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The supply response of aggregate agricultural output in Jamaica

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Abstract

A dominant theme in the development literature is that individual agricultural products responds to price incentives, not because of shifts between products, but that total agricultural output is not responsive to price. The econometric evidence for Jamaica shows that this presumption is not valid. The paper begins by reviewing the growth experience of the Jamaican economy. It then analyzes the trends in agricultural production. The remainder of the paper provides the econometric estimates of broad agricultural output to price. The empirical evidence shows that aggregate agricultural output is responsive to price, but it will take time for agricultural production to materialize. A summary of the published estimates of the supply response for individual crops is also presented. © 1997 Elsevier Science B.V.

1. Introduction

The stagnation of agricultural output in developing countries, and the recent emphasis on structural adjustment programs and market-friendly policies, have renewed interests in the role of agriculture in third-world countries. The prevailing orthodoxy in the development planning literature in the 1950's and 1960's was that agriculture was "not responsive to normal economic incentives" (Schultz, 1964 p. 8). The conventional wisdom was that agriculture was the static sector and industry the dynamic one, and that 'shifting resources from agriculture to industry' would promote growth and modernization. Krueger (1992 p. 129) summarizes this thinking as follows:

That consensus translated, however, into the view that industry was to be highly encouraged through protection against imports, subsidization of imports of needed capital goods and inputs, and other means. It was further believed that most of agriculture represented 'backwardness,' that agricultural output was unresponsive to incentives, and, that therefore, agri-

culture could be discriminated against in order to raise a surplus for industry without large economic costs.

The argument that the supply response of agriculture was low and not statistically significant provided, in part, the justification for taxing agriculture and favoring the inward-looking import-substitution industrialization strategy.¹ Governments of third-world countries, and Jamaica was certainly no exception, treated the agricultural sector as a source of revenue to be extracted by state marketing boards, which, paradoxically, were established with fanfare to stabilize farmers' incomes. Taxation of agricultural exports, suppression of prices paid to farmers by marketing boards, overvalued exchange rates and

¹ For a discussion of the Incentives Legislation enacted to promote industrialization, see Jefferson (1972). The structural features of the economy are dealt with by Jefferson, and this paper relies heavily on Jefferson's description. This paper draw freely from Gafar (1988).

Fig. 1. Gross domestic product at 1974 prices (\$JM); 1964–1990.

the deterioration of agriculture's internal terms of trade (vis-a-vis manufacturing) have been policies pursued to extract agricultural surplus. There are some empirical work on the supply response of individual crops for Jamaica (see Williams, 1972; Gafar, 1980; Pollard and Graham, 1985). Since 1981, Jamaica has adopted the IMF–World Bank structural adjustment program aimed at improving the competitiveness of the economy by removing distortions caused by price controls on food and other price rigidities, monopolies, overvalued exchange rate, and reducing public sector deficits and implementing market-friendly policies. For many third-world countries, the success of economic reforms and structural adjustment programs depends fundamentally on the quick growth of the agricultural output to overcome the food shortage. While the econometric evidence indicates that individual crops do respond to price changes, this does not mean that agriculture as a whole is responsive to price incentives. Schiff and Valdes (1992a p. 59) noted that "few studies have directly analyzed aggregate supply response." In his review of the literature, Biswanger (1989 pp. 231–232) wrote:

In analyzing the response to dismantling indirect discrimination, it is the response of broad agricultural aggregates to the policy changes that must be

examined, rather than that of individual crops. Although there are perhaps thousands of individual commodity studies, the literature on short- and long-term response of aggregate agricultural output to price changes is small... Other aggregates that must be evaluated under structural adjustment are the performance of agricultural and of domestic food production; for these the literature is even thinner.

In her study of the supply response of agriculture to price in nine sub-Saharan African countries, Bond (1983) concentrated on total agricultural output. This paper attempts to fill the gap in the research for a small, open economy, to wit, Jamaica, and it proposes to analyze not only the response of total agricultural output to price, but also, to use the terminology of Biswanger (1989), the response of "broad agricultural aggregates" to economic incentives.² This paper is organized as follows. Section 2 begins by providing a discussion of the phases of economic policy, and an overview of the growth and performance of the economy. Section 3 focuses attention on the trends of broad agricultural aggregates

² There is no published work on the Caribbean that deals with the supply response for aggregate agriculture, and there is no published work which deals with 'broad agricultural aggregates.' This paper supplements Gafar (1980).

Fig. 2. Per capita GDP at 1974 prices (\$JM); 1974–1990.

and it deals with some of the factors that affect agricultural output. The implicit taxation of the agricultural sector, and the behavior of the agricultural sector's internal terms of trade are also discussed. Section 4 formulates and tests a Nerlovian model of the supply response of aggregate agricultural output in Jamaica to price (Nerlove, 1979). Finally, Section 5 summarizes the main results and offers some concluding remarks.

2. Economic growth: an overview

In terms of political economy, there are three distinct phases of economic policy that characterize the 1964–1990 period. Lack of available data has limited us to end the discussion in 1990. The policy rhetoric of the 1964–1972 period (Jamaica Labor Party Government with a pro-USA leaning philosophy) emphasized free markets, but, in reality the government pursued the import-substitution strategy. This policy was based on protectionism, import restrictions and price controls to protect the local industries, and the government also adopted a policy of 'Jamaicanization' of banks and insurance companies.³ Harrigan (1991, p. 312), without providing

any statistical evidence, contends that the import-substitution strategy was responsible for the growth of manufacturing in the 1960's and 1970, while agriculture 'stagnated' because of the unfavorable domestic (internal) terms of trade. The economic pronouncements of the 1972–1980 Manley administration were couched in left-wing ideology ('democratic socialism'), economic populism and dirigisme. Price controls on basic foods and subsidization of essential imported food items intended to appease the volatile urban electorate penalized agriculture heavily. Excessive intervention in the economy by the Manley government created a bureaucratic economic structure unable to respond to the worldwide economic turbulence of the 1970's. The period 1981–1990 marks a return to economic liberalization and the implementation of an IMF–World Bank structural adjustment program.⁴ Fig. 1 illustrates the trend in real GDP during 1964–1990; Fig. 2 depicts the trend in per capita GDP; and Fig. 3 shows the annual growth rates of real GDP. Growth in GDP averaged 6.2% between 1964–1972, minus 2.5% between 1972–1980, 1.96% between 1980–1990 and 1.84% during 1964–1990. Per capita income increased by 48% during 1964–1972, fell by

³ Bonnick (1984), the former Director of Economic Planning discusses this.

⁴ Structural adjustment programs emphasizes the need to control budget deficits and limit domestic credit, liberalization of trade, deregulation and market-determined exchange rates.

Fig. 3. Growth rates (%) of real GDP; 1964–1990.

25% during 1972–1980 and increased by 6% during 1980–1990. Much of the economic expansion during 1964–1972 is due to foreign direct investment in the bauxite–alumina and tourist industries. The economic decline during 1972–1980 is due largely to domestic economic mismanagement, an overvalued exchange rate, huge budget deficits financed by the Central Bank's accommodation and massive external borrowing, emphasis on social welfare spending rather than on growth, and state ownership in sugar, tourism, banking and utilities. External factors, to wit, the world stagflation of the 1970's, the quadrupling of oil prices and the deterioration in Jamaica's commodity terms of trade were partly responsible for the economic decline during 1972–1980 (see Harrigan, 1991 p. 312).⁵ Findlay and Wellisz (1993, p.9) have argued that the expansion of the bauxite and tourist industries in the 1950's and 1960's had the typical 'Dutch disease' effect i.e., the "production of other tradeables, notably agricultural exports, stagnated, while nontradeables, such as construction, boomed." The boom associated with the bauxite industry ended in 1973. With the quadrupling of oil

prices, and in order to pay for the sharp increase in the cost of imports and ease the balance-of-payments difficulties, the government of Jamaica in 1975 imposed a levy on bauxite production equal to 7.5% of the average price of alumina ingot (see Stone and Wellisz, 1993, p. 183). The bauxite levy did increase public revenues substantially, but, it had the deleterious effect in making Jamaica's bauxite uncompetitive by increasing its costs by 17% in the world market (Harrigan, 1991 p. 314). The bauxite revenues were used "injudiciously" (Stone and Wellisz, 1993 p. 184) to finance "government consumption" rather than "capital accumulation" (Harrigan, 1991 p. 314).

In the context of agricultural development, Manley's People's National Party government (1972–1980) used marketing boards to extract 'rents' from export crops (see Section 3 for details). In addition, the Manley government bought from the foreign-owned sugar companies 26,000 acres of sugar land, and, as part of its land lease program, it distributed the land (in the form of sugar cooperatives) to the sugar workers (Stone and Wellisz, 1993 p. 181). This policy failed, and sugar production contracted by 50% during 1972–1980 and 16% during 1980–1986. The period 1981–1990 corresponds to the implementation of structural adjustment and economic liberalization programs under the IMF–World

⁵ Gafar (1995a) showed that between 1972 and 1986, the decline in the terms of trade accounted for a loss of approximately 1.5% annually in Jamaica's GDP.

Table 1
Structure of agricultural output (GDP) for selected years (percent at 1974 prices)

Agriculture aggregates	1964	1968	1972	1976	1980	1984	1988	1990	Average 1964–1990
A. Export agriculture	34.41	33.14	24.87	22.94	16.12	14.42	15.46	14.45	21.69 (7.21)
1. Sugar cane	24.34	22.12	14.57	13.29	10.52	8.25	9.32	8.75	13.55 (5.63)
2. Other main exports	10.07	11.02	10.30	9.65	5.59	6.17	6.14	5.69	8.13 (1.92)
B. Domestic agriculture	34.24	30.34	43.64	43.13	49.70	51.30	49.04	44.06	43.97 (6.98)
1. Root crops	13.19	12.98	24.53	23.22	24.73	24.95	25.98	24.24	22.31 (4.98)
C. Livestock and hunting	24.31	28.92	23.17	27.13	28.21	28.66	29.30	36.46	27.88 (3.50)
D. Forestry and fishing	6.87	7.17	8.03	6.79	5.71	5.68	6.10	5.03	6.46 (0.74)
1. Total agriculture, forestry and fishing ^a	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	—
2. Ratio of:									
(a) Total agriculture/GDP	9.43	7.94	7.34	7.83	8.34	8.81	7.92	7.82	8.08 (0.73)
(b) Manufacture/GDP	18.70	18.10	17.84	18.80	15.36	15.46	16.48	16.93	17.19 (1.09)
(c) Agriculture labor force/ total labor force	N.A.	33	28	29	25	25	25	24	29 (5.18)
(d) Employment in agriculture/ total employment	N.A.	38	34	35	37	33	30	26	34 (4.34)

^a May not add up to 100% due to rounding. Figures in brackets are the standard deviations.

Source: calculated by the author based on data contained in National Income and Product (various issues) and the Labour Force (various issues).

Bank auspices emphasizing growth via export expansion. There has been severe disagreement between the Jamaican authorities and the IMF regarding the use of devaluation as a policy tool to increase Jamaica's export competitiveness. In 1984 and 1985, the government of Jamaica rejected the use of devaluation because of its inflationary and redistribution consequences (Harrigan, 1991 pp. 345–348). ⁶

Although the economy has showed signs of growth under structural adjustment (1981–1990), income inequalities are glaring and widening, resulting in sociopolitical instability; poverty rates have exploded; there has been an increase in the informalization of the labor force; real wage rate and productivity have plummeted. ⁷ Under economic liberalization, marketing boards have been phased out, and Seaga's Jamaican Labor Party government abolished the sugar

cooperatives and placed the land under the management of Tate and Lyle, a UK firm that specializes in sugar (Stone and Wellisz, 1993 p. 200). The Seaga government also took steps to revitalize the banana industry by encouraging joint ventures and privately managed plantations, and it granted subsidies to encourage production of winter vegetables for the USA market. This program was not a success because of transportation and marketing difficulties, and competition from other countries (see Stone and Wellisz, 1993 p. 201).

3. Trends in agricultural output

Tables 1 and 2 show the composition and growth of agricultural output at constant prices for 1964–1990. The volume indices in Table 2 are real GDP for that economic category with 1974 = 100. The index of total agriculture GDP is shown in Fig. 4. The share of agricultural output fell from 17.2% in 1954 to 7.82% in 1990, averaging around 8% during 1964–1990. Examination of the data in Table 2 shows that the growth rates reflect tremendous instability and volatility as evidenced by the large standard deviations associated with the growth rates.

⁶ The econometric evidence by Gafar (1981, 1995b) indicates that the Marshall–Lerner condition for a successful exchange rate depreciation is fulfilled.

⁷ The only data series on the real wage rate are contained in Gafar (1995c). The decline in real wages has led to many experienced civil servants, teachers and public sector employees leaving their positions to be engaged in retail sales and speculative activities.

Table 2

Trends in economic and agricultural output (at 1974 prices)

Agricultural aggregate	Volume indices, 1974 = 100								Annual % rate of growth ^a 1964–1990
	1964	1968	1972	1976	1980	1984	1988	1990	
A. Export agriculture	119	121	112	99	67	67	68	67	–2.18 (8.87)
1. Sugar cane	140	135	107	94	72	63	67	67	–2.83 (9.71)
2. Other main exports	91	103	118	107	60	73	69	68	–1.09 (15.29)
B. Domestic agriculture	63	57	102	97	108	124	111	107	2.79 (12.64)
1. Root crops	42	43	100	91	94	105	103	103	3.44 (16.49)
2. Other primary products	90	77	105	105	128	150	123	113	0.89 (8.84)
C. Livestock and hunting	73	93	98	115	116	131	126	168	3.17 (6.98)
D. Forestry and fishing	86	82	128	104	85	94	95	84	–0.09 (9.33)
1. Total agriculture, forestry and fishing	83	86	106	102	99	110	104	111	1.10 (6.53)
2. Manufacture	66	78	103	98	72	77	86	96	1.44 (5.46)
3. GDP	63	77	103	93	85	89	93	101	1.82 (4.43)
4. Per capita GDP	72	84	107	91	79	78	79	84	0.79 (4.56)

^a Figures in brackets are the standard deviations of the growth rates.

Source: computed by the author based on data contained in the National Income and Product (various issues) published by the Statistical Institute of Jamaica.

Total agricultural output (see Fig. 4) was uneven, and the worldwide commodity price boom during 1975–1976 was responsible for the growth during 1975–1977. In terms of employment, agriculture accounts for approximately 1/3 of the employed labor force.

Agricultural production has undergone changes during 1964–1990 with the share of export agricul-

tural output falling from 34% in 1964 to 14% in 1990. Domestic agricultural output increased its share from 34% in 1964 to 44% in 1990. Export agriculture declined at an average rate of 2.18% per annum, while domestic agricultural output increased at 2.79% per annum. Jamaica's export earnings from bananas and sugar have been influenced by quotas and bilateral pricing policies. Sugar exports were protected

Fig. 4. Index of total agriculture GDP at 1974 prices (1974 = 100).

under the Commonwealth Sugar Agreement, and with the entry of the UK to the European Community, the Sugar Protocol under the Lome Convention came into effect. The Sugar Protocol is unique, it guarantees Jamaica an export quota of 126,000 tons of sugar to the European Union (EU) at remunerative prices. The price that Jamaica receives for its sugar exports is tied to the price the EU pays for its domestic beet sugar, and under the new GATT agreement, if there is liberalization of the EU sugar market and the price of beet sugar falls, there will be a reduction in the price of Jamaica's sugar exports. For instance, the price that Jamaica received for exports of sugar to the EU in 1993 was US\$609 per ton, while the world price of sugar ranged from US\$255 to US\$277, which illustrates the substantial EU subsidy to Jamaica's sugar industry. If there is liberalization of the EU sugar market, Jamaica will have to achieve greater levels of cost efficiency and increases in productivity in order to remain competitive. Jamaica also enjoys preferential arrangements for its sugar exports to the USA, but, between 1982–1983 and 1987, its USA export quota fell by 2/3. Exports of bananas to the UK are also protected under the Lome Banana Protocol. There has been intensive lobbying by the Latin American banana-producing countries for liberalization of the EU banana market. Lack of adequate irrigation, rural roads and extension services impeded the growth of export agriculture. Macroeconomic policies, for example, budget deficits which led to high rates of inflation and macroeconomic instability, and an overvalued exchange rate were factors that affected agricultural exports. For the period 1964–1982, the real exchange rate was basically overvalued. An overvalued exchange rate is a tax on agricultural- and labor-intensive exports; it hurts rural employment and wages thereby exacerbating poverty; and it subsidizes imported foods and raw materials for the import-substituting industries.

The pricing policies of the agricultural boards amounted to a tax on farmers, and this explains the decline in sugar and other (bananas, cocoa, coffee, citrus and pimento) exports.⁸ The statistical evi-

Table 3

Average rates of growth of farmgate and F.O.B. prices and output, and the nominal protection coefficient (NPC) for the period 1970–78

Commodities	Growth rates (%) 1970–1978 ^a			Nominal protection coefficient ^b
	Farmgate prices	F.O.B. prices	Output	
Sugar cane	–1.25	4.13	–2.90	0.82
Bananas	5.06	7.77	–7.43	0.77
Cocoa	1.64	14.06	–0.54	0.72
Coffee	9.80	8.34	2.02	0.61
Coconut	7.06	4.67	–21.00	N.A.

^a Adapted from Pollard and Graham (1985), Table 2.

^b Based on the data in Pollard and Graham (1985), Table 4 for 1970–1979. The NPC is defined as the ratio of farmgate prices (P_F) to F.O.B. prices (P_W) received minus marketing and processing costs (C): $NPC = P_F / (P_W - C)$.

dence contained in Pollard and Graham (1985), and summarized in Table 3, shows that the farmgate prices paid to farmers were generally less than the F.O.B. prices which the marketing boards received. A nominal protection coefficient (NPC) greater than one implies subsidization, while an NPC less than one suggests taxation of the farmers (producers) by the marketing boards.

The evidence summarized in Table 3 reveals that the F.O.B. export prices for bananas and sugar increased by 4.13 and 7.77%, respectively during 1970–1978, while the farmgate price for bananas increased by 5.06% and declined by 1.25% for sugar during 1970–1978. The average tax rate during 1970–1978 was around 26%, which suggests that agricultural boards were used as instruments to extract rents from farmers. This domestic pricing policy on agricultural crops partly explains why acreage in crops for exports fell by 25% during 1972–1980. Stone and Wellisz (1993 p. 181) have pointed out that production of export crops declined at an average rate of 6.1% during 1972–1980, while domestic agriculture increased at an average rate of 0.8% per year. In a comparative analysis of the agricultural pricing policies in 18 countries by the World Bank, it was noted that taxation on agriculture "exceeded 25% in all regions" (Krueger et al., 1991 vol. 1, p. 11). The high taxation on agricultural exports in Jamaica (about 26%, Table 3) made agriculture less attractive than other sectors of the economy; it de-

⁸ For a review of this view see Schiff and Valdes (1992b).

Table 4

Total acreage and the number of farms by size groups, 1954, 1958, 1968/69, 1978/79

Years	Size (acres)				Total
	under 5 acres	5–25 acres	25–100 acres	100 acres and over	
<i>Acreage (% distribution)</i>					<i>Acreage</i>
1954	13.01	26.27	12.13	48.58	1,914,375
1958	14.86	29.97	9.70	35.47	1,822,743
1968/69	14.85	22.13	8.30	54.72	1,489,188
1978/79	16.01	19.28	8.08	52.62	1,327,045
<i>No. of farms (% distribution)</i>					<i>No. of farms</i>
1954	60.81	20.66	2.82	0.61	198,883
1958	70.79	26.72	2.01	0.48	199,489
1968/69	78.55	19.35	1.58	0.62	193,359
1978/79	81.87	16.22	1.30	0.60	183,988

Source: adapted from Census of Agriculture 1978–1979, Preliminary Report, pp. 2–3 of the Jamaican Department of Statistics.

Note: there are no data available for the intervening years.

pressed investment in export agriculture; and it reduced the demand for rural labor thereby increasing migration to the cities and increasing competition for urban employment.

Infrastructure (accessible roads and irrigation), farmers' access to credit, agro-extension services, and availability of fertilizer are factors, in conjunction with prices, that affect agricultural output. Land is one of the major inputs of agricultural production. Jamaica is a hilly and mountainous country, and this presents problems relating to irrigation, cropping patterns and soil erosion. Approximately 80% of Jamaica is mountainous. Because of the mountainous landscape, agricultural production is subject to the vagaries of the weather, i.e., rainfall. However, ex-

cessive rainfall due to hurricanes is known to destroy agricultural production completely. Total acreage under production declined from 1.9 million acres in 1954 to 1.3 million acres during 1978–1979; or approximately by a third during 1954–1979. This decline in acreage partly explains the decline in agricultural output. Table 4 summarizes the essential statistics relating to the number of farms and acreage by size groups. The statistics summarized in Table 4 indicate that the category under 5 acres accounted for approximately 15% of total acreage and 75% of all farms. Gafar (1983) noted that farms in the group under 5 acres are cultivated by old people engaged in subsistence farming. Young people are not interested in agriculture, they leave the rural areas for the urban

Table 5

Terms of trade for agriculture

Year	Volume of agricultural output ^a	Net barter terms of trade ^b	Gross income terms of trade ^c
1964–67 (average)	88	156	137
1968–71 (average)	91	133	119
1972–75 (average)	102	108	110
1976–79 (average)	107	95	101
1980–83 (average)	98	80	79
1984–87 (average)	107	54	58
1988–90 (average)	105	59	62

^a Agriculture GDP at constant prices (1974 = 100).^b Net barter terms of trade is computed by dividing the implicit GDP deflator of the agricultural sector by the implicit GDP deflator for the manufacturing sector (1974 = 100).^c Computed as Column 1 × Column 2 (%); (1974 = 100).

Source: Author's calculations based on data in National Income and Product (various issues).

Table 6
Estimates of price elasticities of supply of agricultural crops for Caribbean countries

	Crop and country	Period	Author and year	Functional form	Price elasticity	
					Short-run	Long-run
1.	Banana	1954–1972	Gafar (1980)	Linear	0.16	0.57
	Jamaica	1961–1979	Pollard and Graham (1985)	Log	0.49	–2.72
2.	Cocoa	1954–1972	Gafar (1980)	Linear	0.41	2.56
	Jamaica	1961–1979	Pollard and Graham (1985)	Log	0.74	0.76
3.	Coffee	1953–1968	Williams (1972)	Log	0.70–0.80	
	Jamaica	1954–1972	Gafar (1980)	Linear	0.92	1.15
		1961–1979	Pollard and Graham (1985)	Log	0.10	0.07
4.	Citrus	1961–1979	Pollard and Graham (1985)	Log	0.56	0.92
	Jamaica					
5.	Coconut	1961–1979	Pollard and Graham (1985)	Log	0.24	–1.33
	Jamaica					
6.	Ginger	1954–1972	Gafar (1979)	Linear	0.38	7.6
	Jamaica					
7.	Sugar	1954–1972	Gafar (1980)	Linear	0.17 – 0.29	0.31 – 0.7
	Jamaica	1961–1979	Pollard and Graham (1985)	Log	0.24	1.41
	Trinidad and Tobago	1962–1981	Gafar (1987)	Log	0.12 – 0.17	0.13 – 0.7
8.	Rice	1963–1990	Gafar (1996)	Log	0.25 – 0.45	0.56 – 0.9
	Guyana					

Notes: Log denotes a logarithmic form.

centers because of the bright lights and in search of salaried employment. Farms in the category 0–10 acres are rain-fed, and farms in this group produce over 90% of food crops for local consumption, as well as a significant portion of crops (bananas, ginger, coffee, cocoa and pimento) grown for export. Most of the 100-plus-acre farms are plantations used for sugarcane cultivation, or for pasture, or left idle. The Census of Agriculture 1978–1979, Preliminary Report of the Jamaican Department of Statistics reported that export crops, domestic crops, and livestock and poultry accounted for 42.7%, 20.1% and 23.1% of total acreage, respectively. Between 1960–1978, the agricultural sector accounted for nearly 7% of total gross capital formation in the economy (Gafar, 1983).

The emphasis on the import-substitution strategy and the use of quantitative restrictions on imports to deal with foreign-exchange shortages, led to the deterioration in the internal terms of trade. The internal (net barter) terms of trade was constructed as the ratio of the price of the agricultural sector (i.e., export and domestic agriculture included) to the price of the manufacturing sector. Table 5 presents the details. The decline in the net barter terms of trade from the mid 1970's is an indicator of the

profitability of agriculture relative to the manufacturing sector. The gross income terms of trade reflects the purchasing power of that sector. Thorbecke and Svejnar (1987 p. 28) noted that an increase in the gross income terms of trade "can be interpreted to reflect a rise in real capital outflow from agriculture to the rest of the economy and vice versa." The decline in the net barter terms of trade provides the mechanism for aiding the migration of labor from rural areas to the cities, and it may partly explain why agricultural output stagnated.

4. The supply response

The prevailing view in the 1960's and 1970's was that while individuals crops respond to price changes, total agricultural production was unresponsive, or at best, slow to respond to economic incentives. This presumption provided the justification for taxing agriculture.⁹ To test the response of 'broad agricultural aggregates' to price, we utilize the Nerlovian

⁹ For a discussion of the Nerlovian Model see Nerlove (1979) and Askari and Cummings (1977). For applications of the Nerlovian model see Gafar (1980, 1987).

adjustment model (Nerlove, 1979). The model is cast within a stock adjustment framework. We assume that the desired output (Q^*) is given by the following long-run relationship:

$$\ln Q_t^* = a + b \ln P_{t-1} \quad (1)$$

where P denotes price, t time, and $\ln$ is the natural log. It is reasonable to assume that actual agricultural output (Q) does not immediately move to Q^* as P changes, but it responds by the following process:

$$\ln Q_t - \ln Q_{t-1} = \lambda(\ln Q_t^* - \ln Q_{t-1}) \quad (2)$$

where $0 \leq \lambda \leq 1$, is the speed of adjustment.

Substituting Eq. (2) in Eq. (1) and adding a time trend (t) to account for such effects as advances in agro-technology, and an error term (u) we have

$$\ln Q_t = A_0 + A_1 \ln P_{t-1} + A_2 \ln Q_{t-1} + A_3 t + u_t \quad (3)$$

where $A_0 = \lambda a$; $A_1 = \lambda b$; $A_2 = 1 - \lambda$; and u_t is assumed to follow

$$u_t = \rho u_{t-1} + e_t$$

such that $|\rho| < 1$; $E(e) = 0$; $\text{cov}(e) = \sigma^2 I$.

The short-run price elasticity of supply is given by A_1 and the long-run price elasticity is b .

Available estimates of the price elasticities of supply for individual crops in the Caribbean are pulled together and summarized in Table 6 for easy reference. Some of the long-run estimates reported by Pollard and Graham (1985) have to be interpreted cautiously because the estimated coefficient for lagged output is negative/greater than one. However, the econometric evidence shows that in the long-run individual crops respond positively to price changes, and it is wrong to assume that taxing agriculture would not reduce its output. Governments should not use social and populist objectives (for example, maintaining cheap food prices to help the poor) to tax agriculture, since the estimated econometric evidence suggests that taxing agriculture would reduce output in the long-run, and this would worsen the conditions of the poor. But while individual crops are responsive to higher prices, Jaeger (1992 p. 9) noted that this "tells us little about the aggregate response to changes in agricultural prices overall."

Table 7
Estimates of agriculture supply response: 1964–1990

Agricultural aggregates	A_0	A_1	A_2	A_3	R^2	S.E.	ρ	h
A. Export agriculture	1.80 (1.92)	0.20 (2.06)	0.43 (2.30)	−0.01 (2.07)	0.93	0.07	−0.12	−1.24
(i) Sugar cane	−0.40 (1.12)	0.28 (2.61)	0.70 (10.44)		0.93	0.09	−0.50	−3.70
(i) Sugar cane	1.74 (1.62)	0.28 (2.73)	0.37 (1.79)	−0.02 (2.10)	0.94	0.08	−0.15	−2.74
(ii) Other main exports	0.95 (1.50)	0.29 (2.47)	0.49 (2.99)		0.58	0.13	−0.14	−1.59
B. Domestic agriculture	0.34 (0.29)	0.13 (1.35)	0.88 (6.95)		0.79	0.12	0.18	0.98
(i) Root crops	0.45 (0.53)	0.07 (0.53)	0.84 (8.17)		0.78	0.16	0.21	1.09
(ii) Other primary products	1.33 (0.95)	0.19 (1.54)	0.81 (5.73)		0.80	0.09	0.19	1.18
C. Livestock and hunting	2.47 (3.07)	0.15 (1.68)	0.28 (1.29)	0.02 (2.92)	0.88	0.06	0.23	1.13
D. Forestry and fishing	1.44 (1.88)	0.02 (0.21)	0.67 (4.26)		0.44	0.09	0.29	1.99
Total agriculture, forestry and fishing	1.77 (0.94)	0.12 (1.19)	0.48 (2.72)	0.01 (1.87)	0.60	0.06	0.18	1.99

Table 7 presents the regression estimates of the supply response of broad agricultural aggregates. The measure of output that is used in this paper is GDP at constant prices with 1974 = 100; the price variable is the ratio of the implicit GDP price deflator to the consumer price index. Askari and Cummings (1977) have argued that if farmers are motivated to buy more of other goods, or to maintain their consumption of other goods the same, then the appropriate price deflator is some index of consumer prices. Table 7 also reports the absolute values of the *t*-ratio in parentheses below the parameter estimates, the correlation coefficient of determination R^2 , the standard error (S.E.) of the regression equation, estimates of ρ and the Durbin *h* statistic. The estimated coefficients for price (A_1) and lagged output (A_2) have the correct signs, and are plausible. The fit is reasonably good, as measured by R^2 . In most cases, the estimated price coefficient is significant at the 10% (one-tail test) and 5% levels, and lagged output is significant well beyond the 5% level. An attempt was made to include the real exchange rate (RER) in the estimated model to capture the influence of macroeconomic variables. When this was done, the parameter estimates were plagued with large standard errors, inappropriate signs and multicollinearity (due to the high correlation, $r = 0.82$, between the price variable and the real exchange rate). Incorporating the real exchange rate (and omitting the price

variable), the estimated equation for total agricultural output (TAQ) becomes:

$$\ln \text{TAQ}_t = 1.43 + 0.08 \ln \text{RER}_t + 0.61 \ln \text{TAQ}_{t-1}.$$

(2.37) (1.44) (4.26)

S.E.	0.059
R^2	0.56
ρ	0.16
<i>h</i>	0.99

Here an increase in the real exchange rate reflects depreciation (improved competitiveness).¹⁰ The short-run elasticity with respect to the real exchange rate is 0.08, and the long-run elasticity is 0.21. For export agricultural output (XAQ), the estimated regression equation is:

$$\ln \text{XAQ}_t = 0.61 + 0.23 \ln P_{t-1} + 0.09 \ln \text{RER}_t + 0.72 \ln \text{XAQ}_{t-1}.$$

(0.85) (2.26) (1.03) (6.75)

S.E.	0.07
R^2	0.92
ρ	-0.29
<i>h</i>	1.77

The short-run elasticity with respect to the real exchange rate is 0.09, and the long-run elasticity is 0.32. The short- and long-run price elasticities are 0.23 and 0.82, respectively.

Based on the results contained in Table 7, the short- and long-run estimates of the price elasticity are presented in Table 8.

The econometric evidence contained in Biswanger (1989, Table 2) indicates that for the USA, the short-run estimate of total agriculture supply price elasticity is 0.05 to 0.17 and the long-run estimate is 0.07 to 1.09; for Argentina the short- and long-run

Table 8
Estimates of the price elasticity of supply for broad agricultural aggregates

Agricultural aggregates	Price elasticity	
	Short-run	Long-run
A. Export agriculture	0.20	0.35
(i) Sugar cane	0.28	0.93
(ii) Sugar cane	0.28	0.38
(iii) Other main exports	0.29	0.57
B. Domestic agriculture	0.15	1.08
(i) Root crops	0.07	0.43
(ii) Other primary products	0.19	1.00
C. Livestock and hunting	0.15	0.21
D. Forestry and fishing	0.02	0.06
Total agriculture	0.12	0.23

¹⁰ In the case of domestic agricultural output (DAQ), the estimated regression is:

$$\ln \text{DAQ}_t = 0.55 + 0.07 \ln \text{RER}_t + 0.81 \ln \text{DAQ}_{t-1}.$$

(1.07) (0.57) (7.78)

S.E.	0.11
R^2	0.79
ρ	0.20
<i>h</i>	1.18

Here the real exchange rate is not significant, which is not surprising, since relative prices are the important determinant in production for domestic use.

estimates are 0.07 to 0.35 and 0.42 to 0.78, respectively; and for India the short- and long-run estimates are 0.09 to 0.30 and 0.30, respectively. Bond (1983, Table 5) reported that for the nine sub-Saharan African countries, the short-run estimates range from 0.05 to 0.54 averaging 0.18, while the long-run estimates range from 0.07 to 0.54 averaging 0.21. Our estimates for Jamaica indicate that the short- and long-run price elasticities for total agricultural output are 0.12 and 0.23, respectively, which fall within the range reported for other countries (see Biswanger, 1989, Table 2). These estimates may be low due to aggregation. If we treat the average output for each broad agricultural aggregate as the appropriate weight (see Table 1), the weighted short- and long-run price elasticities become 0.16 and 0.61, respectively. The evidence summarized in Table 8 shows that broad agricultural aggregates respond positively to economic incentives. The econometric evidence clearly shows that if the Jamaican government wants to increase agricultural output and employment, it should stop taxing agriculture and depressing agricultural prices; it should abandon overvaluation of the exchange rate; and it should stop subsidizing imported foods. In short, imported foods should reflect their true scarcity values.

5. Conclusion

The main conclusions of this paper are the following. First, statistical evidence indicates that per capita GDP increased by 48% during 1964–1972, fell by 25% during 1972–1980, and increased by 6% during 1980–1990. The economic decline during the 1970's is due largely to domestic economic mismanagement and dirigisme policies. Growth during 1980–1990 is due in part to economic liberalization and increased net capital inflows. Second, agricultural output, as a percent of GDP, averaged around 8% during 1964–1990; while the agricultural sector accounted for nearly a third of total employment. The share of export agricultural production fell from 34% in 1964 to 14% in 1990. Domestic agricultural output increased its share from 34% in 1964 to 44% in 1990. Export agricultural output declined considerably during 1964–1990, while there was substantial increases in domestic agricultural output. The implicit average

tax on agricultural exports during 1970–1978 was around 26%, and this is partly responsible for the decline in export agricultural output. The statistical evidence shows that the terms of trade for agriculture declined substantially, and this contributed in part to the stagnation of agriculture. Third, the econometric evidence shows that agricultural output responds positively to price. Our estimates for Jamaica indicate that the short- and long-run price elasticities for total agricultural output are 0.12 and 0.23, respectively, while the weighted short- and long-run price elasticities are 0.16 and 0.61, respectively. These estimates fall in the range reported for other countries. From a policy point of view, the econometric evidence suggests that a 10% increase in the real price of agricultural output, will, *ceteris paribus*, lead to a 1.2–1.6% increase in agricultural output in the short-run, and about 2.3–6.1% in the long-run. The econometric evidence suggests that if Jamaica is to achieve faster agricultural growth, it should end all distortions in price and exchange rates that mitigate against agriculture, i.e., dismantling price subsidies on imported foods, and eliminating the protection to manufacturing via overvaluation of the exchange rate. A competitive real exchange rate and price reforms are important to accelerate agricultural output. Since many small farmers are unable to mobilize the resources on their own to finance investments in irrigation and agricultural infrastructure, the need for stepping up public investments in these areas are essential for the long-run dynamism of agriculture.

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