦ .          ¦ 25 -0.082 -0.062
¦            .*¦ .          ¦            . ¦ .          ¦ 26 -0.041 -0.036
¦            . ¦ .          ¦            . ¦ .          ¦ 27  0.023  0.035
¦            . ¦ .          ¦            . ¦ .          ¦ 28 -0.022 -0.007
¦            . ¦*.          ¦            . ¦*.          ¦ 29  0.082  0.111
¦            . ¦**          ¦            . ¦*.          ¦ 30  0.141  0.108
¦            . ¦ .          ¦            . ¦ .          ¦ 31  0.025  0.004
¦            . ¦*.          ¦            . ¦ .          ¦ 32  0.061  0.030
¦            .*¦ .          ¦            **¦ .          ¦ 33 -0.095 -0.126
==========================================================================
 Q-Statistic (33 lags)   23.531           S.E. of Correlations   0.077
==========================================================================
```

LS // Dependent Variable is A05
Date: 3-12-1990 / Time: 12:26
SMPL range: 1974.01 - 1987.12
Number of observations: 168

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	33.821869	6.3042651	5.3649218	0.000
D	-19.784280	7.8628000	-2.5161876	0.012

R-squared	0.036739	Mean of dependent var	21.10342
Adjusted R-squared	0.030936	S.D. of dependent var	49.60595
S.E. of regression	48.83263	Sum of squared resid	395847.8
Durbin-Watson stat	1.824608	F-statistic	6.331200
Log likelihood	-890.6266		

APPENDIX 3

```
IDENT RESID
Date: 3-12-1990 / Time: 12:34
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
       Autocorrelations        Partial Autocorrelations          ac     pac
==========================================================================
 :            . : .           :           . : .          :  1  0.022  0.022
 :            . :*.           :           . :*.          :  2  0.107  0.106
==========================================================================
 Q-Statistic (2 lags)     1.993                S.E. of Correlations  0.077
==========================================================================
```

```
IDENT RESID
Date: 3-12-1990 / Time: 12:34
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
       Autocorrelations        Partial Autocorrelations          ac     pac
==========================================================================
 :            . : .           :           . : .          :  1  0.022  0.022
 :            . :*.           :           . :*.          :  2  0.107  0.106
 :            . : .           :           . : .          :  3  0.025  0.021
 :            . :*.           :           . :*.          :  4  0.088  0.077
 :            .*: .           :           .*: .          :  5 -0.063 -0.072
==========================================================================
 Q-Statistic (5 lags)     4.064                S.E. of Correlations  0.077
==========================================================================
```

```
IDENT RESID
Date: 3-12-1990 / Time: 12:34
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
       Autocorrelations        Partial Autocorrelations          ac     pac
==========================================================================
 :            . : .           :           . : .          :  1  0.022  0.022
 :            . :*.           :           . :*.          :  2  0.107  0.106
 :            . : .           :           . : .          :  3  0.025  0.021
 :            . :*.           :           . :*.          :  4  0.088  0.077
 :            .*: .           :           .*: .          :  5 -0.063 -0.072
 :            .*: .           :           .*: .          :  6 -0.066 -0.083
 :            . :*.           :           . :*.          :  7  0.066  0.081
 :            . : .           :           . : .          :  8 -0.011 -0.002
 :            .*: .           :           .*: .          :  9 -0.049 -0.051
 :            . :*.           :           . :*.          : 10  0.041  0.052
==========================================================================
 Q-Statistic (10 lags)    6.252                S.E. of Correlations  0.077
==========================================================================
```

```
IDENT RESID
Date: 3-12-1990 / Time: 12:35
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==========================================================================
       Autocorrelations         Partial Autocorrelations        ac      pac
==========================================================================
|            . | .          |            . | .          |  1  0.022  0.022
|            . |*.          |            . |*.          |  2  0.107  0.106
|            . | .          |            . | .          |  3  0.025  0.021
|            . |*.          |            . |*.          |  4  0.088  0.077
|            .*| .          |            .*| .          |  5 -0.063 -0.072
|            .*| .          |            .*| .          |  6 -0.066 -0.083
|            . |*.          |            . |*.          |  7  0.066  0.081
|            . | .          |            . | .          |  8 -0.011 -0.002
|            .*| .          |            .*| .          |  9 -0.049 -0.051
|            . |*.          |            . |*.          | 10  0.041  0.052
|            . |*.          |            . |*.          | 11  0.058  0.046
|            . |*.          |            . | .          | 12  0.039  0.035
|            . |**          |            . |**          | 13  0.151  0.162
|            .*| .          |            .*| .          | 14 -0.056 -0.100
|            . | .          |            . | .          | 15  0.017 -0.026
|            .*| .          |            . | .          | 16 -0.039 -0.012
|            . |*.          |            . |*.          | 17  0.065  0.049
|            .*| .          |            .*| .          | 18 -0.072 -0.041
|            . |*.          |            . |*.          | 19  0.052  0.064
|            . |*.          |            . | .          | 20  0.042  0.021
==========================================================================
 Q-Statistic (20 lags)   14.079           S.E. of Correlations    0.077
==========================================================================
```

APPENDIX 3

```
IDENT RESID
Date: 3-12-1990 / Time: 12:36
SMPL range: 1974.01 - 1987.12
Number of observations: 168
==============================================================================
       Autocorrelations         Partial Autocorrelations          ac      pac
==============================================================================
|            . | .          |            . | .          |  1  0.022   0.022
|            . |*.          |            . |*.          |  2  0.107   0.106
|            . | .          |            . | .          |  3  0.025   0.021
|            . |*.          |            . |*.          |  4  0.088   0.077
|            .*| .          |            .*| .          |  5 -0.063  -0.072
|            .*| .          |            .*| .          |  6 -0.066  -0.083
|            . |*.          |            . |*.          |  7  0.066   0.081
|            . | .          |            . | .          |  8 -0.011  -0.002
|            .*| .          |            .*| .          |  9 -0.049  -0.051
|            . |*.          |            . |*.          | 10  0.041   0.052
|            . |*.          |            . |*.          | 11  0.058   0.046
|            . |*.          |            . | .          | 12  0.039   0.035
|            . |**          |            . |**          | 13  0.151   0.162
|            .*| .          |            .*| .          | 14 -0.056  -0.100
|            . | .          |            . | .          | 15  0.017  -0.026
|            .*| .          |            . | .          | 16 -0.039  -0.012
|            . |*.          |            . |*.          | 17  0.065   0.049
|            .*| .          |            .*| .          | 18 -0.072  -0.041
|            . |*.          |            . |*.          | 19  0.052   0.064
|            . |*.          |            . | .          | 20  0.042   0.021
|            . | .          |            .*| .          | 21 -0.032  -0.047
|            .*| .          |            .*| .          | 22 -0.069  -0.054
|            . | .          |            . | .          | 23  0.005  -0.015
|            .*| .          |            .*| .          | 24 -0.046  -0.065
|            .*| .          |            .*| .          | 25 -0.086  -0.062
|            .*| .          |            .*| .          | 26 -0.046  -0.039
|            . | .          |            . | .          | 27  0.020   0.038
|            . | .          |            . | .          | 28 -0.029  -0.007
|            . |*.          |            . |*.          | 29  0.074   0.107
|            . |**          |            . |*.          | 30  0.139   0.110
|            . | .          |            . | .          | 31  0.027   0.002
|            . |*.          |            . | .          | 32  0.064   0.027
|            .*| .          |            **| .          | 33 -0.094  -0.126
==============================================================================
 Q-Statistic (33 lags)   23.701           S.E. of Correlations   0.077
==============================================================================
```

APPENDIX 3

LS // Dependent Variable is RPB20
Date: 3-12-1990 / Time: 12:33
SMPL range: 1974.01 - 1987.12
Number of observations: 168

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	2.8447897	2.1986448	1.2938832	0.196
RPB20(-1)	0.7169103	0.0807977	8.8729085	0.000
RPB20(-2)	0.1693532	0.0818086	2.0701149	0.038
RPP20(-1)	0.0234075	0.0321865	0.7272445	0.467
X1	-2.4109106	1.8861774	-1.2781993	0.201
X2	-0.5361339	1.8695811	-0.2867669	0.774
X3	1.4096832	1.8474734	0.7630330	0.445
X4	1.7666875	1.8557827	0.9519905	0.341
X5	0.9252952	1.8508582	0.4999277	0.617
X6	-2.6314305	1.8465249	-1.4250717	0.154
X8	1.7284078	1.8420078	0.9383282	0.348
X9	2.9588233	1.8579285	1.5925388	0.111
X10	3.7158469	1.8802062	1.9762976	0.048
X11	5.0748601	1.9048848	2.6641296	0.008
X12	-0.4802743	1.9414314	-0.2473815	0.805

R-squared	0.835892	Mean of dependent var	48.05636
Adjusted R-squared	0.820875	S.D. of dependent var	11.35424
S.E. of regression	4.805472	Sum of squared resid	3533.162
Durbin-Watson stat	1.955916	F-statistic	55.66502
Log likelihood	-494.2444		

IDENT RESID
Date: 3-12-1990 / Time: 12:34
SMPL range: 1974.01 - 1987.12
Number of observations: 168

Autocorrelations	Partial Autocorrelations		ac	pac
¦ . ¦ .	¦ . ¦ . ¦	1	0.022	0.022

Q-Statistic (1 lags) 0.080 S.E. of Correlations 0.077

APPENDIX 3

LS // Dependent Variable is A06
Date: 3-12-1990 / Time: 12:40
SMPL range: 1974.01 - 1987.12
Number of observations: 168

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	33.819895	6.2534085	5.4082337	0.000
D	-19.894263	7.7993707	-2.5507524	0.011

R-squared	0.037717	Mean of dependent var	21.03073
Adjusted R-squared	0.031920	S.D. of dependent var	49.23078
S.E. of regression	48.43869	Sum of squared resid	389487.0
Durbin-Watson stat	1.822397	F-statistic	6.506338
Log likelihood	-889.2659		

APPENDIX 3

LS // Dependent Variable is RPB1
Date: 3-09-1990 / Time: 14:33
SMPL range: 1973 - 1987
Number of observations: 15

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	29.704150	13.323200	2.2295056	0.046
RPB1(-1)	0.4616649	0.2491115	1.8532456	0.089
TREND	-0.4686935	0.5847612	-0.8015127	0.438

R-squared	0.258367	Mean of dependent var	47.35867
Adjusted R-squared	0.134762	S.D. of dependent var	10.51353
S.E. of regression	9.779497	Sum of squared resid	1147.663
Durbin-Watson stat	1.677588	F-statistic	2.090260
Log likelihood	-53.81482		

IDENT RESID
Date: 3-09-1990 / Time: 14:34
SMPL range: 1973 - 1987
Number of observations: 15

```
=============================================================================
      Autocorrelations           Partial Autocorrelations          ac     pac
=============================================================================
 :     .     :     .     :     .     :     .     :  1  0.018  0.018
=============================================================================
 Q-Statistic (1 lags)     0.005                S.E. of Correlations  0.258
=============================================================================
```

IDENT RESID
Date: 3-09-1990 / Time: 14:34
SMPL range: 1973 - 1987
Number of observations: 15

```
=============================================================================
      Autocorrelations           Partial Autocorrelations          ac     pac
=============================================================================
 :     .     :     .     :     .     :     .     :  1  0.018  0.018
 :     . ****:     .     :     . ****:     .     :  2 -0.287 -0.288
=============================================================================
 Q-Statistic (2 lags)     1.241                S.E. of Correlations  0.258
=============================================================================
```

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 14:35
SMPL range: 1973  -  1987
Number of observations: 15
==========================================================================
      Autocorrelations          Partial Autocorrelations         ac     pac
==========================================================================
 |       .        |      .      |       .        |      .      | 1  0.018  0.018
 |       .    ****|      .      |       .    ****|      .      | 2 -0.287 -0.288
 |       .      **|      .      |       .      **|      .      | 3 -0.173 -0.176
==========================================================================
 Q-Statistic (3 lags)      1.691                 S.E. of Correlations  0.258
==========================================================================
```

LS // Dependent Variable is DRPB1
Date: 3-09-1990 / Time: 14:37
SMPL range: 1974 - 1987
Number of observations: 14

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	87.264387	27.246296	3.2027981	0.011
QB(-1)	-0.4728942	0.1674058	-2.8248370	0.020
QP(-1)	2.8045289	0.9134127	3.0703852	0.013
RPP2(-1)	-0.4197214	0.1165378	-3.6015913	0.006
TREND	-0.2849614	0.5032056	-0.5662922	0.585

R-squared	0.740711	Mean of dependent var	0.736428
Adjusted R-squared	0.625471	S.D. of dependent var	10.83196
S.E. of regression	6.629027	Sum of squared resid	395.4960
Durbin-Watson stat	2.546336	F-statistic	6.427563
Log likelihood	-43.25272		

```
IDENT RESID
Date: 3-09-1990 / Time: 14:38
SMPL range: 1974  -  1987
Number of observations: 14
==========================================================================
      Autocorrelations          Partial Autocorrelations         ac     pac
==========================================================================
 |       .    ****|      .      |       .    ****|      .      | 1 -0.283 -0.283
==========================================================================
 Q-Statistic (1 lags)      1.121                 S.E. of Correlations  0.267
==========================================================================
```

APPENDIX 3

```
IDENT RESID
Date: 3-09-1990 / Time: 14:38
SMPL range: 1974 - 1987
Number of observations: 14
==========================================================================
        Autocorrelations           Partial Autocorrelations      ac     pac
==========================================================================
:       .    ****:     .     :      .  ****:        .     :  1 -0.283 -0.283
:       .    ****:     .     :      .******:        .     :  2 -0.317 -0.432
==========================================================================
 Q-Statistic (2 lags)     2.529                 S.E. of Correlations  0.267
==========================================================================
```

```
IDENT RESID
Date: 3-09-1990 / Time: 14:38
SMPL range: 1974 - 1987
Number of observations: 14
==========================================================================
        Autocorrelations           Partial Autocorrelations      ac     pac
==========================================================================
:       .    ****:     .     :      .  ****:        .     :  1 -0.283 -0.283
:       .    ****:     .     :      .******:        .     :  2 -0.317 -0.432
:       .        :**** .     :      .      :*       .     :  3  0.305  0.073
==========================================================================
 Q-Statistic (3 lags)     3.832                 S.E. of Correlations  0.267
==========================================================================
```

LS // Dependent Variable is P22
Date: 3-09-1990 / Time: 14:47
SMPL range: 1974 - 1987
Number of observations: 14

VARIABLE	COEFFICIENT	STD. ERROR	T-STAT.	2-TAIL SIG.
C	9.8721994	16.178113	0.6102195	0.553
D	28.587244	20.177652	1.4167775	0.182

R-squared	0.143301	Mean of dependent var	28.24971
Adjusted R-squared	0.071910	S.D. of dependent var	37.55068
S.E. of regression	36.17536	Sum of squared resid	15703.88
Durbin-Watson stat	3.001992	F-statistic	2.007259
Log likelihood	-69.02338		