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PRICE, EXCHANGE RATE VOLATILITY AND NIGERIA'S AGRICULTURAL TRADE FLOWS: A DYNAMIC ANALYSIS

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I. Introduction

One of the most dramatic events in Nigeria over the past decade was the devaluation of the Nigerian naira with the adoption of a structural adjustment programme (SAP) in 1986. A cardinal objective of the SAP was the restructuring of the production base of the economy with a positive bias for the production of agricultural exports. The foreign exchange reforms that facilitated a cumulative depreciation of the effective exchange rate were expected to increase the domestic prices of agricultural exports and therefore boost domestic production.

Significantly, this depreciation resulted in changes in the structure and volume of Nigeria's agricultural exports as empirically determined by many researchers (Oyejide, 1986; Ihimodu, 1993; Osuntogun et al., 1993; World Bank, 1994. The depreciation also increased the prices of agricultural exports and studies have shown a marked increase in volume of agricultural exports over the years. However, the volatility, frequency and instability of the exchange rate movements since the beginning of the floating exchange rate raise a concern about the impact of such movements on agricultural trade flows.

Structural adjustment and agricultural performance

Among other measures, the structural adjustment programme (SAP), which started in 1986, abolished the Commodity Board, the body that since 1960 had been responsible for organization and purchase of agricultural exports. As a result, farmers could sell their products directly to foreign buyers and local processors without any intermediary, thus obtaining higher prices for their products. This was expected to remove the excessive taxation on farmers' products by the erstwhile marketing boards and leave producer prices to be determined by market forces. Given that agricultural output is influenced by prices among other factors, the depreciation of the naira and abolition of the commodity boards were expected to result in an overall increase in production of exports. Table 1 confirms this expected trend in agricultural output. There was a major increase in five major agricultural export crops that had been on the decline since the 1970s. By 1985, only 37% of the 1970 output was achieved, but by 1988 and 1989, respectively, output reached 79% and 86% of the 1970 level.

Table 2 presents the output performance of the major product groups during the SAP period as compared with the pre-SAP period of 1983–1985. The crops included in each product group accounted for at least 60% of all the crops in the group. A comparison of

Table 1: Output of major agricultural crops

Year	Output* ('000 tons)	Index 1970=100
1970	3.047	100
1971	2.871	94
1972	2.426	80
1973	1.839	60
1974	3.436	113
1975	1.773	58
1976	1.754	58
1977	1.841	60
1978	1.980	65
1979	1.713	56
1980	1.833	60
1981	1.576	52
1982	1.432	47
1983	1.435	47
1984	1.739	57
1985	1.137	37
1986	1.770	58
1987	1.364	45
1988	2.415	79
1989	2.616	86
1990	3.602	118
1991	3.901	128
1992	4.048	133
1993	4.189	137
1994	4.435	146

Source: CBN: 1.Nigeria's Principal Economic and Financial Indicators, 1970-1994.
2.Annual Reports and Statements of Accounts (several years).
*Comprises cocoa, cotton, groundnuts, palm oil and palm kernel.

the two periods shows that export crops performed best, with the average output of the group increasing by about 42% over the pre-SAP period. The staple crops group recorded about 38% increase, while forestry and livestock groups were hardly influenced and the output of fishery fell by about 15%.

As a result of very high increases in the nominal producer prices during the SAP era, coupled with the moderate output increase of most crops during the 1986–1994 period, the nominal incomes of producers rose substantially, as shown in Table 3.

The table also indicates the pattern of the increase in income over the years. While there was a consistent increase in income for cocoa producers, the same cannot be said for producers of cottonseed and palm oil. Generally the rate of change in prices and output is also not predictable. According to Kwanashie et al., (1994), the degree of fluctuation in prices is a major determinant of the changes in earnings given the trend in output over the years.

Table 2: Output of major agricultural product groups ('000 tons)

Year	Export crops	Staples	Forestry	Livestock	Fisheries
1983	1,435	22,404	89,424	753	132
1984	1,739	26,316	90,843	818	100
1985	1,137	29,064	93,451	852	61
Average (A)	1,437	25,928	91,239	808	98
1986	1,770	32,432	93,606	881	107
1987	1,364	34,572	95,946	826	103
1988	2,415	35,934	96,965	783	51
1989	2,616	39,888	101,168	750	70
Average (B)	2,084	35,707	96,921	810	83
1990	3,602	52,154	105,187	659	283
1991	3,901	52,853	107,318	689	291
1992	4,048	60,976	109,787	702	284
1993	4,189	64,916	112,058	724	201
1994	4,435	67,702	114,944	760	199
Average (C)	4,035	59,720.2	109,858.8	706.8	251.6
C/B	1.94	1.67	1.13	0.87	3.03

Sources: Computed from Central Bank of Nigeria, Annual Reports and statements of accounts (various issues).

Notes: Export crops - Cocoa, groundnuts, cotton, palm oil and palm kernel.
Staples - Maize, millet, sorghum, rice, wheat, cassava, yam and beans
Forestry - Roundwood, sawnwood, wood based panel
Livestock - Poultry, goat meat, beef and eggs
Fisheries - Artisan, coastal and brackish water, catches and land, lakes and rivers.

Table 3: Producer incomes from agricultural crops

Year	Cocoa (₦'000) Nominal	Groundnuts (₦'000) Nominal	Cottonseed (₦'000) Nominal	Palm kernel (₦'000) Nominal	Palm oil (₦'000) Nominal
1983	196,000	178,200	67,200	64,170	247,500
1984	180,000	384,150	75,600	136,000	330,000
1985	174,000	465,750	39,100	144,000	-
1986	602,000	640,000	30,000	140,000	650,000
1987	1,162,500	1,494,200	32,000	300,050	816,000
1988	2,200,000	1,543,500	873,000	545,000	1,050,000
1989	3,210,000	5,233,115	1,036,000	1,500,000	910,000
1990	2,074,000	5,037,120	486,200	2,380,000	846,800
1991	2,722,344	8,547,080	1,148,988	3,037,575	881,600
1992	3,721,540	8,875,371	1,167,402	7,519,132	9,877,824
1993	7,735,068	13,452,000	1,307,188	15,322,150	17,189,700
1994	19,577,600	18,763,184	-	17,139,674	17,276,280

Sources:Computed From CBN Annual Reports and Statements of Account, and Economic and Financial Review.

Problem statement

Changes in income earnings of export crop producers come as a result of either increase/ decrease in international world price of exports or devaluation of the currency and the subsequent increase in producer prices. Such price/exchange rate changes, however, may lead to a major decline in future output if they are unpredictable and erratic. Fluctuation – whether positive or negative – is not desirable as it increases risk and uncertainty in international transactions and thus discourages trade. In a sense, trade will be reduced similarly to a reduction following an increase in transportation costs. An IMF (1984) study cites arguments that exchange rate variability would also tend to induce macroeconomic phenomena that are undesirable, for example inflation and protectionism. Despite this assertion and that of other studies, more recent research explains why a positive effect could also be possible (de Grauwe, 1988; Caballero and Corbo, 1989).

If firms hedge against exchange rate risk, one could not expect to find a strong negative effect on trade. Hedging against risk can be done via future or forward markets. Where forward markets exist, the nature of the uncertainty faced by traders is transformed. A forward market represents, in effect, a guaranteed forecast of the exchange rate that will prevail at the end of the contract period, which a trader can take advantage of by payment of a small margin around the forward rates. Since currency uncertainty can be removed from the short-term trading transaction by payment of this margin, the cost of such uncertainty cannot be higher than the cost of purchasing insurance against it.

Unfortunately, the future market is absent in Nigeria and the possibility of hedging via this route is remote. In fact, most studies have not taken hedging possibilities into account. It has been argued that hedging foreign exchange via future/forward markets is an imperfect and costly method of avoiding exchange rate risk. This is because, hedging transactions have a cost. Secondly several studies (Cumby and Obstfeld, 1981; Frenkel, 1981; Hakkio and Rush, 1989) have indicated that the forward rate is a poor predictor of the future spot rate. Thus, even in the presence of forward markets for exchange rates and hedging, trade is likely to be hurt. The IMF (1984) argues that forward/future markets can be used to hedge against nominal exchange rate risk in the short run at small cost. However, long-term export oriented activities would be exposed to higher and possibly unhedgeable risks.

It therefore follows that hedging notwithstanding, exchange rate volatility–which tends to increase the risk and uncertainty in international transactions–may adversely affect trade and investment flows. This will further increase risk on supply of exports. Exchange rate risk measures the volatility and erratic pattern of exchange rate movements: the more volatile the movements, the higher the risk. Producers exports are not only concerned with the magnitude of the price they receive, they also bother about the stability of such prices as it relates to earning a consistent income. In a developing country, where export price increases, as a result of currency devaluation are expected to be an incentive for export growth, a primary concern is the nature and magnitude of risk introduced by the price/exchange rate movements. This concern has strengthened in recent years in response to increasing protectionist trends and slowing growth in world trade.

Many related empirical studies have been conducted on the effect of price or exchange rate on trade (Schuh, 1974; Ihimodu, 1993; Ogiogio, 1993; Osuntogun et al., 1993; Obadan, 1994). However, most of these efforts have concentrated on the price and export effects in a static setting. These studies, either econometric or judgemental, are thus incapable of portraying the dynamic adjustment to a devaluation. Also, the likely relationships between price and exchange rate volatility were ignored in their estimations and a possible impact of price and exchange rate risk on trade flows was neglected.

The major goal of this study is to address these neglected issues. The research intends to provide an empirical basis for the analysis of the effect of price and exchange rate volatility on the volume of agricultural exports. If devaluation is expected to strongly affect the agricultural sector, then a major effect must come through an adjustment in the agricultural trade balance rather than through a portfolio adjustment alone. This study intends to capture this through a dynamic multiplier analysis that appropriately considers the major characteristics and the dynamics of the associated adjustment process.

II. Objectives of the study

The overall objective of the study is to determine empirically the dynamic effects of exchange rate fluctuations on Nigerian agricultural export markets and to examine the relevance of exchange rate risk in agricultural trade flows.

Specifically the study intends to:

- Evaluate the nature and extent of the impact of price and exchange rate volatility on agricultural trade flows.
- Estimate the relationships between price and exchange rate volatility and analyse their effects on exports and imports prices.
- Investigate the dynamic characteristics of the adjustments of agricultural exports and imports to price and foreign exchange fluctuations.

III. Trade policy regimes and the agricultural sector

The balance of payment problems of the country in the late 1960s largely dictated the trade policies in the 1970s. The policies in the 1970s also sought to promote domestic production and generate revenue for government expenditure. There was considerable restriction and regulation of the trade sector before liberalization (i.e., between 1970 and 1985). Import duties and tariffs were quite high (as much as 70% in 1975) to discourage imports. There were also quantitative restrictions on some food imports through import licensing. On the other hand, the focus of export policy was on cash crops (export crops), with the primary purpose being to raise revenue and to moderate farmers' returns and domestic food prices. Main export policy instruments were export duties, sales taxes and centralized marketing. Exchange rate was also administratively determined to ensure cheap imports of raw materials for import-substituting local manufacturing industries.

The oil boom of the mid 1970s and the resulting favourable balance of payments position led to an era of liberal food import policy. Import restrictions were lifted in some cases and import duties were either abolished or reduced in others. The short spell of depression in the oil market in the late 1970s gave rise to tightening of food import tariffs and import prohibition, which was again relaxed as the oil market situation improved.

The period 1981–1986 was one of economic depression and balance of payment crisis. Trade controls were reintroduced to correct the severe distortion. Huge tariffs or outright bans were imposed on most food imports. Export bans and duties were also reviewed to address principally the domestic inflation problem. Centralized marketing was reinforced to increase government revenue.

The 1986 budget introduced the trade liberalization regime as a component of the structural adjustment programme (SAP). The regime included abolition of the import licensing system, reduction of import restrictions, modification of advance payment of import duties, overhauling of custom and excise duty schedules, establishment of tariff review board, allowance of domicilliary accounts operation, abolition of export prohibition, dissolution of commodity boards, and establishment of an export development fund, guarantee scheme, insurance scheme and export promotion zone.

Since 1995, there have been modifications to the liberalization era. Some import restrictions are again in place. A new tarrif structure has been set up, with a range of custom duties, and some restrictions and exemptions. A dual exchange rate is now being used, and the export market is fairly liberalized.

Price and exchange rate changes and agricultural exports in Nigeria

In the early 1960s in Nigeria, there was little concern for exchange rate policy, as it had almost no significance in economic management. Between 1960 and 1967, the Nigerian currency was adjusted in relation to the British pound with a one-to-one relationship between them. Between 1967 and 1974, another fixed parity was maintained with the American dollar. This system was abandoned between 1974 and late 1976, when an independent exchange rate management policy was ushered in that pegged the naira to either the U.S. dollar or the British pound sterling, whichever currency was stronger in the foreign exchange market. The main objective of exchange rate policy in this phase was to operate an independently managed exchange rate system that would influence real economic variables in the economy and bring down the rate of inflation. Consequently, a policy of progressive appreciation of the naira was pursued over the period and was aided by the oil boom that occurred at the same time. Because of the huge earnings from crude petroleum exports over the period, Nigeria persistently ran appreciable external surpluses in the balance of payments, which supported the appreciation of the naira. This practice led to considerable stability in the naira exchange rate.

Throughout this period the pricing of agricultural exports was done by the established government marketing boards. Specifically, these marketing boards were responsible for fixing prices and ensuring quality of crop exports. Though low, aricultural export prices were stable during this period and not subject to changes in the exchange rate (which was more or less fixed) apart from fluctuations in the international prices of primary products.

Late in 1976, as a result of the changing fortunes of Nigeria's economic circumstances, a policy reversal was effected in the management of the naira exchange rate. There was a deliberate policy to depreciate the naira, though this was not systematic. In the effort to realign the naira exchange rate, the monetarists were convinced that a more appropriate way to ensure stability and viability of the naira was to peg it to a basket of currencies. Hence a basket of seven currencies of Nigeria's major trading partner countries was adopted. Towards the end of 1985, as the economic crisis deepened, the government allowed the exchange rate to be determined by market forces. This led to many rates that diverged widely from one another. The evidence between 1985 and 1993 showed elements of distortions in the exchange rate that made it difficult to predict the path towards stability of the rate (Ogiogio, 1993). In the quest for stability of the exchange rate, the Nigerian monetary authorities tried several bidding systems, including the Dutch auction system (DAS) and the marginal rate system. An attempt to ensure viability in the market led to many amendments of the rules, interventions by Central Bank of Nigeria, and opening of different foreign exchange windows for operations during this period. Despite this, the fluctuating rates of the exchange rate continued to be an issue of concern to the authorities. For example, the naira exchange rate, which stood at ₦6.7178 = $1 during the month of January 1989 depreciated to ₦7.5871 by March 1989. The rate strengthened

progressively from ₦7.5808 = $1 in April to ₦7.1388 = $1 in July 1989 after a series of tight monetary policy actions had been taken. The rate averaged ₦7.2593 = $1 in August, compared with ₦7.0389 = $1 in January 1989. As at December 1991, the naira was exchanging for the dollar at the rate of ₦9.9331:$1.00. By June 1993, the naira had depreciated to ₦17.3760:$1.00.

Prior to the policy reforms in 1986, and especially during the 1960s, Nigeria was known mainly as an exporter of primary agricultural commodities and, to a relatively small extent, as an exporter of one or two solid minerals. From 1960, when Nigeria became an independent sovereign state, until 1970, its economy was largely sustained, at least from the point of view of off-shore commitments, by the export earnings from these basic agricultural and mineral commodities. The export list of the country within this period comprised groundnut, cocoa, beans, palm oil and palm kernel, cotton, rubber, ginger, hides and skins, timber, copra, zinc, columbite, tin, and lead.

The commencement of large-scale exploitation and exportation of crude petroleum began in the early 1970s. The huge inflow of foreign exchange revenues that accompanied the oil boom diverted the attention of the government and a considerable number of the producers of the traditional commodities into activities aimed at exploiting the economic oportunities created by the huge oil revenues. This development heralded the decline of agricultural production and the resultant drop in both volume and value of traditional export commodities.

Table 4 indicates the changes in producer prices of major agricultural traded commodities between 1970 and 1995. It also depicts the changes in relation to movement of the exchange rate. The change between 1988 and 1990 is quite significant in all cases, and more profound from 1990 to 1995 in line with the changing policy regime. The sharp changes in the 1990s are particularly attributable to the large fluctuations in the exchange rate.

Table 4: Producer prices and exchange rates, 1970–1995 (₦/tonne)

Year	Cocoa (₦/tonne)	Coffee (₦/tonne)	G/Nut (₦/tonne)	Cotton (₦/tonne)	Rubber (₦/tonne)	Exchange rate
1970-75	419	na	123.4	164.2	na	0.6433
1976-80	1044	1118.3	317	339.6	687.3	0.6070
1981-85	1420	1264	550	617	850	0.7727
1986-90	7375	5741	2937	3775	1425	5.9023
1991-95	38407	67362	11929	23478.3	26003.6	19.1597

Source: CBN Annual Reports and Statements of Account (various issues) and Economic and Financial Reviews (various issues).

Table 5 shows the growth of total merchandise exports, oil exports and non-oil exports over 1960–1994. Total merchandise exports increased phenomenally, from ₦330.4 million in 1960 to ₦14,077.00 million in 1980. In the subperiod 1960–1970, exports grew at an average rate of 11.3% while the rate of increase in the 1971–1981 period was much higher, at 32.9%.

Between 1981 and 1990, the average growth rate was negative, at -2.86%; the period 1981–1985 recorded -4.54% and 1985–1990 had a growth rate of 27.06%. During 1960–1981, the average rate of growth was an impressive 22.1%, while the period 1981–1994 recorded 11.6%. The impressive performance of merchandise exports before 1981 was largely due to the advent of petroleum in the export list. In 1960, non-oil exports, comprising mainly agricultural commodities, accounted for 97.3% of total exports. This percentage, however, declined continuously (except for three years) to 1.8% in 1981. The percentage then fluctuated until 1991, when it started a consistent decline to 2.6% in 1994. In 1992, non-oil exports, which stood at ₦4227.8 million, were at their lowest level since 1960. At the same time, crude petroleum exports, which were valued at ₦8.8 million or 2.7% of total exports in 1960, increased to a record level of ₦201,383.9 million or 97.9% of total exports that same year. Indeed, a closer look at Table 5 reveals that from 1970 onwards, oil exports exceeded 50% of the value of total exports. The average growth rate of crude oil exports has also been significant though declining, being 71.1% in 1960–1970, 44.2% in 1971–1980 and 15.3%, in 1981–1990.

Since the introduction of SAP in 1986 and a policy shift towards support for growth of traditional non-oil exports, there has been an appreciable increase in exports. Thus growth of non-oil exports has been positive except in 1992. The devaluation of the currency, with the attendant increase in domestic prices of exports, was one of the major factors responsible for the increase. In the 1990s, however, the share of non-oil exports has been consistently less than 5% of total merchandise exports. With regard to imports, exchange rate over-valuation in the 1960s and 1970s helped to cheapen imports of competing food items as well as agro-based and industrial raw materials. For example, it was cheaper to import maize for domestic use than to grow it locally, while imported talcum was found to be relatively cheaper than the palm kernel oil used by domestic soap manufacturers. The situation was exacerbated by the liberal food imports policy, especially during 1970–1977 when there was little or no trade tariff on imported food items. This fostered rapid expansion in the importation of these goods to the detriment of local production of similar goods.

When it became obvious that aggregate import demand had outstripped total foreign exchange available for imports, trade restriction through import licensing schemes was introduced. Unfortunately, the implementation of the schemes was grossly abused; it favoured mainly urban political patrons and multinational corporations. With the adoption of SAP, foreign exchange allocation and import licensing procedures were abolished and transactions in foreign exchange were subjected to market forces under an auction system. The new foreign exchange policy has helped to remove the over-valuation problem to the extent that it is now generally felt that the naira is under-valued.

In principle, the sharp depreciation in the naira exchange rate should be expected to boost export earnings and producer prices of export crops. Available data (CBN 1994)

Table 5: Composition and growth of total exports

Year	Total exports (₦mill)	Change in total exports (%)	Crude petroleum exports (₦mill)	Change in crude petroleum exports (%)	Non-oil exports (₦mill)	Change in non-oil exports (%)	Share of oil exports in total exports (%)	Share of non-oil export in total exports (%)
1960	330.4	2.9	8.8	63.0	321.2	1.8	2.7	97.3
1961	346.9	5.1	23.1	162.5	323.8	0.008	6.7	93.3
1962	334.2	-3.7	33.5	45.0	300.7	-7.1	10.0	90.0
1963	371.5	11.2	40.4	26.6	331.1	10.1	10.9	89.1
1964	429.2	15.5	64.1	58.7	365.1	10.3	14.9	85.1
1965	536.8	25.0	136.2	112.5	400.6	9.7	25.4	74.6
1966	568.2	5.8	185.9	35.0	384.3	-4.1	32.4	67.6
1967	483.6	-14.8	144.8	-21.3	338.8	-11.8	29.9	70.1
1968	422.2	-12.7	74.0	-48.9	348.2	2.8	17.5	82.5
1969	636.3	50.7	261.9	253.9	374.4	7.5	41.2	58.8
1970	885.4	39.1	510.0	94.7	375.4	0.003	57.6	42.4
1971	1293.3	46.1	953.0	86.9	340.3	-9.3	73.7	26.3
1972	1434.2	10.9	1176.2	23.4	258.0	-24.2	82.0	18.0
1973	2277.4	58.8	1893.5	61.0	383.9	48.8	83.1	16.9
1974	5794.8	154.4	5365.7	183.4	429.1	11.8	92.6	7.4
1975	4925.5	-15.0	4563.1	-15.0	362.4	-15.5	92.6	7.4
1976	6751.1	37.1	6321.6	38.5	429.5	18.5	93.6	6.4
1977	7976.6	18.2	7453.6	17.9	523.0	21.8	93.4	6.6
1978	6064.4	-16.8	5401.6	-27.5	662.8	26.7	89.1	10.9
1979	10836.8	63.4	10166.8	88.2	670.0	1.1	93.8	6.2
1980	14077.0	29.9	13523.0	33.0	554.6	-17.0	96.1	3.9
1981	10470.1	-25.6	10280.3	-24.0	189.8	-65.7	98.2	1.8
1982	8,206.4	-27.6	8,003.2	-28.5	203.2	6.5	97.5	2.5
1983	7,502.5	-9.4	7,201.2	-11.1	301.3	32.6	96.0	4.0
1984	9,088.0	17.4	8,840.6	18.5	247.4	-21.8	97.3	2.7
1985	11,720.8	22.5	11,223.6	21.2	497.2	50.2	95.8	4.2
1986	8,920.5	-31.4	8,368.4	-34.1	552.1	9.9	93.8	6.2
1987	30,360.1	70.6	28,208.6	70.3	2,152.0	74.3	92.9	7.1
1988	31,191.8	2.7	28,435.4	0.8	2,757.4	30	91.2	8.8
1989	57,971.2	46.2	55,016.8	48.3	2,954.4	6.7	94.9	5.1
1990	109,686.1	47.2	106,626.5	48.4	3,259.6	12.4	97.0	3.0
1991	121,533.7	9.6	116,856.5	8.8	4,677.2	30.3	96.2	3.8
1992	205,611.7	40.9	201,383.9	42	4,227.8	-10.6	97.9	2.1
1993	218,801.1	6.0	213,778.8	5.8	5,002.2	15.8	97.7	2.3
1994	206,285.1	-6.1	200,936.1	-6.4	5,349.9	6.1	97.4	2.6

Source:Central Bank of Nigeria, *Annual Reports, Economic and Financial Review* (various issues).
FCS. *Annual Abstract of Statistics* (various issues).

showed that despite the declining trends in the U.S. dollar prices of Nigeria's agricultural export commodities in the world market, the exchange rate depreciation has resulted in substantial increases in the naira equivalent of the world prices and consequently in local producer prices. Indeed, since the introduction of SAP, producer prices of all export commodities have risen far above what the commodity boards used to pay farmers. This has gone a long way to boost domestic production through improved husbandry of existing farms and the cultivation of increased hectares.

On the imports side, exchange rate devaluation has resulted in dramatic increase in the naira price of imports and this is expected to discourage importation of foreign food items, by raising the level of effective protection for domestic production. On the other hand, the naira costs of imported items have also risen astronomically, taking most of these goods almost out of the reach of many consumers. The sharp rise in the costs of imported inputs could discourage new investments in commercial ventures while the maintenance and rehabilitation of existing equipment would also pose a serious financial strain on modern entrepreneurship.

Marketing channels for agricultural cash crops

Pre-SAP period

Before the deregulation of the Nigerian economy in 1986, the federal government's Nigerian Marketing Boards had the monopoly on export trading in the major cash crops, cocoa, palm produce, groundnut, rubber and cotton. Other agents in the channel were the licenced buying agents, the unlicensed buying agents, and the farmers or producers.

The major functions of the marketing boards were:-

- Arrangement for purchase and onward export of produce.
- Development and rehabilitation of producing areas.
- Maintenance of grade standards in exported produce.
- Allocation of funds, loans, grants and investments.
- Supply of produce to local processors.
- Stabilization of producer prices through minimum pricing.

The purchase department of the boards acquired produce through the licensed buying agents (LBAs), who bought directly from the farmers at fixed prices. The LBAs delivered the quantity they bought to a specific depot nearest to the buying station and made arrangement for the grading with produce inspection staff at a gazetted produce inspection station. As soon as the graded produce was delivered to the depot, weighed and certified correct, the LBAs would be issued a board stored receipt (BSR). The receipt would be taken to their (LBA) bank where they would be paid 100% of the produce value by the arrangement with the board.

The licensed buying agents had the major duties of:

- Purchasing produce at uniform prices at all approved buying stations.
- Arranging produce inspection services in compliance with produce inspection rules and packaging at standard weights.
- Financing purchases and providing suitable storage facilities at buying stations.
- Making returns on graded stocks and purchases as the board required.
- Arranging transportation of produce to final destination such as ports and local processors through approved evacuation routes.
- Complying with regulations and inspection rules for check testing and inspection at ports.
- Insuring produce.

The LBAs received an allowance for the performance of these functions and their capital investment in the trade. They supplied chemicals to farmers to help boost their production capacity, in order to improve the quality of produce and hence the demand. LBAs also acted as intermediaries between the farmers and the government and hence served as a major channel of information flow.

Unlicensed local buying agents comprised another fact of the channel at retail level. Selling mostly to the LBAs, the unlicensed agents:

- Were located mostly in villages or rural areas close to the farmers.
- Had most of their activities financed by the LBAs.
- Extended credit and supply of inputs to the farmers.

This regulated marketing system was bedeviled by series of problems, such as:

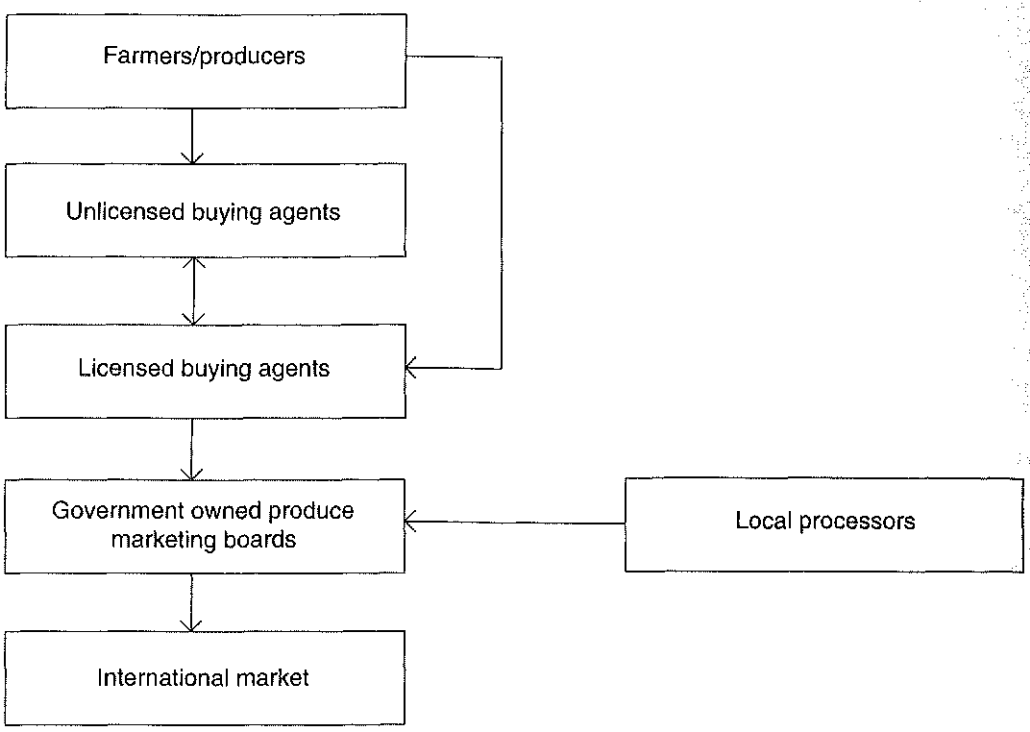
- Fixing of prices that were significantly lower than world prices, thus leading to reduced production and increased smuggling activities.
- Delayed payments by marketing boards to LBAs' banks.
- Delayed evacuation and marketing of products.
- Increased unavailability of production inputs.

The problems and shortcomings of the regulated marketing system, and mainly the need to conform to the principles of SAP led to the abolition of marketing boards in 1986 with the consequence that cash crop marketing is now in an open market system.

The SAP period

Under the deregulation system, the marketing of cash crops is undertaken in the open market. All the commodity boards have been abolished and the market is characterized by operations of private individual exporters. Most of the agents who operated in the government controlled market are still operating, however, but with different linkages and modified functions.

Figure 1: The agricultural cash crop marketing channel in the pre-SAP period



At the apex of the channel are the indigenous and non-indigenous exporters who are registered as licensed agents in the Ministry of Trade and Commerce of the states in which they buy the produce. The exporters buy mostly from licensed buying agents whose functions still remain same as in the pre-deregulation era.

One major difference in the chain compared with pre-deregulation era is that the exporter can now buy from the unlicensed buying agents and even directly from farmers. Where the exporters do buy directly from the unlicensed buying agents or farmers, they have to carry out the duties of the licensed buying agents (standardization, grading, packaging) before such produce becomes exportable.

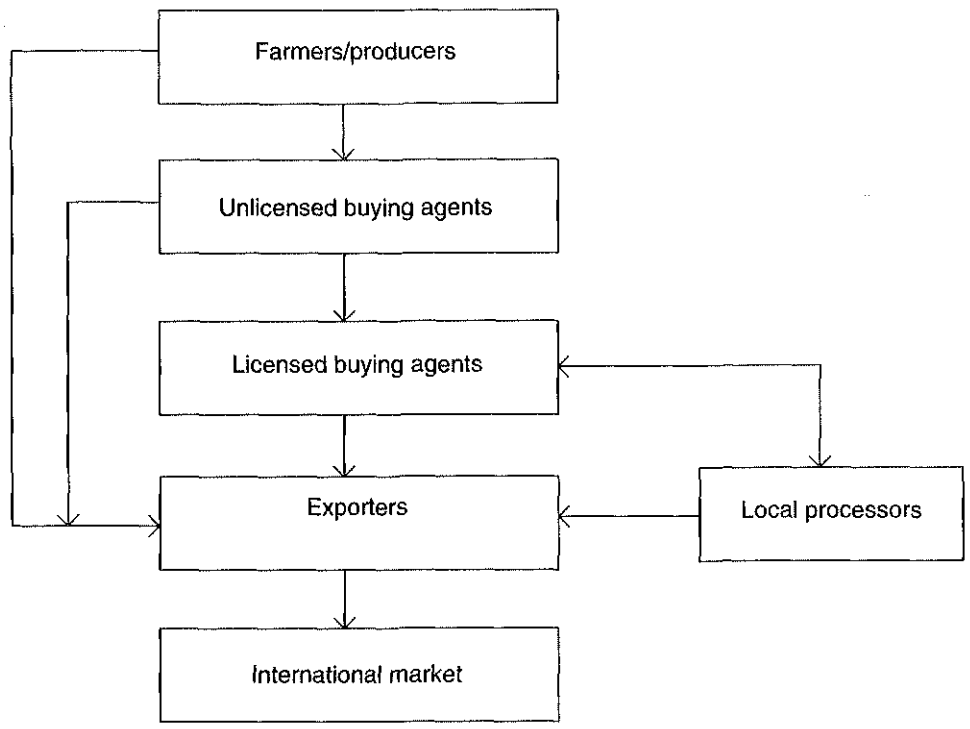
Another difference is that unlike the pre-SAP period when local processors bought only from marketing boards, the local processors now buy from exporters and licensed buying agents. They cannot buy from farmers and unlicensed buying agents because of the need to grade and standardize the produce and also the need to pay tax to the producing state; the tax is paid at the point of grading, i.e., at LBA stage.

It must be recognized, however, that although there is now no legal restriction preventing the exporters from buying directly from the farmers, the bulk of export purchases is still through the LBAs. There are essentially three reasons for this:

- The LBAs have an association that will not allow exporters to buy directly from farmers because they may underprice the LBAs.

- The economy of transaction costs demands that the exporters, who need a large quantity within a very short time, prefer to deal with a few LBAs who can supply large quantities rather than numerous small-scale producers.
- The LBAs still perform some functions that may be very difficult for high volume exporters to perform; for example, they extend credit and supply of inputs to the farmers during the off-season that are paid back in kind during the produce season. This credit is given on familiarity basis without any form of security, so that if an exporter, particularly a foreign exporter, attempted it the rate of default would be very high.

Figure 2: The agricultural cash crops marketing channel during the SAP period



IV. Literature review

Since the adoption of floating exchange rates in the developing countries in 1973, the question of whether exchange rate changes/uncertainty have independent adverse effects on exports and trade has attracted a lot of attention in the literature. The introduction of structural adjustment programmes by many of these countries and the attendant liberalization of exchange rates have brought the discussion of this issue further into global focus. A review of the literature shows that the issue is far from settled though not all studies are fully comparable. For example, Lastrapes and Koray (1990), Cushman (1988), and Caballaro and Corbo (1989) indicated a significant depressive effect of exchange risk. IMF (1984), Gotur (1985), and Chambers and Just (1991), however, supported a contrary view. Abel (1983) showed that if one assumes perfect competition, convex and symmetric costs of adjusting capital, and risk neutrality, investment is a direct function of price (exchange rate) uncertainty.

There is also a vast body of empirical literature on exchange rate effects on external trade and it is reasonable to focus on the most relevant ones. Much of this research concentrated on the manufactured goods trade and also produced inconclusive results (Hooper and Kohlhagen, 1978; Gotur, 1985; Lastrapes and Koray, 1990).

Maskus (1986), however, provided a link between his study and previous work by comparing the effects of exchange rate risk across major sectors of an economy, e.g., manufactured goods, agriculture, chemicals and others. He found that aggregate bilateral agricultural trade (the United States and its major western trading partners) is particularly sensitive to exchange rate uncertainty. Maskus argued that agriculture, compared with manufactured goods trade, is more responsive to exchange rate changes because (a) agricultural trade is relatively open to international trade (where openness is measured by the ratio of exports and imports to domestic agricultural output), and (b) agriculture exhibits a low level of industry concentration.

In Nigeria, Ajayi (1988) and Osagie (1985), while taking the structuralist approach in their study of external trade flow, opposed the adoption of a more flexible exchange rate policy in Nigeria. Their arguments were based on the structuralist thesis that exchange rate devaluation would be stagflationary and have no significant effects on the external trade balance in the less developed countries. This is because of low price elasticity generally associated with the excess import and export demand functions (Taylor and Krugman, 1977). The findings of Ajayi (1988) and Osagie (1985) support an earlier study by Ojo (1978), who suggested that exchange rate changes need not play any significant role in the explanation of Nigerian import-export balance.

Two other studies that are relevant to our work are Egwaikhide (1993) and Osuntogun et al. (1993). Egwaikhide worked on determinants of imports in Nigeria using a dynamic specification. The study concentrated on imports alone, however, and left out the effects on exports. The effects on domestic disappearance were also not examined. Osuntogun et al. (1993), in their analysis of strategic issues in promoting Nigeria's non-oil exports, determined the effects of exchange rate uncertainty on Nigeria's non-oil export performance as a side analysis. Theirs is the pioneering effort in Nigeria to determine the effects of exchange rate risk on exports. However, their model did not take into consideration the cross-price effects. Furthermore, estimates of the exchange rate risk obtained are not standard and are sensitive to the measure of exchange rate risk proxy that is used. As pointed out by Pick (1990), the measure of risk as postulated by Caballero and Corbo (1989) is faulty as it over-exaggerates the risk measure. Nevertheless, this was the risk measure used in Osuntogun et al. The present work, apart from introducing dynamism into the study, uses a standard measure of exchange rate risk that has been refined in the literature.

V. Research methodology

Conceptual and methodological issues in exchange rate volatility

Volatility or risk in international commodity trade usually emanates from two main sources: changes in world prices or fluctuations in exchange rates. These may affect trade by increasing the uncertainties of trade or effecting a change in the cost of transaction, processing, etc. The state of the two major sources determines the eventual domestic trade price of a commodity over a period of time. Thus, a decision to produce for export involves uncertainties about the prices in foreign exchange that such sales will realize, as well as the exchange rate at which foreign exchange receipts can be converted into domestic currency. In a period of fixed exchange rates, the major source of concern in international trade for a developing country is the fluctuation that may arise from the world price of primary commodities, which constitute the bulk of exports of these countries. With the increasing embrace of the structural adjustment programmes that have devaluation of currency or market determination of exchange rate and all prices as the fulcrum, the attention has shifted to the fortunes of the currencies at the foreign exchange market. Given the erratic pattern of the exchange rate in most developing countries as a result of devaluation, there has been increasing concern about the possible effects of exchange rate volatility on trade. In other words, for international traders with a given price, the major source of uncertainty is the exchange rate at which they can translate their sales revenue in foreign currency into local currency.

There has been substantial literature on the effects of exchange rate volatility on the volume of trade. Most of these studies focus on the argument that exchange rate volatility increases the risk and uncertainty in international transactions and thus discourages trade. If traders are risk averse, they will be willing to incur an added cost to avoid the risk associated with the exchange rate volatility. Thus, a firm's export supply (import demand) curve will shift to the left (right) in the presence of exchange rate volatility; for any quantity of exports or imports, the corresponding price will be higher under exchange rate volatility (risk) than without it (Qian and Varangis, 1992). Some studies (e.g., de Grauwe, 1988; Caballero and Corbo, 1989; Kumar and Dhawan, 1991) have in fact concluded that due to the political economy effects of exchange rate volatility, its increase was responsible for the slowdown in trade in the 1970s. In essence, the flexible exchange rates led to misalignments of major currencies, which led, in turn, to adjustment problems in the tradeable goods sectors and political pressures toward protectionism.

However, it has been shown that a positive impact by exchange rate volatility on trade is also possible. Bailey and Tavlas (1988) argue that if exporters are sufficiently risk averse, an increase in the exchange rate volatility raises the expected marginal utility of export revenue and therefore induces them to increase exports. Kroner and Lastrapes (1991) also indicated that under perfect competition, convexity in profit functions, symmetric costs of capital adjustments and risk neutrality, increases in exchange rate volatility will increase exports. According to their arguments, unfavourable exchange rate movements lead to a reduction in production by firms, a situation that will ensure that they have more capital than is optimal. But with favourable exchange rates, firms' production increases and they will have less capital. Assuming a convex profit function, the potential profits forgone due to insufficient capital are higher than the losses due to underutilized capital. So profit maximizing firms will tend to overinvest and thus export more in the face of uncertainty. If these assumptions are relaxed, however, exports will decline with increasing exchange rate uncertainty.

Despite these arguments for positive effects, most studies have concluded that increased exchange rate volatility reduces trade. However, the empirical evidence on this point is inconclusive. The studies by Abrams (1980), Cushman (1983, 1988), Coes (1981), Akhtar and Hilton (1984), Thursby and Thursby (1987), Kenen and Rodrik (1986), Kumar and Dhawan (1991), de Grauwe (1988), and Caballero and Corbo (1989) found statistically significant evidence that exchange rate volatility does impede trade. Contrarily, the results from studies by Bailey, Tavlas and Ulan (1986, 1987), Bailey and Tavlas (1988), Gotur (1985), Koray and Lastrapes (1989), Medhora (1990), IMF (1984), and Hooper and Kohlhagen (1978) could not find conclusive evidence that exchange rate volatility has had statistically significant deterrent effects on trade. Even in this latter group of studies, the results are inconsistent across countries; results from Kroner and Lastrapes (1991) also indicate that for some countries, exchange rate volatility has a negative effect on trade but for others it does not.

It has been shown that the analytical framework and testing procedure used to measure the effects of exchange rate volatility on trade usually determine the conclusions thereof.

The model used in the majority of studies is based on a linear regression form:

$$Q_t = \alpha_o + \alpha_1 Y_t + \alpha_2 RP_t + \alpha_3 V_t + \epsilon_t \qquad (1)$$

where Q_t is the quantity of exports or imports, Y_t is a measure of real economic activity (GNP, or index of industrial production), RP_t is a measure of relative prices relevant to the analysis, V_t is a measure of volatility, and ϵ_t is a random error. In this model, a statistically significant and negative coefficient for α_3 indicates the existence of a negative relationship between volatility and trade. The most notable variations of this methodology are by Koray and Lastrapes (1989), who use the vector autoregressive (VAR) model, and Kroner and Lastrapes (1991), who use the generalized autoregressive conditional heteroskedasticity (GARCH) in mean model.

There are three issues regarding the model. The first is how to measure exchange rate volatility; the second is which measure of volatility, nominal or real exchange rates, is proffered in modeling. The third issue is the effects of aggregate or bilateral trade data on

the study. Qian and Varangis (1992) dealt with the issues in their work and after careful examination of the previous analytical frameworks on exchange rate volatility and the factors discussed above, they concluded that there should be no imposed beliefs as to whether exchange rate volatility affects trade volumes positively or negatively; thus the model to be used has to be general and flexible in its specification to take into account all the dynamics in the data generation process of the exchange rate and international trade volume variables. The data on exchange rate should be in nominal terms and either multilateral or bilateral trade data could be used in order to investigate differences in the magnitude of the exchange rate volatility effects on trade.

In this study, data on trade refer to the indicators of agricultural trade. The agricultural trade data include both import and export trade data with some exogenous variables. The data are annual but converted to quarterly using a transformation discussed by Goldstein and Khan (1976).

Analytical framework

ARIMA model

An extended vector autoregressive (EVAR) model in first differences was the statistical framework chosen for our research work, given the concern for the model's generality. Trade volume, relative price and other exogenous variables in levels were tested for stationarity and if found non-stationary, were differenced to ensure stationarity and to avoid the spurious regression problem. Such a model in its simplest reduced form encompasses many different types of structural models. The model allows joint estimation of relationships between volatility and agricultural trade, as well as how past information related to perceived volatility, thus avoiding the problem other studies have faced in the two-step approach.

It has been observed that price and exchange rate movements follow a martingale process. Such an assumption implies that changes in the price or exchange rate in the next period are random and uncertain, given observations on the current and past exchange rates. See, for example Messe and Rogoff (1983), Dixit (1989), Diebold and Nasan (1990), and Messe and Rose (1990), to mention a few.

Moreover, large changes of prices and exchange rates tend to be followed by large changes and small changes, tend to be followed by small changes of either sign. A general ARIMA model is considered very suitable to model exchange rate movements and provides a rich class of possible parameterizations of heteroskedasticity. It has been of interest to economists to estimate the ARIMA model explicitly in their various models, most noticeably in models estimating the time-varying risk premiums in financial markets. A multivariate ARIMA model extends to the multivariate environment to allow the conditional variance to affect the mean. Empirically, this implies that changes in exchange rate volatility (measured as conditional variance) directly affect the agricultural trade volume.

According to Qian and Varangis (1992), the advantages of this approach over the other approaches described above are, first, that the risk resulting from price and exchange rate volatility is explicitly modeled and included as a regressor in the trade volume equation, thus avoiding arbitrariness in defining the measure of volatility risk. Second, possible heteroskedasticity has been taken into full account in the estimation process, thus avoiding the possibility of biased estimates of the test statistics.

The multivariate ARIMA model used by Kroner and Lastrapes (1991) and modified by Qian and Varangis (1992) is of the form:

$$a_x(L)\Delta X_t = \Phi_x \Delta S_t + b_x(L)\Delta p_t + C_x(L)\Delta Y_t + d_x F(h_{t+1}) + \in_{xt} \quad (2)$$

$$a_p(L)\Delta P_t = \Phi_p \Delta S_t + b_p(L)\Delta X_t + C_p(L)\Delta Y_t + d_p f(h_{t+1}) + \in_{pt} \quad (3)$$

$$\Delta S_t = C_{so} + \in_t \quad (4)$$

where L is the back shift operator, and $a_x(L)$, $b_x(L)$ $C_x(L)$, $a_p(L)$, $b_p(L)$ and $C_p(L)$ are polynomials in lag operators thus denoting the coefficient structure of the system of equations. In general, they have the form

$$^1 a(L) = 1 - a_1 L - a_2 L^2 - \ - a_{na} L^{na} \quad (5)$$

$$b(L) = {}_{b1}L + {}_{b2}L^2 + \ldots\ldots\ldots\ldots b_{nb} L^{nb} \quad (6)$$

$$c(L) = 1_{c1}L + {}_{c2}L^2 + \ldots\ldots\ldots\ldots c_{nc} L^{nc} \quad (7)$$

$$\Sigma_t = [\Sigma_{xt}, \Sigma_{pt}, \Sigma_{st}] \quad (8)$$

The same structure goes for $b(L)$ and $c(L)$; Δ is the first difference operator. X_t is the exports from the home country to the rest of the world during time t; P_t is the corresponding price of exports denominated in foreign currency; S_t is the exchange rate in terms of the foreign currency per unit of home currency; and C_{so} is a constant. Y_t is the vector of exogenous variables and Œ's are white noise processes. $f(h_{t+1})$ is the function of the expected time-varying conditional variance term of the exchange rate for $t+1$.

These notations are adapted in this study for Nigerian data. By following the model by Qian and Varangis (1992), our approach does not intend to make any implicit or explicit discrimination against any structural model; rather it quantifies the dynamics of the underlying true structural model of exchange rate level and exchange rate volatility. It also clarifies and simplifies their relationship in the presence of heteroskedasticity with agricultural trade exports and other economic variable indicators. Our approach corrects for heteroskedasticity in exchange rate level and removes the effects of cross-covariance functions in the estimates of the dynamic structure involving the value of trade and its prices with exchange rate level.

Identification for general ARIMA model

Suppose we have a stochastic sequence $\{X_t\}^N_{t=1}$ that is stationary and invertible. To identify which process to fit on $\{X_t\}$ we consider its autocorelation function (*ACF*) 1_k and partial autocorrelation function (*PACF*), α_{kk}. If the PACF cuts off after a lag P and its *ACF* decays exponentially, we identify an autoregressive (AR) model of order *P*, but if the *ACF* cuts off after lag *q* and its PACF decays exponentially, we identify a moving average of order *q*. But if neither the ACF nor the *PACF* cuts off, we identify an autoregressive moving average ARIMA of order (*p,d,q*); the term d stands for the order of differencing used to attain stationarity. (See Chatfield, 1985.)

Estimation

The following equations were considered in the estimation procedure of the model:

$$\Phi(B)\, S_t^* = \theta(B)\, \in_{st} \tag{9}$$

where $\Phi(B)$ is constrained to be unity.

$$H_T(m) = E\ [S^*_t(m)/S^*_t(m)]_{m=1} \tag{10}$$

$$\alpha_x(B)X_t = \theta_x \in_t + \beta_x(B)\, \Delta P_t + \theta_x(B)\, \Delta Y_t + \delta_x H_{T+1} + \in_{xt} \tag{11}$$

$$\alpha_p(B)P_t = \theta_p \in_t + \beta p(B)\, \Delta P_t + \theta_p(B)\, \Delta Y_t + \delta_p H_{T+1} + \in_{pt} \tag{12}$$

where:

$\in_t$ = the estimate of $\in_{st^*}$, in Equation 10.
Δ = first difference operator.
X_t = real value of agricultural exports from Nigeria to rest of the world at time t in ₦million. This is the nominal value of agricultural exports deflated by GDP deflator.
P_t = price of exports denominated in foreign currency. Export prices are equivalent to producer prices paid to producers and quoted by Central Bank of Nigeria annual reports.
S_t = Exchange rate in terms of foreign currency per unit of home currency.
Y_t = vector of the following exogenous variables: GDP, weather variable and a constant level.
$\in$ = white noise process.

We estimated the autoregressive parameters using the Levinson-Durbin algorithm (Durbin, 1960) given as follows:

Start with $\sigma^2 = \delta_o$, the variance of S^* and for K = 0, 1, 2, . . . compute

$$\phi_{k+1} = \alpha_{k+1,K+2} = \frac{1}{\sigma^{2k}}[\delta_{k+1} - \sum_{i=1}^{k} \alpha_{k,i}\delta_{k+1-i}] \quad (13)$$

and
$$\alpha_{k+1,i} = \alpha_{k,i} - \phi_{k+1}\, \alpha_{k,k+1-i} \quad (14)$$

with
$$\sigma^2_{k+1} = \sigma^2_k (1 - \phi^2_{k+1}) \quad (15)$$

The errors in the moving average process are a non-linear function of the parameters, hence the iterative methods are required to minimize the residual sum of squares. We therefore use a non-linear least squares technique with some convenient initial values to estimate the parameters of the MA model until convergence is achieved. In particular an advanced statistical package, SYSTAT, is used for modeling Equation 9. The exchange rate volatility is measured in Equation 10 by the conditional mean square predictor model:

$$H_T(m) = E\ [S^*_{t+m}/S^*_t : - < T \quad t] \quad (16)$$

This estimator is chosen because it gives the minimum mean square error as follows:

Let $H_T(m)$ denote the mean square error for the M-step ahead predictor. Then $S^*_T(m)$, that is $H(m) = E[(S_{t+m} S^*_t(m))^2]$

where $\hat{S}_t(m)$ is any predictor. Suppose we take $\tilde{S}_t(m)$ as another predictor, then

$$\begin{aligned} H(m) &= E\ \{[(S_{t+m})-\tilde{S}_t(m) + (\tilde{S}_t(m) - \hat{S}_t(m)]^2\} \\ &= E[(S_{t+m} - \tilde{S}_t(m))^2 + E\ (\tilde{S}_t(m) - \hat{S}_t(m)]^2 \\ &+ 2E\ [(S_{t+m} - \tilde{S}_t(m)\ (\tilde{S}_t(m) - \hat{S}_t(m)] \end{aligned}$$

$$\begin{aligned} \text{Let } K_s &= E\ [(S_{t+m} - \hat{S}_t(m)\ (\tilde{S}_t(m) - \hat{S}_t(m)] \\ &= E_{sT- < T\ t}[E\ (S_{t+m} - \tilde{S}_t(m)\ (\tilde{S}_t(m) - \hat{S}_t(m) \backslash \hat{S}_T : - < T \quad t] \end{aligned}$$

$\tilde{S}_t(m)$ and $\hat{S}_t(m)$ are based on $S_T : - < T \quad t$, hence given $S_T : - < T \quad t$, we have $\tilde{S}_t(m)$ and $\hat{S}_t(m)$ as mixed estimators, therefore

$$K_s = E_{sT}[\tilde{S}_t(m) - \hat{S}_t(m)]\ E_{ST- < T\ t}[\ (S_{t+m} \backslash S_T - \tilde{S}_t(m)] = 0$$

Hence for $H_T(m) = E[\ S_{t+m} \tilde{S}_t(m)]^2 + E[(\tilde{S}_t(m) - \hat{S}_t(m)]^2$ to be minimum $\hat{S}_t(m) = \tilde{S}S_t(m)$;

that is, $S_t(m) = E[S_{t+m} \backslash S_{T}$ - $< T \quad t\ ]$ has the smallest mean square error. In this study m is taken to be one.

The residuals of Equation 9 are not heteroskedastic, and the volatility of the exchange rate as well as the price indexes obtained in Equation 10 are used in equations 3 and 4. Equations 3 and 4 are then estimated by applying OLS. These applications will produce unbiased and consistent estimates of the model parameters.

Data sources

Quarterly data from 1986 to 1993 were used for this study. Data on price indexes, exports, imports and exchange rates were obtained from the Central Bank of Nigeria's (CBN) *Statistical Bulletin, Economic and Financial Review*, and annual reports and statements of accounts, as well as Trade Summary of the Federal Office of Statistics and Abstracts of Statistics of FOS. Foreign reserves and GDP figures were obtained from the International Financial Statistics of the IMF.

Exchange rates were obtained from CBN reports in quarterly series. Transformation of the other data to quarterly series was performed using the modulus of the Goldstein and Khan (1976) approach. The series generated through this method were compared with the exchange rate and oil export figures and it was discovered that they follow the same quadratic distribution, which made the generated series suitable for analysis. Agricultural imports were taken to cover all components of food imports: animal and vegetable imports, food and live animals, sugar, beverages and tobacco, stockfish, rice, wheat, flour, etc., and intermediate capital goods. Agricultural imports were assumed to be influenced by foreign reserves, exchange rate and price of imports. Prices, exchange rate and GDP were conventionally treated as determinants of export supply. In both export and import equations, price and exchange rate volatilities were estimated and incorporated as independent variables.

VI. Estimation results

The systems of equations 11 and 12 were estimated after correcting for heteroskedasticity in the manner described by Equation 9. The volatility was obtained from Equation 10 for both the exchange rate and the trade prices. The volatility of price indexes is more significant in all the equations than the exchange rate volatility. The price and exchange rate volatility were used individually and jointly in equations 11 and 12 to measure their separate and joint effects on the endogenous variable.

First stage identification and modeling

The first difference of the price indexes and exchange rates for export and import trade was used. The autocorrelation functions (ACF) cut off after lag 1 and the partial autocorrelation functions (PACF) decayed exponentially to zero for all the series, signifying that the series are best described by a moving average process (MA) of order one. For a moving average process the disturbances are not autocorrelated, which removes the problem of heteroskedasticity. The series are invertible and stationary due to differencing conducted. Because the series met these conditions we have these MA models with their standard errors in brackets:

$$(1)\ P_{Expt} = \epsilon_t - 0.873\ \varepsilon_{t-1}, \text{ for export price indexes} \quad (0.089)$$

$$(2)\ P_{Impt} = \epsilon_t - 0.925\ \varepsilon_{t-1} \text{ for import price} \quad (0.050)$$

$$(3)\ P_{Exch} = \epsilon_t - 0.824\ \varepsilon_{t-1}, \text{ for exchange rate} \quad (0.102)$$

In all these models, the estimates are unbiased and efficient, as indicated by their standard errors. Equation 10 was then applied to obtain their respective volatilities, which were subsequently used in the second stage of estimation.

Second stage model estimation

This involves the estimation of independent equations for real export earnings, import earnings, export price, and import price and export price local. Explanatory variables in the model are exchange rate, weather, export prices (in foreign currency), import prices, exchange rate, and price and exchange rate volatility. Both individual and joint effects of the volatility in price and the exchange rate are observed in the models. The results are presented in the Appedix. Three equations each were estimated for real export earnings (Appendix tables A1–A3), real import earnings (Appendix A4–A6), export prices (Appendix A7–A9), import prices (A10–A12) and export price local (Table A13), in order to determine the relationship between local export price and the world price).

For all the equations, the explanatory variables determined the trade earnings and prices in all cases by well over 75% as indicated by the adjusted R^2, although some of the coefficients are not statistically significant. All the volatility coefficients are in all cases statistically significant (except for Table A6) and the regression models used are appropriate and adequate as depicted by the probability of their F-statistics. Generally, our model specification is adequate for modeling the trade and price indexes in the presence of heteroskedasticity. This is justified by the power of the models fitted.

In the real export earnings equation, only the exchange rate is not significant in the model and the values of coefficients are high. For models fitted on real import earnings, the import price and foreign exchange reserves as well as the volatility of import price are not consistently significant, but the volatility of import price and the volatility of exchange rate are consistently significant. For the models fitted on export price, only the exchange rate is not significant, while all other variables are statistically significant. The volatility of the exchange rate is the only non-significant variable in the models fitted on import price. Also, the world price and exchange rate are significant contributors on export price.

Impact of price and exchange rate volatility on export trade

Appendix tables A1–A3 show the results of the three export trade models estimated. The first model examined the effect of export price and volatility on export trade, while the second focused on the effect of exchange rate volatility. The third model examined the combined effect of both variables on major agricultural exports from Nigeria to her major trading partners. For ease of reference, these models are presented in Table 6 as equations 1–3.

Table 6: Estimated results for export earnings

	Export price	Exchange rate	Weather index	Price volatility	Exchange rate volatility
Equation 1	0.098	-1.065	0.001	0.012	
	(3.94)	(-2.18)	(0.48)	(3.18)	
Equation 2	0.170	-0.777	0.004		-36.08
	(7.95)	(-1.48)	(2.32)		(-3.22)
Equation 3	0.117	0.133	0.007	0.14	-45.142
	(6.78)	(0.34)	(5.06)	(5.74)	(-5.77)

t-ratios are in parentheses.

The three equations were unanimous in showing that export price (in foreign currency), price volatility, and exchange rate and its volatility are major determinants of the export trade. The four variables exert significant direct influence on the export trade from Nigeria.

However, exchange rate volatility showed better estimates of model coefficients when compared with export price volatility. Thus, changes in exchange rate volatility have a high level of impact on exports. Exchange rate volatility influences exports negatively, while export price volatility affects exports earnings positively. This is an indication that erratic changes in agricultural prices have been favourable to agricultural exports trade while the volatility of the exchange rate affects production and earnings negatively to a high magnitude. The results support the idea that exchange rate volatility shows high significant influence on exports when aggregate data or multilateral trade data as used in this study are adopted.

In the case of Nigeria, the result can be further justified in the sense that the exchange rate has been moving downwards; that is the exchange rate has been depreciating. But it appears that the volatility of the exchange rate has masked the influence of exchange rate depreciation (see tables A1–A3). So the cost to the exporter in terms of risk introduced by exchange rate fluctuations is more than the gains in income to exporters through depreciation. This is also vividly shown in Appendix Table A3, which combines the effect of exchange rate and price and their volatilities. An interesting result here is that the overwhelming influence of export price caused the exchange rate variable to have a positive effect on export trade, but the volatility of the exchange rate still has a stronger negative effect on exports.

It is worthy of note that export price and its volatility influence exports positively and this is statistically significant. The combined effects of these two variables can increase export earnings if the volatility of the exchange rate is not too high. However, the stronger and more statistically significant effect of exchange rate volatility is a serious indication

of the overriding effects on exports when the exchange rate changes erratically. Thus a 1% increase in exchange rate volatility can reduce export earnings by as much as ₦45 million. The magnitude of the coefficient in the equations is high. Appendix tables A7–A9 also show the effect of the variables on export price. The results are presented as equations 1–3 in Table 7.

Table 7: Estimated results for export prices

	Real export earnings	Exchange rate	Int. world price	Price volatility	Exchange rate volatility
Equation 1	1.82 (1.71)	-9.99 (-2.0)	9.88 (5.4)	-0.07 (-2.92)	
Equation 2	2.01 (2.31)	-2.53 (0.68)	0.33 (2.39)		122.99 (5.18)
Equation 3	2.05 (2.55)	-6.77 (-1.78)	0.50 (3.44)	-0.05 (-2.45)	107.88 (4.75)

t-ratios are in parentheses.

Table 7 shows the results of three export price models estimated and gives an interesting picture when complemented by the data in Table 6. The result shows that price volatility exerts a significant negative effect on export prices. If this result is related to that presented in Table 6, which indicates a significant positive effect on export earnings, we can conclude that price volatility exerts a positive effect on export trade in Nigeria through its positive effect on volume of production. Second, the results show that exchange rate volatility exerts a positive and significant effect on export prices. In tables A1–A3, it has a negative effect on export earnings. This implies that an increase in exchange rate volatility will cause an increase in export prices, but a decrease in export earnings through a decline in production of exports.

Finally, the export price models show that the exchange rate exerts a negative influence on the export prices of agricultural products. That is, a decline in the value of the naira will result in an increase in export price and this will translate to increased export earnings (in local currency).

The following are the major conclusions from the discussions under this section:

- Exchange rate volatility has a direct negative effect on the level of agricultural export trade in Nigeria by causing a decline in export production.
- An increase in exchange rate (appreciation of the local currency) decreases export earnings (in local currency), while an increase in export price increases export earnings.
- Price volatility exerts a positive effect on the level of agricultural exports from Nigeria.
- The more erratically the export price changes, the greater the export earnings –but a volatile exchange rate reduces the export trade.

Impact of price and exchange rate volatility on import trade

Appendix tables A4 to A6 show the results of the three import trade models estimated. The first model examined the effect of import price and volatility on import trade while the second examined the effect of exchange rate volatility on imports. The third model examined the joint effect of exchange rate and price volatility on import.

Estimates of price and exchange rate volatility coefficients were not significant. Structural parameters like foreign exchange reserves played a more prominent role in the determination of the level of imports of agricultural produce. A priori, one expects the foreign exchange reserves to influence import trade positively. This exactly was the case as the sign of its coefficient was positive. However, the negative influence of exchange rate volatility as indicated in the results in Table A5 made this impact less prominent. This implies that although the foreign reserve is expected and does have a positive effect, its influence can be seriously affected when the volatility of the exchange rate is more prominent.

The estimated relationship among import prices and exchange rate, exchange rate volatility, and price volatility is shown in Appendix 3 Graph and also reported in appendix tables A10 to A12. The estimation revealed that changes in the exchange rate and its volatility significantly affect import earnings, the same way they affect import prices. The exchange rate significantly affects import price in the negative direction; that is, an appreciation of the exchange rate will result in decreased import prices. However, both exchange rate volatility and import price volatility have a positive effect on import trade, which implies that the more erratic the exchange rate and the import price, the greater the import trade.

The discussions under this section can support the following inferences:

- Exchange rate exerts a significant negative influence on agricultural import levels in Nigeria.
- Exchange rate volatility positively and significantly affects the level of agricultural imports into Nigeria, either directly or indirectly through import prices.
- Import price volatility affects import levels positively but has a negative effect on import price.

A matrix (Table 8) was constructed to indicate the effects of volatility in exchange rate and prices on export and import trade. The matrix indicates only the sign of the effect.

If earnings is taken as a function of price and quantity, then the negative effect of exchange rate volatility on export earnings must have been to reduce the volume of production since it has a positive effect on price. An increase in exchange rate (i.e., an appreciation of the local currency) also has a negative effect on both export and import

quantity and prices. Furthermore, when price is volatile, it will have a positive effect on production but tend to have negative effect on prices. Thus it reduces the rate of increase in prices.

Table 8: Matrix of price and exchange rate volatility

	Export earnings	Import value	Export price	Import price
Exchange rate volatility	-ve	+ve	+ve	+ve
Exchange rate	-ve	-ve	-ve	-ve
Price changes	+ve	-ve	None	None
Price Volatility	+ve	+ve	-ve	-ve

-ve = negative effect.
+ve = positive effect.

VII. Major findings and policy implications

The study was able to establish that exchange rate volatility has a negative effect on agricultural exports, while price volatility has a positive effect. Thus, the more volatile the exchange rate changes, the lower the income earnings of farmers, which subsequently also leads to a decline in output production and a reduction in export trade. However, price volatility exerts a positive effect on the level of exports. Also an appreciation of the local currency decreases export earnings, while an increase in export price influences the level of exports positively. The implication is that if the exchange rate change is more volatile, it tends to increase the prices of export crops, but the general effect leads to a decline in export production. Furthermore, the study also established the efficacy of price increase as a tool for increasing output of export crops. For import trade, the appreciation of the exchange rate reduces imports, while its volatility has a positive effect. If the exchange rate and import prices are volatile, they tend to increase the level of imports. The study has also shown that the SAP era, though beneficial in terms of price increases of agricultural exports, has also resulted in a high level of price and exchange rate fluctuations.

Two policy implications arise from this study:

- The monetary authorities should adopt a mechanism that will lead to the stability of the exchange rate. Erratic changes in the exchange rate have a long-term negative effect on production of agricultural exports.
- The government should monitor the marketing system of agricultural exports to ensure that farmers are paid fully by the buying agents so that the full benefit of production increases resulting from liberalization can be reaped. Community exchange programmes should be explored as a plausible mechanism for assisting farmers and exporters to hedge against a rash of changes in the marketing system in both prices and exchange rates.

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Appendix A

Table of results

Table A1: Equation fitted

Real export earnings: Φ export price + θ exchange rate + Σ weather + ß volatility of export price

Coefficient	Value	T	Prob
Φ	0.098	3.940	0.000
θ	-1.065	-2.188	0.037
Σ	0.001	0.484	0.632
ß	0.012	3.182	0.004
Model signf. (F) level		123.275	0.000

Table A2: Equation fitted

Real export earnings: Φ export price + θ exchange rate + Σ weather + ß volatility of exchange rate

Coefficient	Value	T	Prob
Φ	0.170	7.948	0.000
θ	-0.777	-1.485	0.149
Σ	0.004	2.315	0.028
ß	-36.080	-3.218	0.003
Model signf. (F) level		124.071	0.000

Table A3: Equation fitted

Real export earnings: Φ export price + θ exchange rate + Σ weather + β_1 volatility of export price + β_2 volatility of exchange rate

Coefficient	Value	T	Prob
Φ	0.117	6.779	0.00
θ	0.133	0.340	0.737
Σ	0.007	5.057	0.000
β_1	0.014	5.738	0.000
β_2	-45.142	-5.770	0.000
Model signf. (F) level		219.001	0.000

Table A4: Equation fitted

Real import earnings: Φ import price + θ exchange rate + Σ foreign exchange reserves + β volatility of import price

Coefficient	Value	T	Prob
Φ	0.042	0.209	0.836
θ	-7.672	-0.611	0.546
Σ	0.031	5.439	0.000
β	0.195	2.578	0.015
Model signf. level (F)		39.526	0.000

Table A5: Equation fitted

Real import earnings: Φ import price + θ exchange rate + Σ foreign exchange reserves + β volatility of exchange rate

Coefficient	Value	T	Prob
Φ	-0.150	-1.411	0.169*
θ	-46.040	-6.127	0.000
Σ	0.004	0.814	0.422*
β	679.945	7.854	0.000
Model signf. (F) level		113.446	0.000

Table A6: Equation fitted

Real import earnings: Φ import price + θ exchange rate + Σ foreign exchange reserves + β_1 volatility of import price + β_2 volatility of exchange rate

Coefficient	Value	T	Prob
Φ	-0.303	-2.376	0.025
θ	-37.149	-4.392	0.000
Σ	0.003	0.680	0.502*
β_1	0.092	1.971	0.059*
β_2	628.821	7.277	0.000
Model signf. (F) level		100.887	0.000

Table A7: Equation fitted

Export price: Φ Real export earnings + θ exchange rate + Σ
int. world price + ß volatility of export price

Coefficient	Value	T	Prob
Φ	1.821	1.707	0.088*
θ	-9.990	-2.000	0.055*
Σ	9.883	5.444	0.000
ß	-0.071	-2.921	0.007
Model signf. level (F)		247.528	0.000

Table A8: Equation fitted

Export price: Φ *Real export earnings* + θ exchange rate + Σ
int. world price + ß volatility of exchange rate

Coefficient	Value	T	Prob
Φ	2.013	2.306	0.029
θ	-2.528	-0.684	0.499*
Σ	0.335	2.390	0.024
ß	122.992	5.178	0.000
Model signf. (F) level		389.860	0.000

Table A9: Equation fitted

Export price: Φ real export earnings + θ exchange rate + Σ *int. world price* + β_1 volatility of export price + β_2 volatility of exchange rate

	Value	T	Prob
Φ	2.049	2.549	0.017
θ	-6.771	-1.775	0.087
Σ	0.502	3.438	0.002
β_1	-0.047	-2.453	0.021
β_2	107.880	4.747	0.000
Model signf. (F) level		368.989	

Table A10: Equation fitted

Import price: Φ real import value + θ exchange rate + Σ int. world price + β volatility of import price

Coefficient	Value	T	Prob
Φ	-0.362	-6.038	0.000
θ	-32.475	-4.167	0.000
Σ	2.516	11.091	0.000
β	-0.052	-2.343	0.026
Model signf. level (F)	281,527		0.000

Table A11: Equation fitted

Import price: Φ real import value + θ exchange rate + Σ
int. world price + ß volatility of exchange rate

Coefficient	Value	T	Prob
Φ	-0.505	-4.079	0.000
θ	-27.230	-3.346	0.002
Σ	1.965	12.890	0.000
ß	131.884	1.318	0.198
Model signf. (F) level		249.188	0.000

Table A12: Equation fitted

Import price: Φ real import value + θ exchange rate + Σ
int. world price + $ß_1$ volatility of import price + $ß_2$
volatility of exchange rate

	Value	T	Prob
Φ	-0.456	-3.816	0.001
θ	-36.129	-4.104	0.000
Σ	2.408	9.366	0.000
$ß_1$	-0.094	-2.080	0.047
$ß_2$	87.629	0.904	0.374
Model signf. (F) level		223.909	0.000

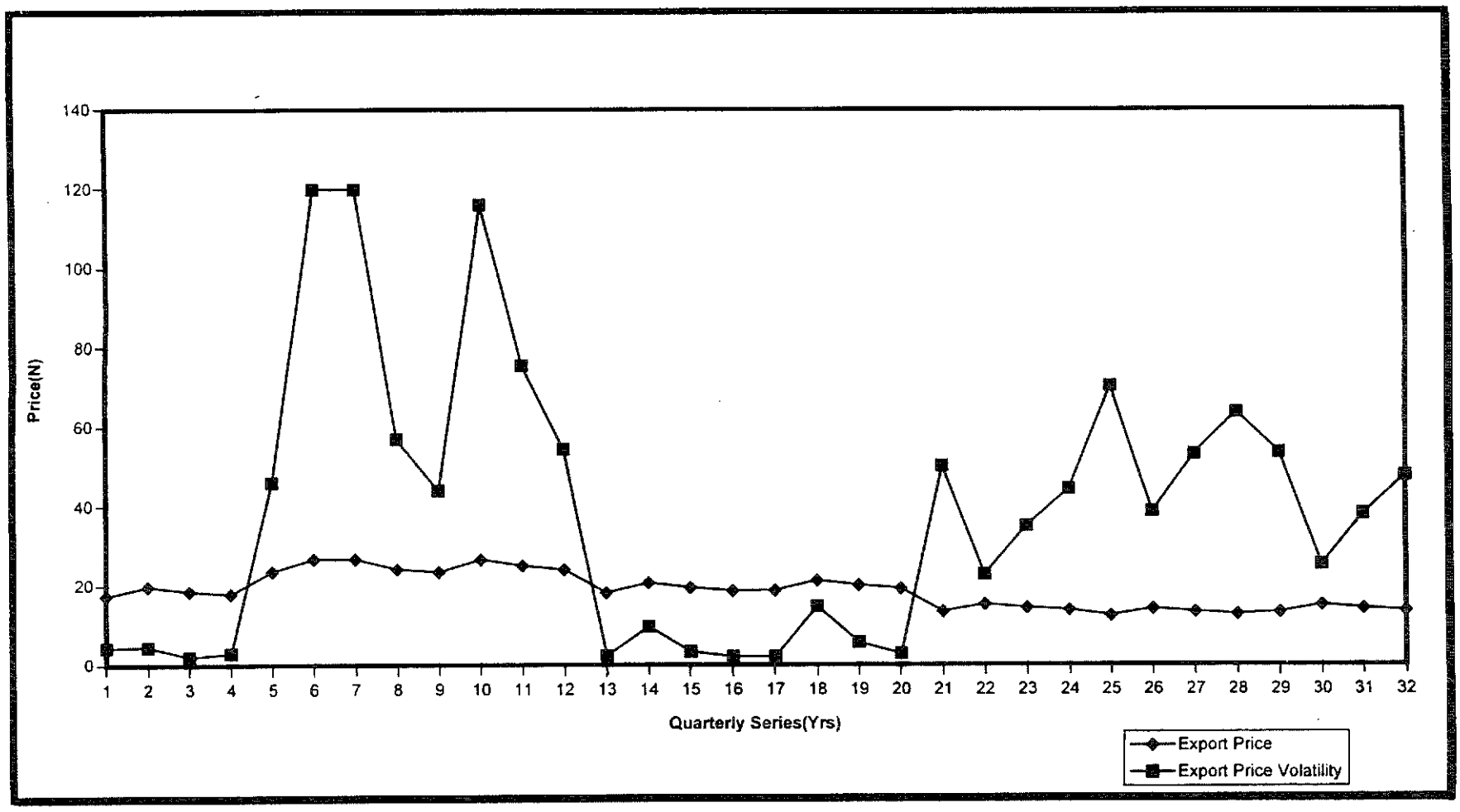
Table A13: Equation fitted

Export price local: Φ world price + θ exchange rate

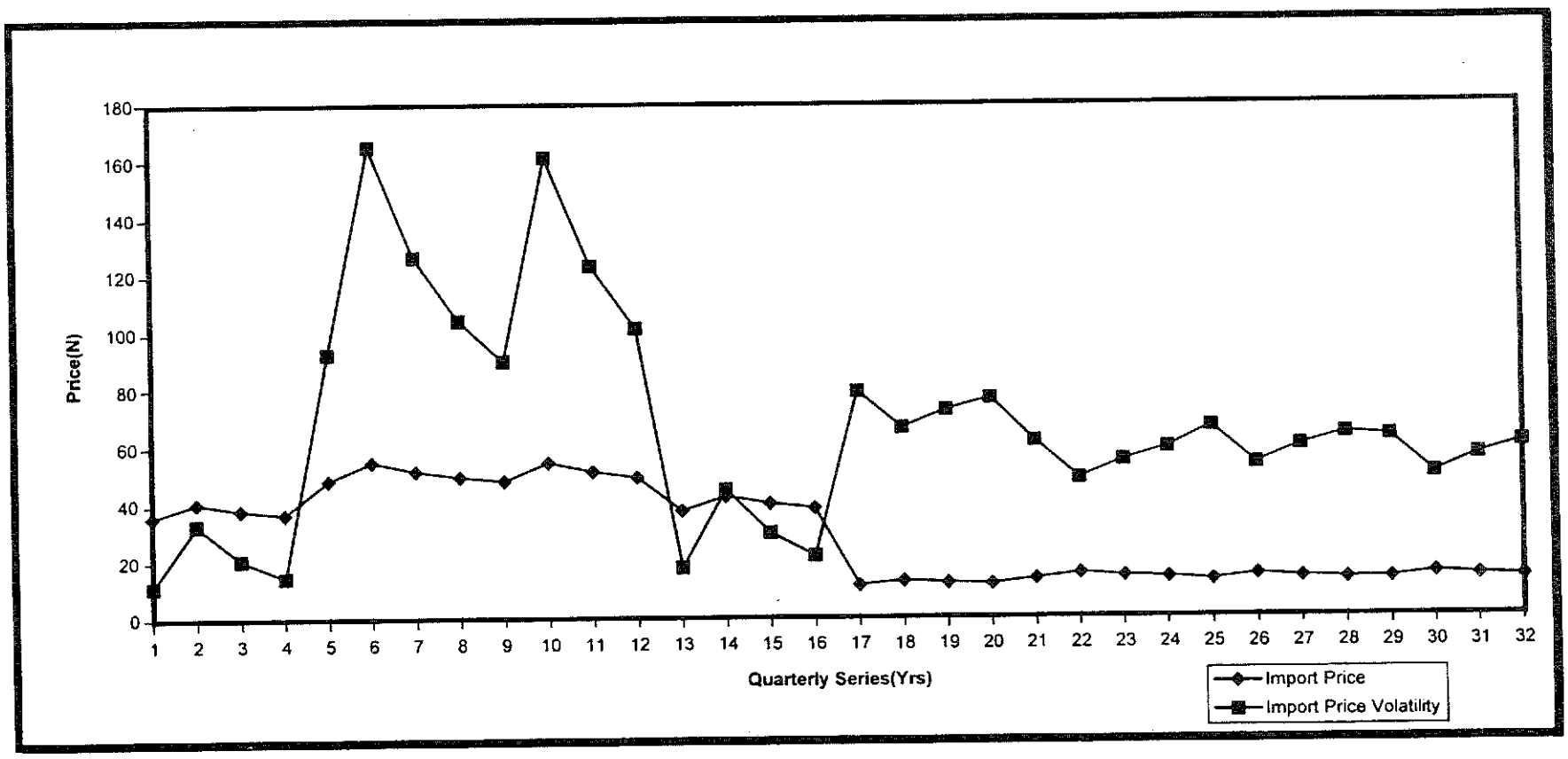
Coefficient	Value	T	Prob
Φ	0.927	20.215	0.000
θ	-9.346	-2.859	0.008
Model signf. (F) level		390.886	0.000

Note: Not significant at 5% level.

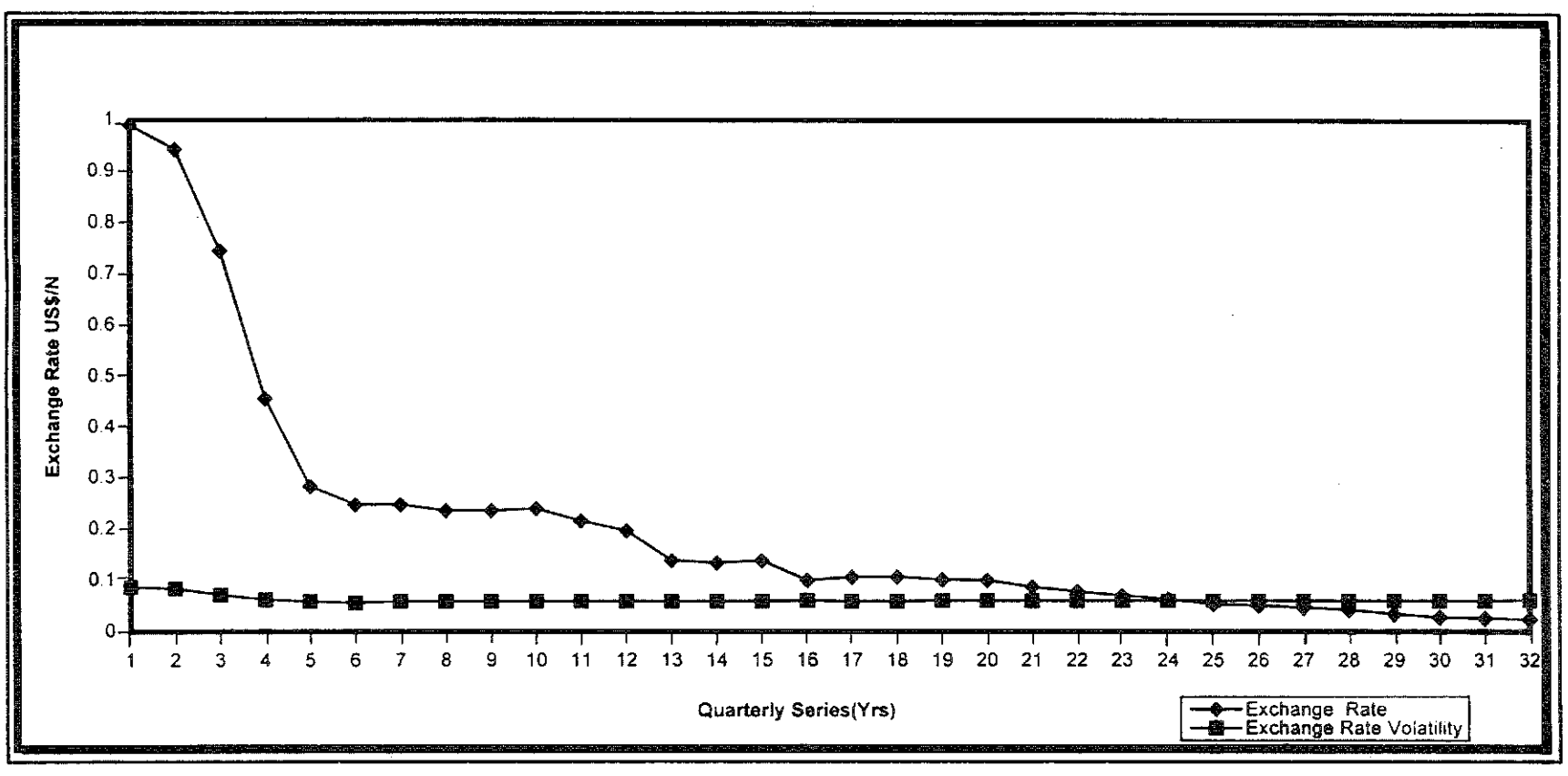
Export price and volatility of export price



Import price and volatility of import price



Exchange rate and volatility of exchange rate



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