International Coffee Organization
Organización Internacional del Café
Organização Internacional do Café
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Cyclical patterns in the supply of coffee

Background

In the context of the programme of activities approved by the Council in May 2002 (document EB-3817/02) the Organization pays particular attention to problems related to production patterns which are, in part, responsible for price instability. This report aims to analyse cycles in the behaviour of production.

Action

The Executive Board is requested to note this document.

1. Inasmuch as the behaviour of supply is the main source of price instability, it is a subject of major concern to the world coffee market. Supply varies from one crop year to the next as a result of the unstable nature of production, which is influenced by a wide variety of factors, including some linked to cyclical phenomena. This study aims to investigate factors related to cyclical behaviour in world coffee production. It should be borne in mind that the proper management of supply calls for cyclical patterns in world coffee production to be identified and taken into account. Moreover, if the supply of coffee is indeed subject to cycles, it is necessary to determine their frequency and amplitude. In the methodology used for this purpose the first stage involves observation of production changes from one crop year to the next in order to confirm or dismiss the presence of cycles in the pattern both of world coffee production and of individual countries. The next stage involves the use of statistical methods to test for evidence of cycles. The following points will be covered:

I. Observation of world coffee production patterns
II. Evidence of cyclical patterns based on statistical methods

I. Observation of world coffee production patterns

A. Steady growth in production

2. Visual observation of the production structure since crop year 1965/66 indicates that there has been a steady upward trend in the growth rate interrupted by periodic falls. Graph 1 illustrates this trend, which gives some signs of the presence of cyclical patterns with varying periods and amplitudes (see Annex I). Graph 1 also shows world production excluding Brazil. The data indicates that world production of coffee has experienced steady growth interrupted by periodic falls. Moreover, periods of rapid growth have alternated with periods of decline or stagnation. Falls in overall production are rare since the general pattern observed is one of rapid growth or slackening in the volume of production. During sixteen consecutive crop years from 1965/66 to 1980/81 production levels varied from around 60 to 80 million bags. After this period production ranged between 80 and 100 million bags and has remained at levels of over 100 million bags since crop year 1998/99. In the 1960's and 1970's average production was 69 million bags rising to 88 million bags in the 1980's. Since the 1990's production has been increasing sharply, averaging 101.2 million bags per crop year.

3. Regional production is shown in Graphs 2 to 6 (see Annex I).

B. Irregular sequences in production patterns

4. The production pattern is generally characterized by a marked instability, with an alternation between an increase in one crop year and a decrease in the next. Instability is understood here as a series of inter-annual fluctuations, producing a rapid succession of

production surpluses and shortfalls and creating considerable uncertainty as to the short and medium term behaviour of the market. Table 1 below shows changes in world and Brazilian production.

Table 1: Changes in world and Brazilian production: 1965/66 to 2002/03

Crop year	World	World-Brazil	Brazil	Crop year	World	World-Brazil	Brazil
1966/67	-26.62%	-6.11%	-48.91%	**1985/86**	7.36%	-4.02%	40.62%
1967/68	18.51%	15.12%	25.27%	**1986/87**	-9.95%	10.27%	-50.31%
1968/69	-12.99%	-5.35%	-27.01%	**1987/88**	32.91%	-2.02%	187.57%
1969/70	7.02%	8.63%	3.16%	**1988/89**	-17.10%	2.50%	-46.67%
1970/71	-11.11%	2.20%	-44.49%	**1989/90**	5.22%	4.61%	-6.99%
1971/72	31.42%	-0.86%	180.35%	**1990/91**	-0.88%	-5.31%	-11.32%
1972/73	4.24%	10.94%	-6.68%	**1991/92**	8.96%	12.85%	-0.09%
1973/74	-18.64%	-7.55%	-40.14%	**1992/93**	-12.62%	-15.47%	-4.85%
1974/75	23.73%	9.62%	66.02%	**1993/94**	1.10%	0.25%	3.14%
1975/76	-10.50%	-7.34%	-16.75%	**1994/95**	6.29%	4.36%	10.83%
1976/77	-17.44%	6.58%	-70.31%	**1995/96**	-9.78%	6.94%	-46.83%
1977/78	16.71%	1.00%	140.82%	**1996/97**	19.40%	6.87%	75.27%
1978/79	15.48%	11.12%	29.94%	**1997/98**	-6.20%	-1.96%	-17.74%
1979/80	0.57%	0.02%	2.12%	**1998/99**	10.21%	-2.64%	-51.81%
1980/81	0.39%	7.28%	-18.73%	**1999/00**	8.13%	15.12%	-6.37%
1981/82	24.49%	3.77%	100.42%	**2000/01**	-2.69%	-3.57%	-0.44%
1982/83	-15.73%	0.20%	-45.96%	**2001/02**	-1.56%	-4.82%	6.51%
1983/84	5.41%	-7.19%	49.72%	**2002/03**	8.33%	-5.00%	37.80%
1984/85	-5.91%	2.27%	-23.73%				

5. The figures in the above table show that during the period covered world production fell significantly in 13 crop years, namely:

Crop year	World	Brazil
1966/67	-26.62%	-48.91%
1968/69	-12.99%	-27.01%
1970/71	-11.11%	-44.49%
1972/73	+4.24%	-6.68%
1973/74	-18.64%	-40.14%
1975/76	-10.50%	-16.75%
1976/77	-17.44%	-70.31%
1980/81	+0.39%	-18.73%
1982/83	-15.73%	-45.96%
1984/85	-5.91%	-23.73%
1986/87	-9.95%	-50.31%
1988/89	-17.10%	-46.67%
1992/93	-12.62%	-4.85%
1995/96	-9.78%	-46.83%
1997/98	-6.20%	-17.73%
1999/00	+8.13%	-6.65%

6. Graph 7 shows annual changes in world production and graphs 8 to 11 show annual changes in regional production (see Annex I).

7. Table 1 indicates that, with the exception of crop years 1975/76 and 1976/77 which recorded consecutive falls, the period as a whole witnessed a decline followed by one or more periods of growth, confirming that falls in production are rare and of short duration whereas increases can extend over a number of years. Increases were recorded in five consecutive crop years from 1977/78 to 1981/82. During this period, however, Brazil recorded a significant fall in production in crop year 1980/81. Brazil, which is by far the world's leading producer with around 40% of total world production in 2002/03, can sometimes be affected by adverse weather conditions (frosts and droughts) entailing exceptional cases of sharp falls in production. In the case of Brazil, it is also evident that, for agronomical reasons, a bumper crop is usually followed by a sharp fall in production in the next crop year. The crop of 38.7 million bags in 1965/66 was followed by a much smaller crop, representing a fall of 48.91% in production for 1966/67. Production in 1988/89 was down by 46.7% in relation to the crop of 43 million bags in 1987/88. On the basis of this pattern, we can expect a significant fall in crop year 2003/04 following the bumper crop of 2002/03 (around 47.3 million bags).

8. Graph 8 shows that the changes in Brazilian production reflect a sequence of around two years of upward and downward movements in production (see Annex I). In recent years, however, this pattern seems to be changing. In the past, frosts had a very serious effect on production. This threat has become less significant as production moves away from the country's southern regions, which are more vulnerable to frosts. Only one-third of the area under coffee is still located in frost-vulnerable regions, namely the States of Paraná and São Paulo. However, the new coffee-growing areas in the north have soils which retain less moisture. As a result, fear of droughts has replaced fear of frosts. Like most agricultural commodities, coffee is subject to wide variations in production due to agricultural and weather conditions. Too little or too much rainfall, for example, can affect the volume of production from year to year. The source of this instability cannot easily be isolated and it is difficult to identify a single cause. Nonetheless, the pattern of world production reflects the behaviour of Brazilian production, which is frequently affected by climatic phenomena (droughts and frosts).

II. Evidence of cyclical patterns based on statistical methods

A. Production cycles

9. In theory the level of prices is linked to the level of supply and determines investments (growth), disinvestments and waiting periods. In the case of perennial crops, the phenomenon is accentuated by the length of time required for the crop to come into production. The potential of new plantings can only be judged after a number of years,

making it necessary to provide for investments over a longer period. In the case of coffee, new trees planted in response to a rise in prices only come into production at the end of 5 years (3 years for the new hybrid varieties). This behaviour, explained by the "Cobweb" diagram in economic theory, accounts for the succession of cycles of overproduction and shortfalls. It should be noted that in a shortfall situation, prices may remain high for some time, leading to the establishment of new plantings and, a few years later (3 years), to even longer periods of overproduction due to the perennial nature of the coffee tree. Visual observation does not provide a sufficient basis for establishing the presence of cyclical patterns in coffee production. For this reason, structural time series analysis was carried out.

10. A number of techniques can be used to assess cyclical behaviour in time series. These techniques range from mobile average analysis to more sophisticated techniques such as parametric modelling or spectral analysis. Time series analysis makes it possible to determine the salient features of the series and to provide an indication of the presence or absence of a cycle in production. It also makes it possible to determine the duration, nature and amplitude of each cycle and to identify the dominant cycle. The traditional econometric approach to model a time series is to specify and estimate the following equation:

$$Y_t = \alpha + \beta_t + \varepsilon_t,\ \varepsilon_t \sim \text{NID}\ (o, \sigma^2_{\varepsilon}),\ t = 1,\ldots,T$$

(NID = Normally and Independently Distributed) with an average of zero and a variance of σ^2. T is the time trend, α and β are parameters called level and slope of the trend estimated by the OLS (ordinary least square) method and ε_t is a random disturbance.

11. It should be noted that cycles can be deterministic and stochastic. In the case of a deterministic cycle the frequency and amplitude of the cycle are constant in time, a situation which is very rare in economics since the behaviour of the variables depends on a number of factors, some of which are random. In the case of coffee production, a deterministic cycle would reflect downward and upward movements that are symmetrical around a trend implying that all coffee producers in the world or in a specific country are coordinating their decisions and that weather, prices, plant diseases and other factors do not influence production. In these circumstances, deterministic cycles are not likely to occur in the case of coffee.

12. Estimation was carried out by Koopman's STAMP method (Structural Time Series Analyser Modeller and Predictor). The series data used were the production figures for coffee years 1965/66 to 2002/03. Tests were carried out by the Statistical Division of the FAO[1]. The econometric test results are summarized in Table 2 below.

[1] *Details of the analysis may be obtained from the Secretariat of the International Coffee Organization.*

Table 2: Econometric test results

	Cycles	Amplitude of cycle in relation to trend	R^2 Coefficient of determination
World production	2-year cycle	5.56%	0.65
Brazil	2-year cycle	11.47%	0.67
Colombia	No cycle		0.16
Ecuador	Weak 2-year cycle	0.037%	0.30
Mexico	2-year cycle	0.006%	0.22
Guatemala	No cycle		0.08
Costa Rica	No cycle		0.44
Honduras	2-year cycle	0.11%	0.53
El Salvador	2-year cycle	0.01%	0.37
Ethiopia	5 and 15-year cycles	0.45%	0.52
Kenya	No cycle		0.29
Uganda	- No cycle - Indication of a 4-year cycle	0%	0.21
Côte d'Ivoire	No 2-year cycle but indication of 4 and 14-year cycles	0%	0.79
India	2-year cycle		0.67
Indonesia	No cycle	0%	0.22
Vietnam	No cycle	0%	0.03

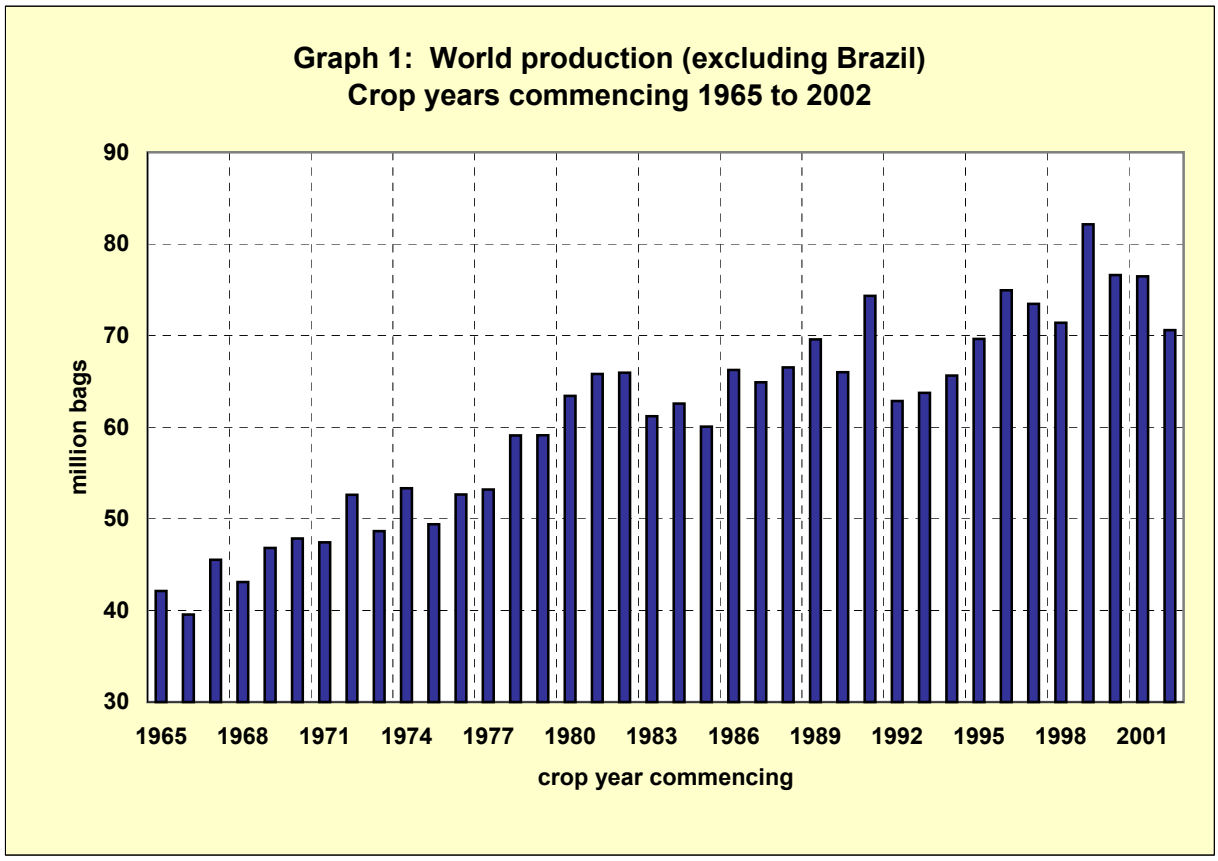
B. Observations

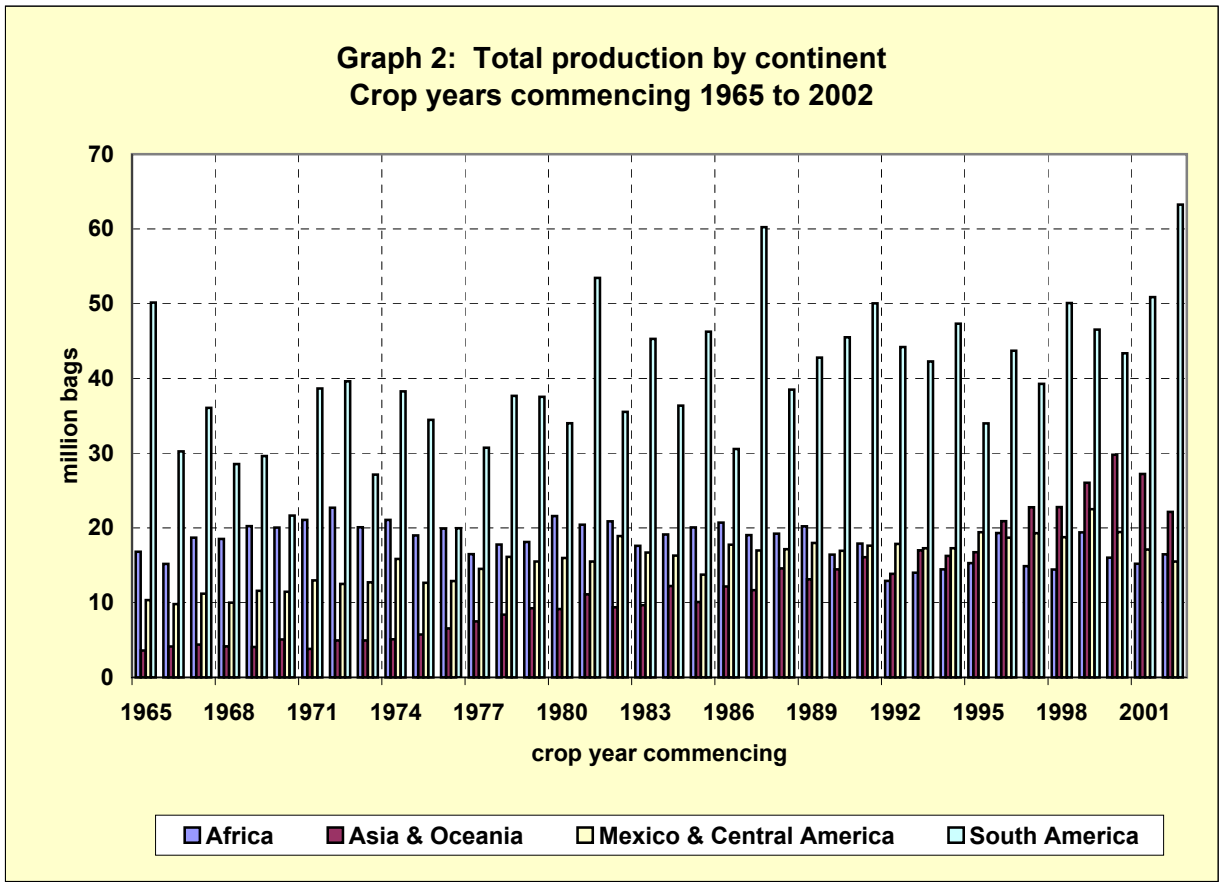
13. The analysis shows that:

- There is no evidence of a cycle in the production of Colombia, Costa Rica, Kenya and India.
- The deterministic cycle detected in Guatemala is not statistically significant since the coefficient of determination (R^2) is very weak.
- In Mexico, Honduras, El Salvador, Ethiopia, Uganda, Côte d'Ivoire, Indonesia and Vietnam the production series contains a two-year cycle or other stochastic cycles with different frequencies. The variances are very small, however, and indicate that these cycles are not statistically significant. In certain cases this lack of statistical significance is confirmed by the very small amplitude of the cycle.
- In Brazil, production shows a two-year stochastic cycle. The amplitude of the cycle is equal to 11.47% of the trend. As Brazil accounts for around 40% of world coffee production, the world production series shows the same two-year cycle with amplitude equal to 5.56% of the trend.

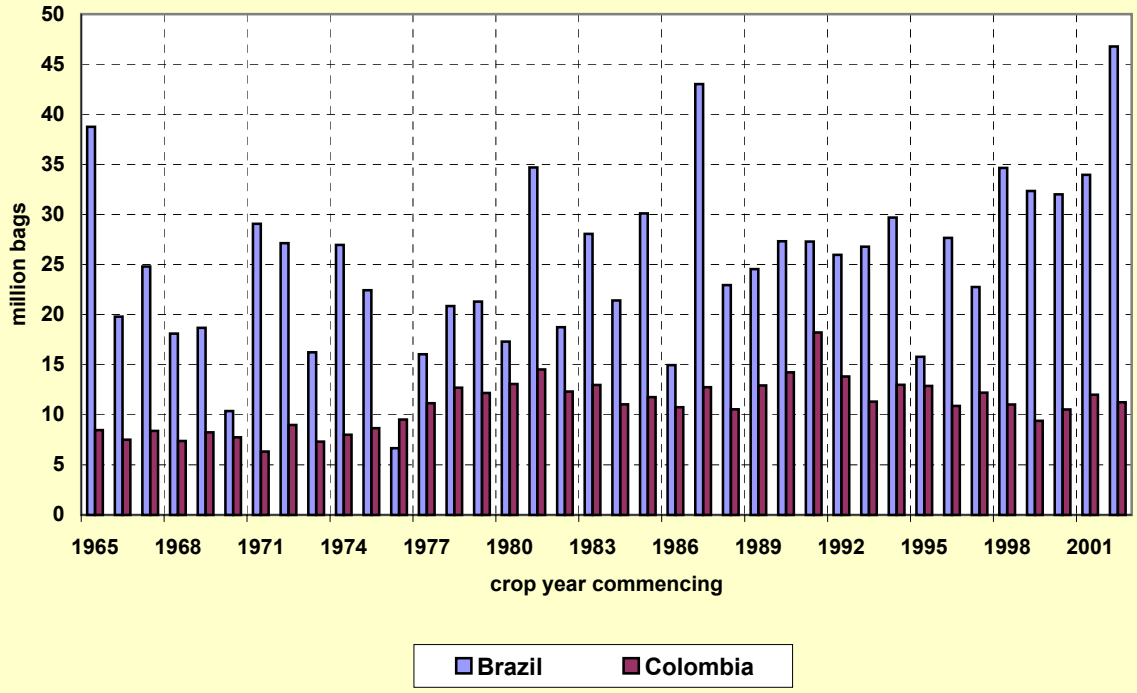
Conclusion

14. The econometric tests indicate that the succession of upward and downward movements in the production of certain countries are of an irregular nature, making it impossible to diagnose the presence of cycles. Until recently, the growth of world production was traditionally based on a succession of cycles in which overproduction in one year was followed by shortfalls in the next and vice versa. In effect, the emergence of significant overproduction leads to a fall in prices which provokes a stagnation in production and, in the medium/long term, produces a price explosion. This model of world production growth seems to be somewhat challenged since the 1980s. The change has been particularly apparent since 1990 with the emergence of the so-called "Asian phenomenon" reflecting the growing importance of Vietnamese, Indian and Indonesian production. There is an ever-increasing risk of structural overproduction since Brazil is no longer solely responsible for significant changes in production inasmuch as the almost exponential growth of Asian supply (Vietnam) has profoundly altered the supply situation and the production cycle.

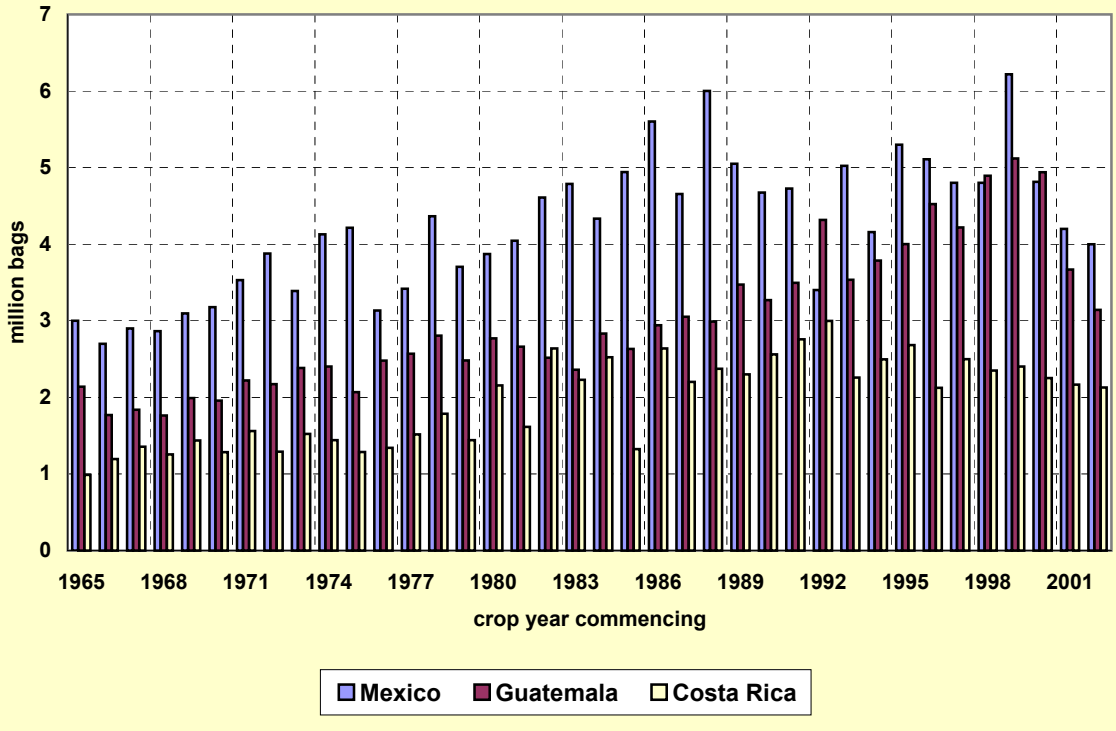




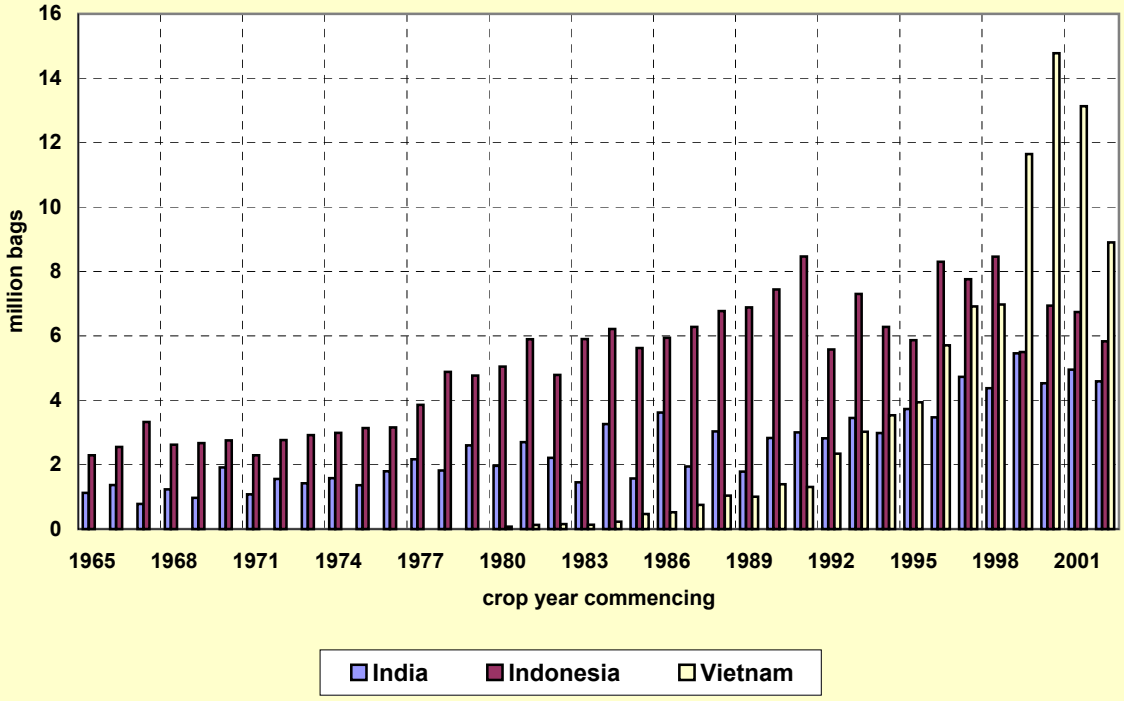
Graph 3: Total production: Brazil and Colombia
Crop years commencing 1965 to 2002



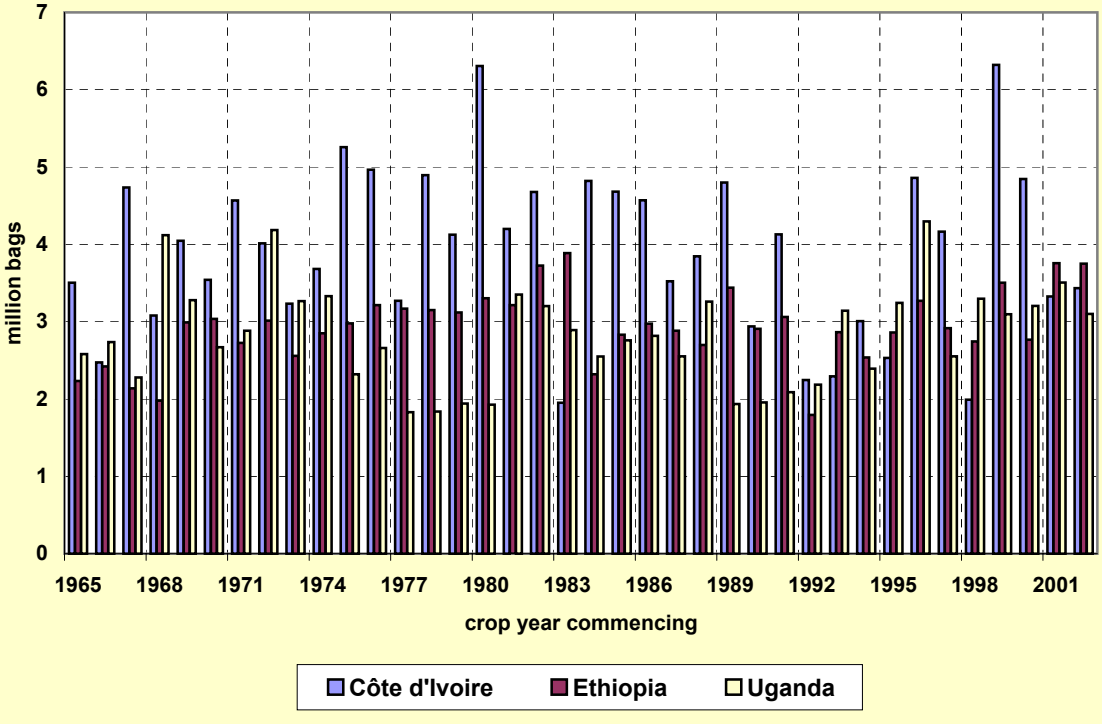
Graph 4: Total production: Mexico, Guatemala and Costa Rica
Crop years commencing 1965 to 2002



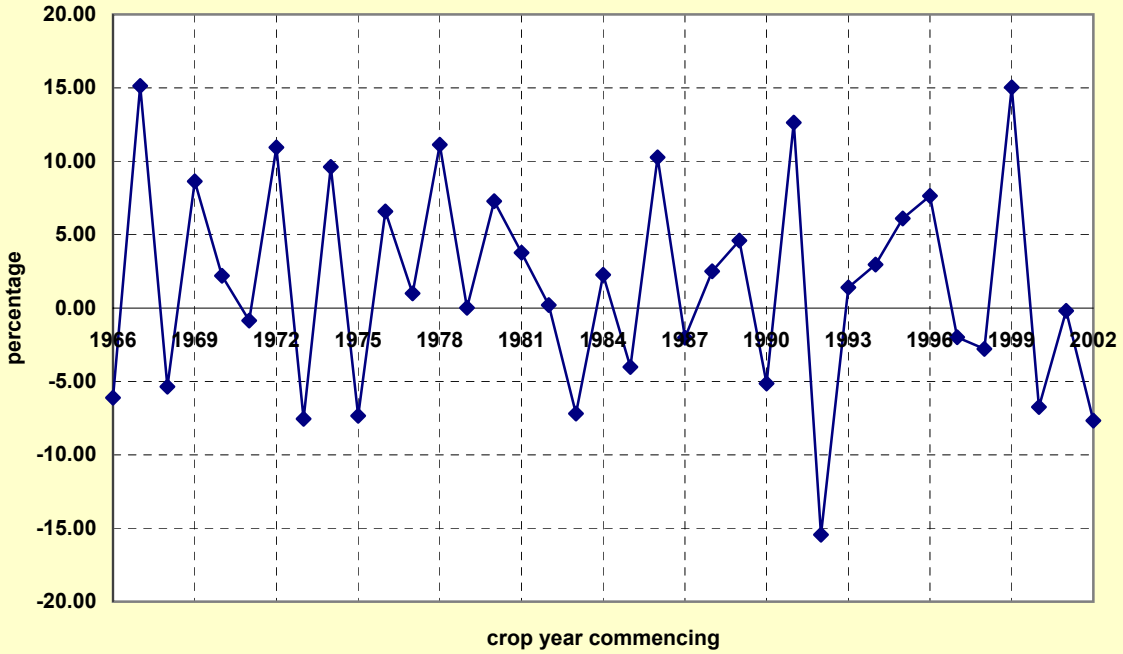
Graph 5: Total production: India, Indonesia and Vietnam
Crop years commencing 1965 to 2002



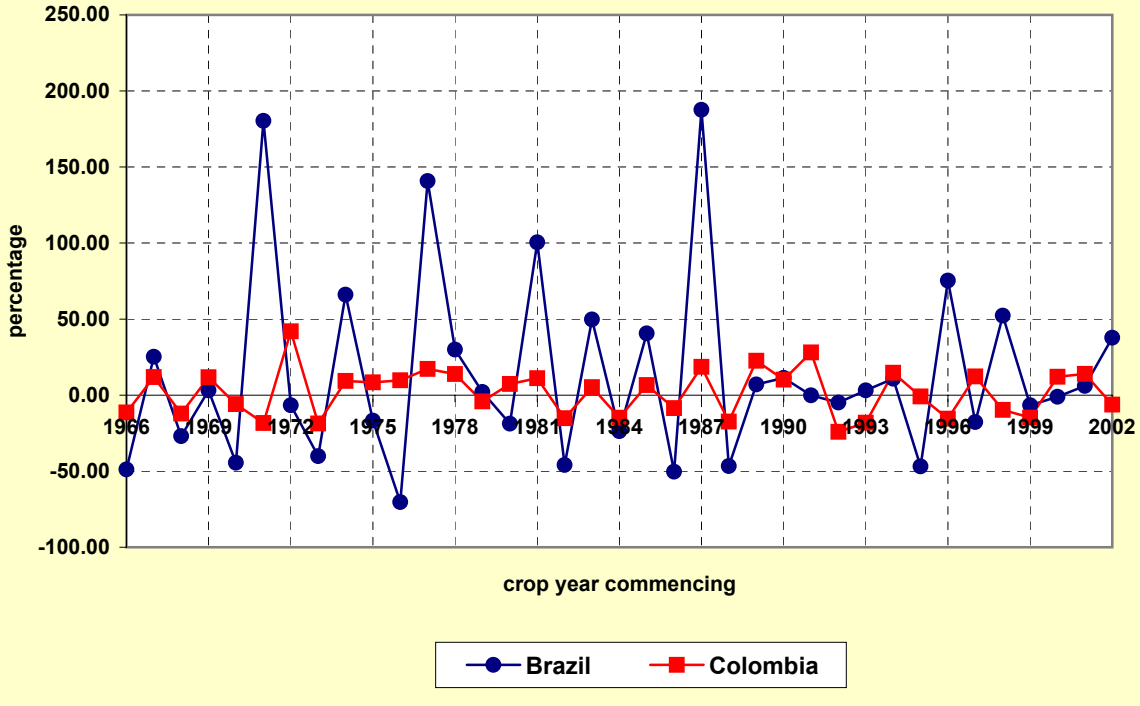
Graph 6: Total production: Côte d'Ivoire, Ethiopia and Uganda
Crop years commencing 1965 to 2002

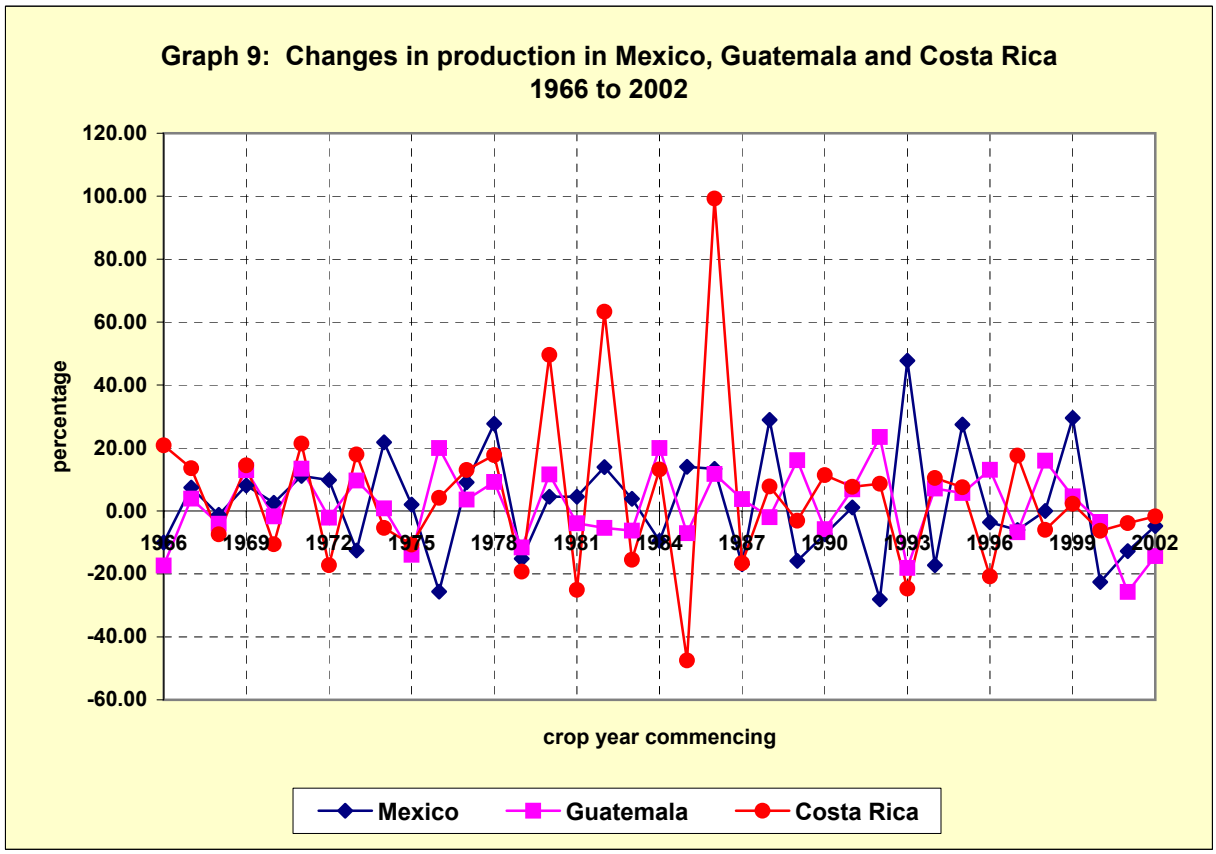


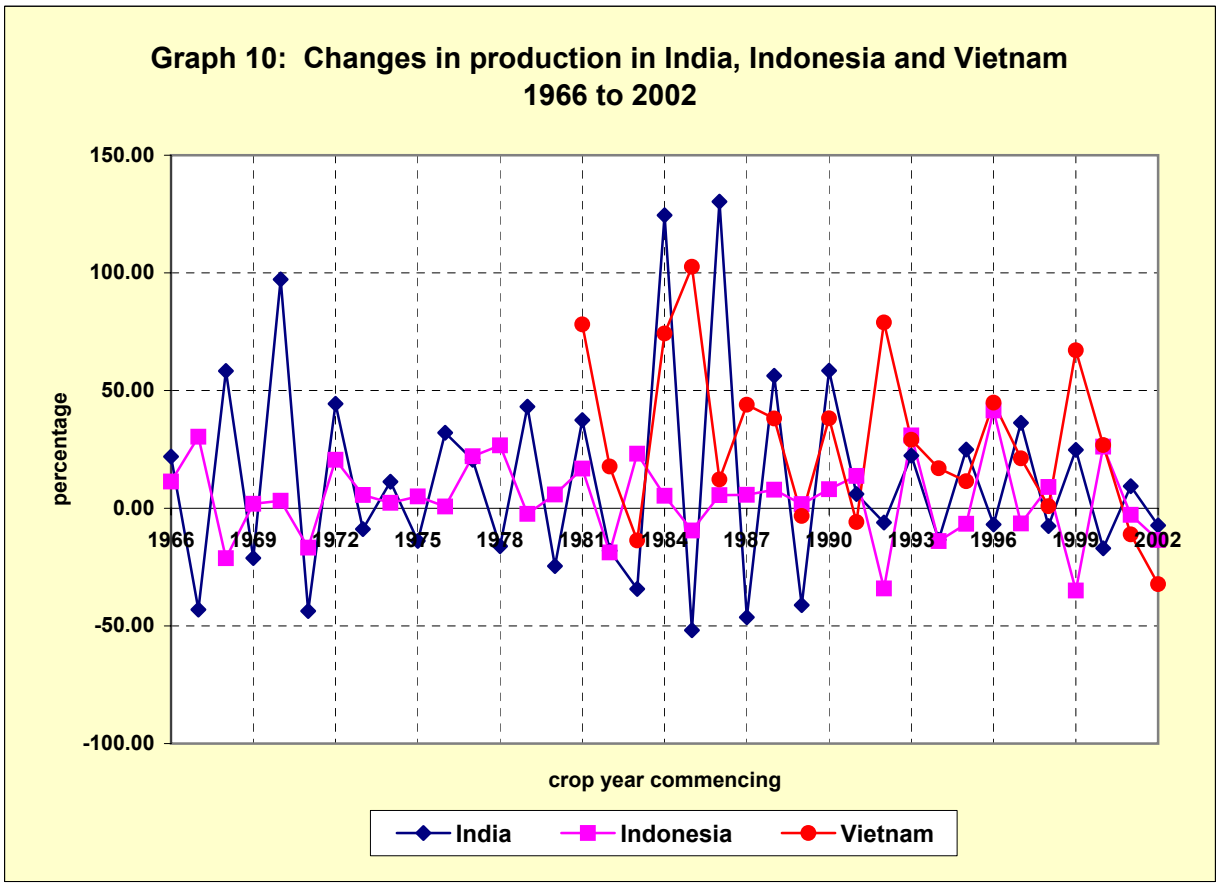
Graph 7: Changes in world production (excluding Brazil) 1966 to 2002

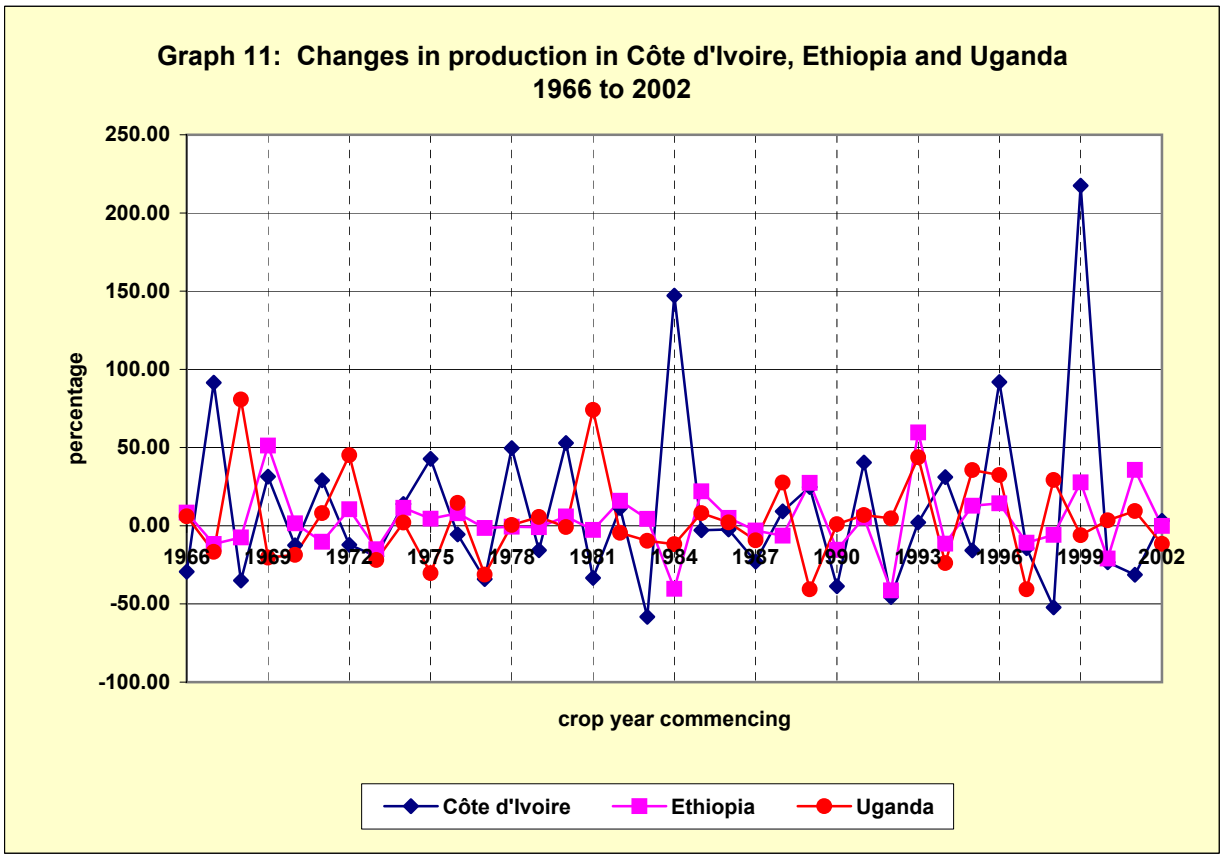


Graph 8: Changes in production in Brazil and Colombia 1966 to 2002








Graph 11: Changes in production in Côte d'Ivoire, Ethiopia and Uganda
1966 to 2002
250.00
200.00
150.00
100.00
50.00
0.00
-50.00
-100.00
percentage
1966
1969
1972
1975
1978
1981
1984
1987
1990
1993
1996
1999
2002
crop year commencing
Côte d'Ivoire
Ethiopia
Uganda