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Can Price Incentive to Smuggle Explain the Contraction of the Cocoa Supply in Ghana?

Aleš Bulíř[1]
International Monetary Fund

From the early 1960s to the early 1980s, the officially recorded output of cocoa in Ghana declined by 60%. During the 1983–95 Economic Recovery Programme, however, the official output of cocoa doubled. Although these developments have inspired much empirical research, most of the studies have been unable to explain the medium-term persistence of cocoa output in remaining below its estimated capacity level. The paper argues that the price incentive to smuggle can explain as much as one-half of the observed decline in official output from its trend and the subsequent recovery. A co-integration analysis and a dynamic error-correction model of cocoa supply support the analysis.

1. Introduction

From the early 1960s to the mid-1980s, officially recorded output of cocoa beans in Ghana declined by 60%, and although it recovered in the 1990s, it is still below its peak levels. This paper argues that the contraction of the Ghanaian cocoa sector can be explained by several adverse external factors and by the distortionary effect of domestic taxes, which, by widening the producer price differential between Ghana and Côte d'Ivoire, increased the incentive to smuggle. On the one hand, real international cocoa prices receded from their peak levels in the late 1950s, the relative prices of competing domestic crops increased, and the sector experienced several years of severe drought in the 1970s and 1980s. On the other hand, the cocoa sector has been badly affected by a high cocoa export duty, and implicit taxes in the form of exchange rate distortions and marketing inefficiencies.

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A number of empirical studies have investigated the response of the supply of cocoa in Ghana to exogenous factors. In fact, cocoa in Ghana is one of the most modelled commodities in the developing world. Three approaches to the modelling of cocoa can be distinguished: long-term technological capacity models, traditional partial-adjustment supply models, and models that take into account smuggling to neighbouring countries. Following the third approach, this paper argues that as much as one-half of official output fluctuations with respect to the trend can be attributed to price differentials *vis-à-vis* Ghana's neighbours, and Côte d'Ivoire in particular.

The paper is organised as follows: historical developments in official cocoa output in Ghana are reviewed in Section 2; the effects of the direct and indirect taxation of cocoa in Ghana are evaluated in Section 3; previous empirical studies are assessed and a dynamic model of cocoa supply is estimated in Section 4; and Section 5 presents my conclusions.

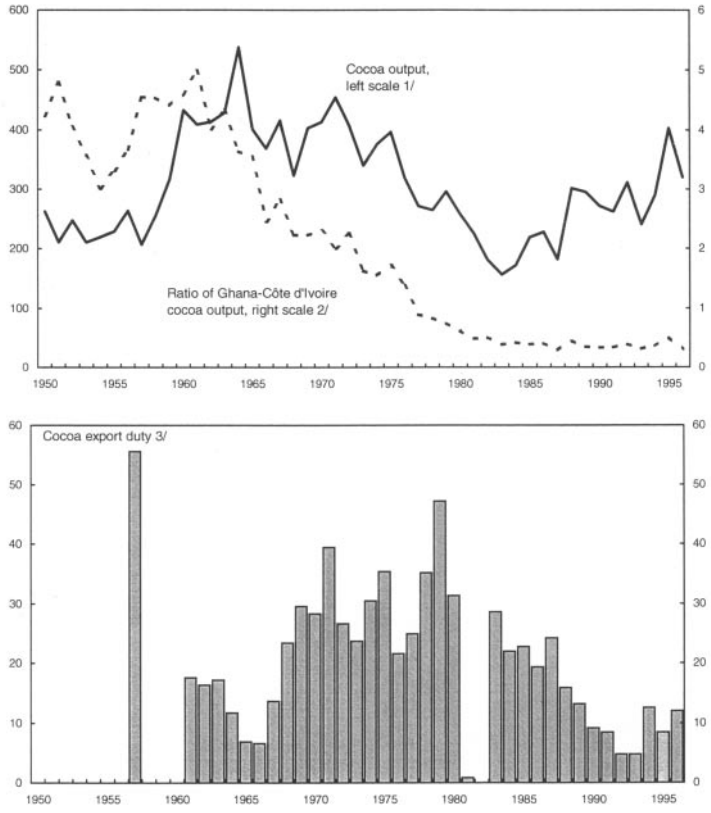
2. Cocoa Output in Ghana: a Review of Recent History

Cocoa has historically been the key economic sector in Ghana, and a major source of export and fiscal revenue. However, officially recorded output declined from a peak in the early 1960s of ~400,000–450,000 metric tons, or >35% of world production, to barely 200,000 metric tons, or <10% of world production, in the early 1980s. While in 1960 Ghana produced five times more cocoa than its neighbour, Côte d'Ivoire, by the early 1980s Ghana's official production was only one-third that of Côte d'Ivoire (Figure 1). The impact of the contraction in official cocoa output on Ghana's domestic and external imbalances was dramatic, in part because the country failed to diversify its export base.[2] The ratio of cocoa exports to GDP fell from ~20–5% in the early 1950s to 5% in the early 1990s. Foreign exchange receipts fell accordingly: the share of cocoa export receipts in total exports declined from 50–60% in the late 1950s to 20–30% in the 1970s, and the cocoa export duty fell accordingly. Official output increased after the launching of the Economic Recovery Programme (ERP) in 1983 and averaged 350,000 metric tons in 1990/1–2000/1 — still below the levels of the early 1960s.

Despite producing about one-third of world output in the 1950s, Ghana has been a price taker, and the world price and supply con-

[2] In 1983/4, the US dollar value of Ghana exports was less than the average thereof for the 1960s.

Figure 1: *Ghana — Cocoa Output Developments, 1950–96*



Sources: Cocoa Marketing Board (COCOBOD), Berg (1964) and author's estimates.
[1]Official sales to COCOBOD; in crop years (ending in September), thousands of metric tons.
[2]In crop years (ending in September).
[3]In percent of total government revenue; fiscal year (ending in December). Data for 1950–56 and 1958–60 are not available.

ditions have had a powerful impact on its cocoa sector (Figure 2). Although the International Cocoa Organisation (ICCO) intervened in the market, smoothing short-term fluctuations through its buffer stock facility, the success was usually only temporary and these efforts were eventually abandoned.[3] External developments can be characterised

[3] Empirically, there is no evidence that during 1950–95 Ghana's domestic producer prices or cocoa output had a visible impact on international prices; see Section 4.

Figure 2: *Ghana — Cocoa Price Developments, 1950–95 (Crop Years; October–September)*

Sources: Cocoa Marketing Board, Berg (1964) and author's estimates.
[1]Converted at the official exchange rate; in constant 1963 cedis, deflated by the CPI.
[2]In constant 1963 cedis, deflated by the CPI and food price index.
[3]Converted at the black market rate.
[4]In percent, deflated by the CPI.

by a few stylised facts. Evidence suggests the existence of long-term international cocoa price cycles and, given the low income and price elasticities of world cocoa demand, large stocks of cocoa and recurrent oversupply have caused the real international cocoa price to decline by an average of 2% per annum since 1950 (Weymar, 1968; Bateman *et al.*, 1990). In addition, production of cocoa beans is price inelastic in the

short run — the time span between new plantings and their first crop is ~3–5 years, and trees bear beans for >30 years with minimal maintenance and low harvesting cost. In the long run, however, production has been sensitive to higher-than-average international prices because of new plantings: in 1957–64 and 1976–84, following spells of cyclically high prices, world output rose at annual rates of 9 and 6%, respectively.

Although cyclical price developments contributed to the initial contraction of the Ghanaian cocoa sector in the late 1960s and early 1970s, the macroeconomic policies pursued at the time by the government further aggravated the situation. As has been well documented in earlier studies, price and fiscal policies aiming at import substitution shifted the balance of incentives in the economy toward industry and nontradable goods, and away from exportable goods (see Frimpong-Ansah, 1991; Fosu, 1992; Jaeger, 1992; Coleman *et al.*, 1993). Among agricultural producers, cocoa farmers were hardest hit: while between 1963 (the peak of Ghana's official output) and 1980 the nominal producer price of cocoa rose 21 times, the respective prices of maize and rice rose 49 and 60 times, and the overall consumer price index (CPI) rose ~55 times. By way of comparison, international cocoa prices (in US dollar) rose ~10 times, while the exchange rate depreciated four times. The resulting price squeeze was further exacerbated by cost inefficiencies in the operations of the Cocoa Marketing Board (COCOBOD) that ultimately had to be borne by the farmers (Table 1).[4] These unfavourable developments resulted in the virtual cessation of new plantings in the late 1960s and 1970s, and the ageing of cocoa trees.[5]

However, the effects of international and relative domestic producer prices and macroeconomic policies alone cannot explain the 50% contraction in official output between 1960–5 and the early 1980s. By way of comparison, cocoa production in Côte d'Ivoire during the same period rose ninefold to ~1 million metric tons (see Akiyama, 1988). Assuming steady plantings in the past and a 30 year productive period for cocoa trees, in each year the productive capacity could have declined by only ~3–4% — that is, a ratchet effect was in place. To get

[4] At its peak, the COCOBOD employed >100,000 ghost workers and collected almost 40% of export proceeds. During the ERP, the payroll was reduced to <20,000 workers without any adverse impact on crop quality or the timeliness of deliveries.

[5] Nevertheless, cocoa farmers remained richer than other farmers (Roe and Schneider, 1992).

Table 1: *Cocoa Sector: Producer Income, Marketing Cost and Government Revenue, 1951–96*

	1951–5	1956–60	1961–5	1966–70	1971–5	1976–80	1981–5[a]	1986–90	1991–6	1993/4	1994/5	1995/6
Share of[b] (% of total cocoa export revenue)												
Producers	45.6	53.2	65.0	44.1	37.5	39.0	32.2	44.4	47.6	35.6	53.9	51.0
COCOBOD	6.0	10.0	17.3	8.8	18.4	26.8	35.7	30.3	31.1	24.9	26.5	13.5
Cocoa tax revenue	48.4	36.8	17.6	47.2	44.2	34.2	32.1	25.3	21.3	39.5	19.7	35.5
Memorandum items:												
Producer price[c] (% of international price)	168.7	48.6	48.1	39.8	39.3	41.2	64.6	39.3	41.1	23.1	43.5	47.2
Producer price[d] (% of Ivoirien producer price)	87.8	82.8	107.9	46.8	58.9	27.1	36.7	57.4	104.1	81.9	135.0	109.0

Sources: Berg (1964), Stryker *et al.* (1990) and International Monetary Fund *et al.* (1996).
[a]Excluding 1981/2.
[b]Share of international price accruing to producers, COCOBOD, and the government. The sum of those shares may not always equal to 100 because of rounding.
[c]Converted at the official exchange rate.
[d]Converted into US dollars at black market/forex bureau rates.

a 50% contraction in official output, there would have had to have been no new plantings for 20 years.[6] Although new plantings and maintenance were neglected in some periods and regions, there is no evidence of a 20 year planting shutdown, a widespread felling of cocoa trees or persistent bush fires. Some studies have suggested that the decline in production was much smaller, at least in some regions, because of smuggling.[7] Official COCOBOD estimates of smuggling are conservative, at ~5–10% of the officially recorded crop, but in the late 1970s and early 1980s the amount smuggled may have been significantly higher (May, 1985).

Can one actually show the impact of the smuggling incentive on the aggregate level of output or is it just a local and unimportant phenomenon? It would be next to impossible to prove it for non-stationary series, such as Ghanaian and Ivoirien output series after 1960. It can be shown, however, using data for 1949–60 from Berg (1964), when output was stationary in both Ghana and Côte d'Ivoire. Periods of higher Ghanaian producer prices, relative to those in Côte d'Ivoire, were associated with faster sales growth to domestic marketing institutions in Ghana compared with Côte d'Ivoire, and vice versa (Figure 3).[8] This pattern was broken only in 1957, when production fell sharply in both countries.

During the ERP, policies were introduced to reverse the decline in official cocoa output. Increases in the producer price relative to neighbouring countries weakened the incentive to smuggle, a cyclically higher international price further buttressed the supply response and new cocoa varieties were introduced.[9] As a result, by the mid-1990s, official output was almost double that of 1982/3 crop, and it grew steadily, if slowly, in the late 1990s.

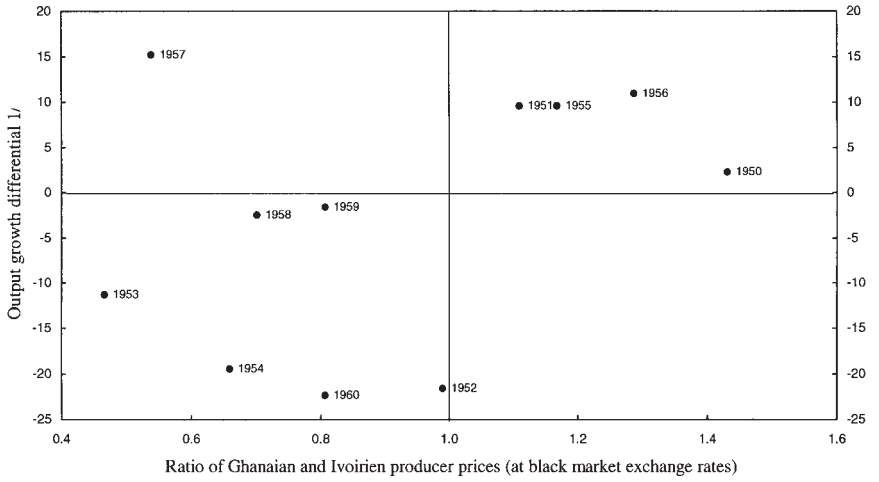
[6] Even a complete planting shutdown is not likely to generate the observed halving of official cocoa output. First, cocoa trees bear fruits long after their prime productive age. Secondly, the cyclically high international prices in the late 1950s and early 1960s spurred plantings of trees, most of which were in their prime in the 1970s and early 1980s.

[7] The literature provides no direct evidence regarding observed smuggling. All estimates of smuggling are based on indirect evidence (for a review see Stryker *et al.*, 1990).

[8] Numerically, for every percentage point of the Ghanaian–Ivoirien producer price differential above (below) unity, the cocoa output in Ghana grew faster (slower) than that of Côte d'Ivoire by some 0.3 percentage points.

[9] See Leite *et al.* (2001) for a summary of recent developments.

Figure 3: *Ghana and Côte d'Ivoire — Cocoa Producer Prices and Output, 1950–60*



[1]A simple difference between official Ghanaian and Ivoirien cocoa output growth rates, in percentage points.

3. Taxation of Cocoa in Ghana

Cocoa has traditionally been taxed by the government's collecting the difference between the expected international price and the cost of marketing the crop, which consists primarily of payments to farmers and the COCOBOD's operating expenses. Producer prices, which are set at the beginning of each crop season, have been set so as to stabilise the domestic environment and maximise the cocoa duty yield. But, as evidence suggests, the pricing mechanism achieved neither stability of domestic producer prices nor stability of domestic fiscal revenues. Regarding the former, Ghana depleted reserves accumulated in the COCOBOD-operated reserve fund in the early 1960s, and the fund was effectively abolished soon thereafter. Regarding the latter, rather than being driven by an optimal tax argument,[10] cocoa taxation was geared toward maximising short-term fiscal gains — a feature of Ghanaian

[10] In principle, the optimal short-run export tax is simply a function of the world elasticity of demand and the country's share in world production. In the long run, the optimal export tax should also take into account the impact of new international prices on other producers and the speed with which this affects planting and production.

Table 2: *Projected and Actual Macroeconomic Developments, 1992/3–1994/5*[a]

	Inflation (%)		Exchange rate (cedis per US dollar)		Rural wage (cedis per day)		International price (Fob)[b]	
	Projection	Actual	Projection	Actual	Projection	Actual	Projection	Actual
1992/3	10.0	11.5	400	584	770	1,000	1,100	957
1993/4	8.0	25.0	650	882	1,080	1,500	950	1,235
1994/5	22.0	24.9	1,055	1,022	1,830	2,500	1,300	1,450

Source: Cocoa Marketing Board.
[a]Crop year runs from October to September.
[b]US dollars per metric ton.

policies that Frimpong-Ansah (1991) appropriately called 'the vampire state'.

The past assumptions used to calculate producer prices were unrealistic, rendering the estimates of the farmers' share of the export price irrelevant. For example, the 1983 average black market exchange rate was ~80 cedis per US dollar, and the so-called effective rate used for official transactions was only 2.75 cedis per US dollar (*World Currency Yearbook*, 1986). Even in the 1990s, the deviation between the macroeconomic projections, which are used to fix the producer price, and the actual outcomes has been relatively high, and usually in favour of the government and against farmers (Table 2). Specifically, the farmers' share in real terms has been eroded by the faster-than-expected depreciation of the cedi and by higher-than-expected inflation. Although farmers were *ex post* compensated for those deviations, in 1992–5, according to COCOBOD information, the value of compensations was less than the actual loss.[11]

The issues of an optimal long-run producer price, the level of taxation and the efficiency of the COCOBOD have been intertwined in Ghana for decades (see, for example, Bateman *et al.*, 1990). For most of the post-independence period, producer prices in Ghana were ~30–50%

[11] The compensation mechanism was activated when the actual forward international price at the moment of the trade was higher than the expected price that had been used earlier to compute the producer price. The aim of the mechanism is to defend the originally stipulated share of farmers in export proceeds. As a result, the government's share could shrink if the actual international price was less than expected.

of the international price and often lower than what is estimated to be the break-even point of the long-run planting cost (Stryker *et al.*, 1990). Moreover, the producer–international price ratio was below the levels prevailing in the other cocoa-producing countries: producer prices in Brazil and Malaysia, and — up to 1993 — in Cameroon and Côte d'Ivoire, averaged 60–80% of international prices.[12]

It is well known that commodity taxes affect the marginal rate of return more than their more complex alternatives, e.g. profit tax.[13] It has been argued, however, that the efficiency losses arising from export taxes may be limited if production is relatively inelastic with respect to price, that is, if the supply of rural labour is perfectly elastic and it is possible to switch only a small amount of production away from cocoa. In Ghana, however, the empirical work presented below provides little or no evidence of price inelasticity in the long run. Anecdotal evidence offers some explanations of why this might be the case: Tabatabai (1986) found that 1–2 million rural workers migrated from Ghana in the 1970s; Konings (1986) argued that in the 1970s cocoa farmers in certain regions shifted their lots from cocoa production to food crops, which suffered much smaller real price deterioration than cocoa; May (1985) found significant exchange-rate incentives for smuggling in the 1965–80 period; and Shively (1996) provided some evidence that black market exchange rate movements may have explained maize price volatility.

4. Empirical Analysis of the Cocoa Supply in Ghana

A number of econometric analyses of cocoa supply and demand functions for Ghana have been undertaken since the 1960s. However, most of the research to date suffers from the problems associated with the estimation of nonstationary time series and the arbitrary selection of lag structures; accordingly, these models have been unable to explain the massive decline in official output. After a brief review of the previous results, a model of cocoa output is described and estimated that, using a simple error-correction technique for the sample period 1957–95, invokes smuggling to other countries to explain the shortfall of cocoa supply *vis-à-vis* its potential output. Smuggling, which cannot

[12] Côte d'Ivoire, for example, has fixed the producer price in nominal terms well above the long-term planting cost; occasionally, when the international price has been low, it has repealed the tax altogether.
[13] For a further discussion of cocoa taxation in Ghana, see Bateman *et al.* (1990).

be observed directly, in this context really means two things: selling Ghana-produced cocoa across the border and non-collection of cocoa.

4.1 Research to Date

The studies can be divided into three broad groups. First, some studies model the supply of cocoa as a 'technological' function of the stock of cocoa trees and fertilisation efforts. The resulting long-run or technological capacity function is usually accompanied by a short-run function that takes into account price and weather shocks. Secondly, a traditional partial-adjustment supply model has been used with properly defined own and cross elasticities of domestic producer prices. Finally, a few studies have estimated the supply response of cocoa to changes in producer prices in neighbouring countries. These studies have generally found that smuggling explains supply fluctuations better than most other variables.

Important contributions to the first group (technological capacity models) have been made by Bateman (1974). As a first step, he estimated a long-run production capacity equation for Ghana based on tree yields and several variables measuring the chemical spraying of cocoa trees that had a built-in ratchet effect (Bateman, 1974). As a second step, his short-run supply function included the previously estimated production capacity, real producer prices and three rainfall variables. Both equations were estimated separately for the three major cocoa-producing regions in Ghana, and the short-term price elasticities of supply were found to be of a similar magnitude, ranging from 0.14 to 0.22. These results were later replicated (Bateman *et al.*, 1990). Another example of the technology-driven approach to estimating the supply of cocoa is that of Gyimah-Brempong (1987).

There are three problems with this approach. First, data on new plantings are scarce and unreliable — satellite pictures have shown larger areas under cocoa cultivation than previously reported by the COCOBOD (Stryker *et al.*, 1990). Secondly, combining the separately estimated long- and short-run output functions might cause serious identification problems when estimating by ordinary least squares (see Wilson, 1984). Thirdly, the estimates seem unable to explain the medium-term persistence of official output above or below its capacity level (the so-called missing cocoa supply).

The second and largest group of empirical studies has relied on the traditional partial-adjustment model using several domestically deter-

mined explanatory variables (see, for example, Abbey and Clark, 1974; Yeung *et al.*, 1979; Berthelemy and Morrisson, 1987; Stryker *et al.*, 1990). In these studies, the estimated equations and the results of those estimates are similar. As a representative example, Stryker *et al.* regressed official output on its lagged value, an estimate of cocoa production capacity, producer prices of cocoa and producer prices of competing food crops. The estimated own short- and long-run producer price elasticities were 0.22 and 0.62, respectively, and the cross-price elasticities were poorly estimated, at –0.14 and –0.40, respectively. In addition, some authors have included the supply of manufactured goods to capture the impact of goods market rationing on the farmers' motivation to produce.[14]

The problems with this approach — as with the technological capacity models — are threefold. First, the inability of farmers to substitute for cocoa in the short run explains the small absolute size or poor statistical significance of short-term cross-price elasticities in many time-series studies (Wilson, 1984; Stryker *et al.*, 1990) and one recent cross-section study (Hattink *et al.*, 1998). Secondly, the partial adjustment model used in most estimates leads to spurious regressions if the data are nonstationary. This problem has been corrected by Abdulai and Rieder (1995), who applied co-integration and error-correction techniques to the previously described model. Thirdly, and most important, the models are still unable to explain the missing cocoa supply. For example, in the Stryker model the actual output was on average lower by 16% than the potential production in 1965–75, and the average gap rose to 32% (!) in the next decade.

The third group of authors has focused on the price incentive to smuggle to explain why the officially recorded cocoa output stayed for several years above or below its estimated production capacity.[15]

[14] See Bevan *et al.* (1989). Arguments put forward by Abdulai and Rieder (1995), however, raise some doubts about the meaning of this variable. Why would farmers revert to subsistence production or smuggling in order to obtain goods rationed in Ghana? Would it not be easier to produce cocoa, exchange the export proceeds into dollars and smuggle goods, as suggested by Azam and Besley (1989)? Both the supply of manufactured goods and cocoa output might be driven by overall macroeconomic conditions. A real exchange rate appreciation affects manufacturing as well, even though its impact, through the availability of foreign exchange for imported inputs, may be slower than its impact on agricultural exports.

[15] See Sheikh (1989) for a summary of the existing models of smuggling. See also Younger (1992) analysis of the impact of the official exchange rate on black market developments.

These authors realised that cocoa is a cash crop that can be easily smuggled, because the borders with Côte d'Ivoire and Togo are practically unguarded. As early as in 1982, Akiyama and Duncan regressed official output on real prices (both in first-order differences) and a rainfall variable; in addition, their equation included three variables lagged one year: cocoa output, real producer prices, and the Ghana-Côte d'Ivoire price differential (all in levels).[16] Both short- and long-run domestic producer price elasticities were low and statistically insignificant. However, their model has shown the strong impact of price developments in Côte d'Ivoire: raising the price differential by 1% lowered the Ghanaian supply of cocoa by 0.25%. In other words, official sales to the COCOBOD may have been affected by smuggling rather than by changes in cocoa production. These findings have been confirmed by Fosu (1992), who estimated the short-term elasticity of Ghana's cocoa exports with respect to the Ghana-Côte d'Ivoire price differential to be ~0.17.[17] May (1985), in estimating the regional motivation to smuggle cocoa to neighbouring countries, found that as much as 50% of the crop in some regions may have been smuggled into either Côte d'Ivoire or Togo. As a result, he found that virtually all new cocoa plantings in Ghana in the 1970s and 1980s were made in areas adjacent to Côte d'Ivoire and Togo in order to minimise the cost of transporting the smuggled cocoa. Azam and Besley (1989) formulated and tested a general equilibrium model of Ghana's economy that features parallel foreign exchange and consumer good markets, and cocoa smuggling.

4.2 Determinants of Cocoa Supply in Ghana

In the long run, cocoa production is a function of relative prices, even though short-term production capacity is constrained and official output may fluctuate because of weather conditions, fertiliser availability, distortionary policies of the government and so on. Relative prices signal changes in the expected return on cocoa *vis-à-vis* competing activities. Therefore, they affect plantings, input purchases and harvesting efforts, as well as farmers' decisions to sell domestically or to smuggle.

[16] This is effectively an error-correction mechanism. An unrestricted estimation using ordinary least squares, however, is not the proper way to proceed (see Charemza and Deadman, 1992).

[17] The objection to the estimation of nonstationary time series applies to Fosu (1992), too.

The farmers' decision-making problem can be simplified into two steps. First, from the long-term perspective, farmers decide whether the expected return covers their long-run planting and maintenance cost. Depending on the answer, they would either uphold (or expand) the area under cultivation or contract the area and switch output. Secondly, from the short-term perspective, they decide whether the current producer prices in Ghana and neighbouring countries are sufficient to cover their harvesting cost and expected profit. If the answer is positive, depending on the price differential, farmers either sell cocoa to the COCOBOD or smuggle it. If the answer is negative for all possible producer prices, farmers will not harvest.[18] In other words, a high estimate of the impact of the differential between Ghanaian and Ivoirien producer prices does not necessarily imply that all cocoa was smuggled — that would probably be technically impossible. The actual impact would be split between smuggling and non-collection of the crop.

Which prices are most important for the long- and short-run decisions? This study measures the price incentives by three variables: the real international price, the real producer price, and the differential between Ghanaian and Ivoirien producer prices in US dollar terms (Figure 2). Given the earlier described construction of domestic producer prices as a derivative of international prices, I expect the long-term, expected-return information content to be much stronger in the international price. Similarly, the impact of Ivoirien producer prices is likely to take place in the medium to long term: the process of gathering information on foreign producer prices, expected exchange rates, transaction and transportation costs is likely to be high for one-time or small-scale smugglers, but can be relatively low for 'career smugglers'. As any market, this one also requires some credibility: buyers must have sufficient guarantees that farmers will deliver cocoa of adequate quality and farmers must believe that buyers will pay as agreed and on time.[19] I will test whether these stylised facts fit the data in Section 4.3.

[18] This may be a too strong conclusion. It is possible that small, liquidity-constrained farmers would harvest even with negative profits, because cocoa is their only cash crop. Large-scale farmers tend to be much less liquidity constrained, in part owing to their diversification into other cash crops, such as pineapple.

[19] The short-run effect of the smuggling incentive may be further complicated by the existence of a reservation producer price: once the domestic producer price exceeds farmers' short-run cost plus expected profit, farmers may automatically sell to COCOBOD.

The null hypotheses behind these three relative prices are as follows. First, the real international price (US dollar price converted at the official exchange rate and deflated by the CPI) is expected to convey information about secular and cyclical price developments, and to signal the expected return on cocoa production. Therefore, an increase in real international prices should lead to an increase in planting and, with a lag, production capacity. Over time, in the absence of distortionary government policies, producer prices will mirror international prices, and the latter can therefore be treated as an expectation of the former.

Secondly, the real producer price measures the rate of return of farming cocoa relative to other crops, e.g. maize or rice, and alternative, nonfarming activities, the prices of all of which move in tandem with the CPI or food price index (Figure 2).[20] Hence, the increase in real producer prices should lead to a short-run increase in official output. The cross-price effect of CPI or food price index changes should not be very strong, because cocoa, as the unique cash crop, does not have close short-run substitutes for farmers, either agricultural or nonagricultural.[21] Moreover, Bateman (1974) noted that until the early 1960s producer prices were 'ineffectively' high, that is, well above the long-term planting cost. Such a high price resulted primarily in windfall profits, rather than in more output or bigger planting efforts. As a result, the information value of international prices for the expected return on cocoa was limited. Producer prices exceeded international prices again in 1981–3. During this period, however, the COCOBOD's payments were effected in the official exchange rate, which was 10–20 times higher that black market exchange rates. For these reasons, I focus on the post-independence period and make adjustments for the 1981–3 period (see below).

Finally, the ratio of Ghanaian to Ivoirien producer prices, called the

[20] We find that the CPI is a good proxy for the price of the alternative crops: maize and rice. This is partly tautological — maize and rice are significant components of the CPI. Indeed, it is easy to show that the maize and rice price indices, as well as the food price index, unlike the cocoa price index, have been centred around the CPI. Incidentally, cocoa producer prices deflated by the food price index have been substantially lower than those deflated by the CPI only during the 1987–94 period, i.e. when official cocoa output began to recover. See also Alderman and Shively (1996) for a discussion of food price trends in Ghana.

[21] Our results remain unaffected if the food price index is used instead of the CPI: I found identical long-run, co-integrating results and marginally less statistically significant results in the short-term dynamics.

smuggling incentive, measures the rate of return on cocoa sold domestically compared with that of cocoa smuggled to Côte d'Ivoire. Closing the gap between neighbouring countries' producer prices should also increase short-run official output.[22]

A few words about the construction of price series. Both producer and international prices were deflated by the CPI. International prices were converted into cedis at the official exchange rate because this rate was used by the COCOBOD to calculate producer prices. The Ghana-Côte d'Ivoire price differential, however, was computed using the black market exchange rate from the *World Currency Yearbook* for the period before the exchange rate liberalisation in the mid-1980s and the foreign exchange bureaux' rate for the period afterward: if farmers smuggle cocoa to Côte d'Ivoire or Togo, they are paid in CFA francs, which they exchange into cedis at the parallel market rate.

4.3 Empirical Results

This study uses data from various sources. For the pre-1960 Ivoirien producer prices, I used data from Berg (1964); for the pre-1990 observations of output (measured in actual tonnage) and domestic and international prices, time series published by Stryker *et al.* (1990); and for the 1960–82 observations of the Ghana-Côte d'Ivoire price differential, data from May (1985). For subsequent observations, I used data published by the IMF (1996) and the *World Currency Yearbook*. However, the collapse of international prices in 1980–2 and the devaluation of the cedi in 1983 generated a potential measurement problem. In this model, international prices operate as an expectation of domestic prices, and those expectations obviously did not decline six times in real terms between 1979 and 1982. To correct for the 1980–2 'outliers', in the regressions presented below I replaced these observations by a Hodrick–Prescott filter. In any case, the measurement problem did not seem to affect the estimated coefficients. Whether I used raw international prices, raw data with 1980–3 observations replaced by a Hodrick–Prescott filter or the complete international price series filtered by a Hodrick–Prescott filter, the estimates were little affected.[23]

[22] In the pre-ERP period, Ghanaian farmers were motivated to smuggle cocoa both by higher producer prices (relative to international prices) in Côte d'Ivoire and Togo and by the overvalued official exchange rate. During the ERP period, when exchange rates were liberalised, the main motivation to smuggle came from lower domestic producer prices (higher cocoa export duty).

[23] The only discernible effect was a marginally faster speed of adjustment to the

Table 3: *Unit Root Tests, 1957–95*[a]

Null hypothesis of variable nonstationarity	Variable			
	Cocoa supply	Producer price	International price	Smuggling incentive
Levels	–2.14 (0.83)	–2.26 (0.88)	–3.20 (0.70)	–1.94 (0.70)
First differences	–5.17* (–0.32)	–5.84* (–0.39)	–4.07* (0.14)	–3.89* (–0.20)

Source: Author's calculations.
[a]Augmented Dickey–Fuller test with one lag and the estimated coefficient on the lagged variable in the Dickey–Fuller equation (in parentheses). *The rejection of a unit root at the 1% level.

Integration

Before modelling time series, it is useful to determine the orders of integration for the variables considered (all variables, except for the Ghana-Côte d'Ivoire price differential, are in natural logarithms). Table 3 lists first-order augmented Dickey–Fuller statistics for official output, producer and international prices, and the smuggling incentive for the post-independence period. The estimated root appears next to each augmented Dickey–Fuller statistic; this number should be close to one if the series has a unit root. Unit root tests are given for each variable in levels and for their first differences, and this permits testing whether a given series is I(0) or I(1), respectively.

Empirically, all variables seem to be integrated of order one, that is, the null hypothesis variable stationarity, I(0), can be rejected at the 95% confidence level. Moreover, the estimated roots for individual variables are all numerically quite close to unity, and also visual evaluation (Figure 2) suggests that the series may have a unit root. Thus, all four series are treated below as I(1).

Co-integration and Granger Causality

Co-integration analysis helps clarify the long-run relationship between

changes in the long-run equilibrium if the raw international price series was replaced with a Hodrick–Prescott filter.

Table 4. *Test Statistics for Selecting the Order of the VAR*

Order of the VAR	Akaike information criterion	Schwarz Bayesian criterion
4	7.58	–22.82
3	10.94	–11.86
2	14.86	–0.33
1	16.36	8.76
0	–156.62	–156.62

Source: Author's calculations.

variables integrated of order one. Two co-integrating relationships were tested: the international–domestic price pass-through and the long-run cocoa supply functions. I employed the maximum likelihood procedure for finite-order vector autoregressions (VARs) developed by Johansen and Juselius (1990). Empirically, the lag of the VAR is not known a priori, but has to be established. Estimating an unrestricted VAR with output, international and producer prices, and the smuggling incentive, both the Akaike and Schwarz criteria point to a first-order specification (Table 4).

First, the paper hypothesises that domestic producer prices follow the international cocoa price developments.[24] To test this hypothesis, I investigate the existence of a long-run relationship between international and domestic producer prices, namely the co-integrating relationship and the direction of Granger causality. I find that the two variables are co-integrated in one co-integrating vector and that international prices are Granger prior to producer prices (Table 5). The hypothesis of producer prices Granger causing international prices is rejected both for 1957–95 and 1975–95.[25] I show the regression results only for the post-independence period because, as reported in the literature, the pre-independence producer prices were held artifi-

[24] We also tested the hypothesis whether Ghana's output may have Granger-caused international cocoa prices. The existence of a co-integrating vector was comfortably rejected and no unidirectional Granger causality could be identified for any of the periods under consideration.

[25] No statistically significant unidirectional Granger causality is detected for the first half of the sample period (1950–70).

Table 5. *Co-integration and Granger Causality Tests for International and Producer Prices (Regressions with One Lag, Unrestricted Intercepts and No Trends in the VAR)*

1. Co-integration test[a]						
Test statistics for	a unique vector			two vectors		
Maximal eigenvalue	16.67**	(14.88)	[12.98]	3.35	(8.07)	[6.50]
Trace	20.01**	(17.86)	[15.75]	3.35	(8.07)	[6.50]
2. Granger causality tests[b]	1958–95			1975–95		
(i) Producer prices Granger cause international prices	0.257			0.518		
(ii) International prices Granger cause producer prices	0.002			0.000		

[a]Critical values for likelihood ratio tests at the 5% and 10% significance level in parentheses and brackets, respectively. * and ** indicate significance at the 10 and 5% level, respectively.
[b]Marginal significance levels for the hypothesis that the lagged explanatory variables are different from zero.

cially high, much above the international prices, with the help of the COCOBOD-administered price stabilisation fund.

Secondly, I establish a long-run relationship between official output and various measures of real prices. I first estimate the co-integrating vector with all four variables, namely output, international and domestic prices, and the smuggling incentive:

$$\text{supply} = \beta_1 \text{ international price} + \beta_2 \text{ producer price} + \beta_3 \text{ smuggling incentive} + \alpha. \quad (1)$$

Both the eigenvalue and the trace tests are statistically insignificant at the 5% level, but would pass the test at the 10% level (Table 6, upper panel). However, the normalised estimate of the parameter of producer prices is negative, albeit significant, i.e. higher domestic prices signal lower output. Hence, I reject the hypothesis that producer prices, deflated either by the CPI or by the food price index, are a part of the co-integrating relationship.[26]

[26] The results based on the food price index are available upon demand.

Table 6. *Co-integration Tests, 1958–95 (Regressions with One Lag, Unrestricted Intercepts and No Trends in the VAR; Standard Errors in Parentheses)*

(i) Full model

supply = 0.780 international price – 0.897 producer price + 0.927 smuggling incentive
(0.27) (0.32) (0.34)

Test statistics for[a]	a unique vector			two vectors		
Maximal eigenvalue	26.26*	(27.42)	[24.99]	11.89	(21.12)	[19.02]
Trace	47.38*	(48.88)	[45.70]	21.11	(31.54)	[28.78]

(ii) Model without producer prices

supply = 0.525 international price + 0.628 smuggling incentive
(0.16) (0.17)

Test statistics for[a]	a unique vector			two vectors		
Maximal eigenvalue	21.08*	(21.12)	[19.02]	6.29	(14.88)	[12.98]
Trace	32.62**	(31.54)	[28.78]	11.54	(17.86)	[15.75]

Source: Staff calculations.
[a]Critical values for likelihood ratio tests at the 5% and 10% significance level in parentheses and brackets, respectively. * and ** indicate significance at the 10 and 5% level, respectively.

I then narrow the co-integrating vector to three series: output, international prices and the smuggling incentive (Table 6, lower panel). The maximal eigenvalue test of this specification narrowly misses the 5% significance level, but it passes the trace test. Parameters for both the international prices and the smuggling prices are statistically significant and have the expected signs. Moreover, these parameters are analogous to those in earlier studies: the normalised elasticity and semielasticity of supply with respect to the international price and to the Ghana–Côte d'Ivoire price differential are ~0.5 and 0.6. These findings seem to support the earlier discussed hypotheses that the information content of the international price dominates that of the producer price and that other crops are not long-run substitutes for cocoa production. In the next section, I will use these results to formulate an error-correction model of cocoa supply.

A Single-equation Model of Cocoa Supply

This section presents the estimation results for a parsimonious single-equation model of cocoa output, with the error-correction term embedded. Because international prices are used as a proxy for expectations of domestic producer prices, the former do not enter the short-run portion of the error-correction model (first row of equation 2); correspondingly, domestic producer prices do not enter the long-run portion of the model (second row of equation 2). The general equation with a choice of lags was specified as follows:

$$\begin{aligned}(2)\quad \Delta\text{Supply}_t &= \alpha + \sum_{i=0}^{2}\beta_{1i}\Delta\text{Producer price}_{t-i} + \sum_{i=0}^{2}\beta_{2i}\text{Smuggling incentive}_{t-i} \\ &\quad + \gamma(\text{Supply}_{t-1} - \delta_1\text{International price}_{t-1} - \delta_2\text{Smuggling incentive}_{t-1}) + \varepsilon_t\end{aligned}$$

where γ is the parameter of the error-correction term, which captures the speed of adjustment to disequilibrium conditions; Δ is a first-difference operator; and ε is an error term.

The feed-through of the previous period's departures from long-run equilibrium into current-period output developments is based on the notion that cocoa output does not adjust instantaneously to the desired levels consistent with the international price and the Ghana–Côte d'Ivoire price differential. One reason for this partial adjustment is the cost of gathering information on international and Ivoirien producer prices, and expected exchange rates. Uncertainty about the transaction and transportation costs of smuggling would be a second reason.[27] Finally, new plantings — as well as switching output from cocoa to other crops, and vice versa — are time consuming and costly.

The general equation (2) was simplified — using the Akaike and Schwartz criteria — to a version in which only current changes in producer prices matter for short-term output decisions (Table 7, equation B). The results correspond both to a priori economic assumptions and to the previously estimated co-integrating relationship: the long-run elasticity and semielasticity of output with respect to the international price and to the Ghana-Côte d'Ivoire price differential are both ~0.6. The speed of adjustment to long-run price changes, as measured by the coefficient of the error-correction term, suggests that about one-third

[27] For example, in the early 1980s, the Ghanaian government attempted, albeit unsuccessfully, to close the borders with Côte d'Ivoire and Togo.

of the deviation from the long-run equilibrium in the previous year translates into the current supply decisions made by farmers.[28] As found in previous studies, the short-run producer price elasticity is about one-quarter, and significant at the 5% significance level. The short-run semielasticity of the Ghana–Côte d'Ivoire price differential is statistically insignificant, confirming the medium-term character of decisions regarding of smuggling or crop collection.

The error-correction model confirms that price incentives, stimulated mostly by the Ghana–Côte d'Ivoire price differential, played an important role in the two adjacent markets. The sharp increase in the smuggling incentive in the 1970s — from 0.7 to 0.3, or by 130% — would have reduced the officially recorded supply of cocoa by some 40,000–60,000 metric tons. In other words, smuggling (or crop non-collection) might explain as much as half of the output decline *vis-à-vis* the potential (or trend) output.

Two tentative conclusions regarding short-term cocoa output substitution and smuggling can be made. First, given the absolute value of the Ghana–Côte d'Ivoire price differential, any further decline in the real domestic producer price motivates Ghanaian farmers to increase the amount of cocoa smuggled (or not to collect the crop at all if both the Ghanaian and Ivoirien producer prices are below the short-term harvesting cost and transportation cost). Although output of food crops cannot be quickly substituted for that of cocoa, farmers can change their work/leisure ratio. Secondly, smuggling appears to be costly in the short run as farmers must gather information and enter into across-the-border contracts that lack reputation: the post-1960 short-run variations in output do not seem proportional to the Ghana-Côte d'Ivoire price differential. In other words, smuggling and crop non-collection seem to be based on long-term decisions rather than on immediate price signals.

4.4 Simulated Medium-term Effects of Producer Price Changes on Government Revenue

I used the estimated model presented in Table 7, equation B to examine whether the expected initial positive effect of lower producer prices on

[28] Although this speed of adjustment is less than that reported by Akiyama and Duncan (1982), their estimate is probably biased because an incorrect estimation technique was used.

Table 7. *Cocoa Supply Regression Results, 1957–95*[a] *(Absolute Value t-statistics in Parentheses)*

Variable	Equation A	Equation B
Short–run dynamics		
Constant	0.682 (1.26)	0.680 (1.27)
Producer price, first difference	0.224 (2.03)*	0.223 (2.05)*
Smuggling incentive, first difference	0.074 (0.61),	
Error correction term	–0.358 (3.65)*	–0.364 (3.77)*
Long–run equilibrium relationship		
International price, lagged once	0.600 (3.04)*	0.611 (3.16)*
Smuggling incentive, lagged once	0.602 (2.56)*	0.566 (2.57)*
R^2	0.475	0.470
Adjusted R^2	0.394	0.405
Durbin–Watson	2.430	2.382
S.E. of regression	0.143	0.141
RESET $\chi(1)$	1.033	0.492
Heteroscedasticity $\chi(1)$	0.690	0.379
ARCH $\chi(1)$	0.612	1.089

Source: Author's calculations.
*Significant at the 5% level.

government revenue can be sustained.[29] The results show that lower producer prices will only temporarily boost government revenue. Consider a situation in which the Ghanaian producer price is unexpectedly lowered, *ceteris paribus*, by 10% to increase government revenue from cocoa export duty. How will the consequent changes in the supply of cocoa be distributed over time? In the first year, official output will drop by ~2–3%, owing to the lower producer price; inputs will be switched to other crops, cocoa crops yielding submarginal

[29] I constrain my simulations to the medium term in order to avoid modelling international price effects on the potential output. In the long run, a much bigger Ghanaian contribution to the world supply of cocoa is likely to depress international prices. See Weymar (1968) for an introduction to the determination of cocoa international prices.

returns will not be harvested or some cocoa will be smuggled. Hence, government revenue will increase by 5–6% only. In the second year, farmers will adjust their long-run equilibrium supply downward by 30–40% of the initial disequilibrium and official output will drop by another 3–4 percentage points. The revenue effect of lower producer prices will thus be entirely dissipated in 2–3 years; after that, government revenue will decline from its initial level as official output continues to drop.

5. Conclusions

Multiple effects were at play in the decline of Ghana's share in world cocoa output between the early 1960s and the early 1980s. Nevertheless, the most important factor adversely affecting the cocoa sector was the government's policies: in the late 1960s and in the 1970s, the effective cocoa duty rates were punitive, and the overvalued exchange rate further hurt the cocoa sector. Most of these policy mistakes have been rectified in the 1990s.

The government has traditionally taxed cocoa by retaining export proceeds at COCOBOD and by paying farmers a preset price in domestic currency. On the one hand, this practice helped to insulate domestic producers from short-term fluctuations in the international cocoa price, and the cocoa export duty remained an administratively simple and quantitatively important source of fiscal revenue. On the other hand, excessive explicit and implicit taxes on cocoa led to the smuggling of cocoa abroad.

The paper argues that international prices and the price incentive to smuggle (the Ghana–Côte d'Ivoire price differential) can explain more of these fluctuations than any other variable. A simple model of cocoa supply determination is described and estimated, using the co-integration and error-correction techniques for the sample period 1950–95. The speed of adjustment to long-run price changes is high: more than one-third of the deviation from the long-run equilibrium in the previous year translates into the current supply decisions made by farmers. Smuggling or crop non-collection might have reduced the officially recorded output of cocoa by 40,000–60,000 metric tons, that is, about one-half of the observed decline in output in the 1970s. I find, however, little evidence of domestic short-term substitution between cocoa and other crops.

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