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Cote d'Ivoire:

Volatility, Shocks and Growth

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Abstract

Key economic variables in Cote d'Ivoire vary widely from their long-run trends, moving in multi-year cyclical patterns. Cocoa prices move with cycles in growth rates, capital stock, real exchange rates, terms of trade, cocoa production, and coffee production and output. These patterns have become more pronounced since the 1970s as volatility increased. This paper characterize these cycles, estimates the cocoa price-quantity relationship, and analyzes co-movements due to shocks generate a forecast. Three key conclusions follow.

First, the economy of Cote d'Ivoire has experienced two fundamental transitions, one in 1976 related to cocoa, and another in 1994 related to exchange rates. From 1960 to 1976, world cocoa prices grew steadily, and then fell in real terms. The country's growth showed a similar pattern. An econometric model indicates that the relationship between cocoa price and quantity experienced a break in 1976 and provides evidence of Cote d'Ivoire's significant influence on world cocoa prices.

Second, cocoa price shocks affect growth rates and trade indicators, and are important sources of volatility in the Cote d'Ivoire. The terms of trade and real exchange rate are also sources of volatility for growth and productivity.

Third, a forecast of per-worker output based on these variables predicts continued declines in GDP per worker in Cote d'Ivoire for the near future. This dismal forecast implies the need for a radical and rapid improvement on political, security, and economic management to reverse the two and a half decades of economic decline.

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*Zeljko Bogetic, Carlos Espina and John Noer ***

AFRICA REGION
PREM 4

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1.   INTRODUCTION AND OVERVIEW

This paper seeks to investigate sources of volatility in Cote d'Ivoire, and to quantify and describe the nature and impact of major external shocks to the economy. In the accompanying paper (Bogetic, Noer and Espina, 2007a), we found that very long run trends in output per worker and total factor productivity in Cote d'Ivoire seemed to be significantly affected by agricultural commodity prices in general and world cocoa prices in particular.

Cote d'Ivoire is heavily specialized in raw cocoa production, its major product and export, and it is the world's leading producer of cocoa. When cocoa, coffee and cotton prices boomed in the 1960s and 1970s, Cote d'Ivoire's output and productivity soared. From their peak in 1976, cocoa and the other commodity prices declined steadily, cocoa falling to about one-seventh of the peak level in real terms by 2000. At the same time, Cote d'Ivoire's growth stalled as cocoa prices fell. This paper builds on these earlier findings by characterizing the interplay among these variables, and the influence of the key commodities on Cote d'Ivoire's economy. This is a purely empirical paper, seeking to establish and characterize patterns in Cote d'Ivoire's volatility.   The focus is on economic growth, trade, and cocoa prices. The study period is 1960 to 2003. We look at two macroeconomic "productivity" variables, per worker output and capital per worker; two trade "prices", the real exchange rate and the terms of trade; and cocoa prices, production, and yields.

In terms of methodology, the first part of this paper uses descriptive statistics to present broad stylized facts as background to the analysis. We review long-run trends in key variables, and look at the short-run deviations from those trends. The result: there is a noticeable multi-year cycle to the Cote d'Ivoire economy. The last two cycles have been twelve to fourteen years long. The multi-year cycle in cocoa prices and output coincides with the multi-year cycles in the macro and trade variables, to a remarkable degree. We also identify two key transition years in the country's economic history: 1976 and 1994.

We also analyze the dynamic interaction between the various time series, in an effort to understand their dynamic relationships and develop unconditional forecasts of growth in the immediate future. The result: impulses to cocoa prices have an impact on growth rates over several years, and an immediate impact on trade indices. Output growth is also affected by impulses to the trade indices. Finally, based on the identified dynamic model, we present a forecast predicting a further decline in GDP per worker in the near future.

1.   TRENDS AND DEVIATIONS FROM TREND

We first seek to distinguish between long run trends in certain time series, versus short run deviations from those trends. Hoderick and Prescott[1] (HP) pioneered the use of "HP filtering" to "smooth" or "de-trend" time series, producing a less volatile time series, which arguably represents a localized moving central tendency for a time series. When a time series fluctuates upwards and grows precipitously to a peak, it will exceed the trend. If it falls into a trough, will move under trend. In this section, we first review some of the times series and trends in the levels. We then focus on the difference or deviations between times series and their trend. When treated in this fashion, it is easier to see when time series move above or below trend, and cyclical patterns in the time series become apparent.

Time Series of Key Indicators and Trends

We look at some examples at three different kinds of variables: measure of output or productivity; trade price indices, and commodity data. In the units in which they are normally measured, they have quite different profiles over time. Trends lines can be readily fitted to each.

Figure 1: Real Output per Capita Versus Trend in Cote d'Ivoire, 1960-2002

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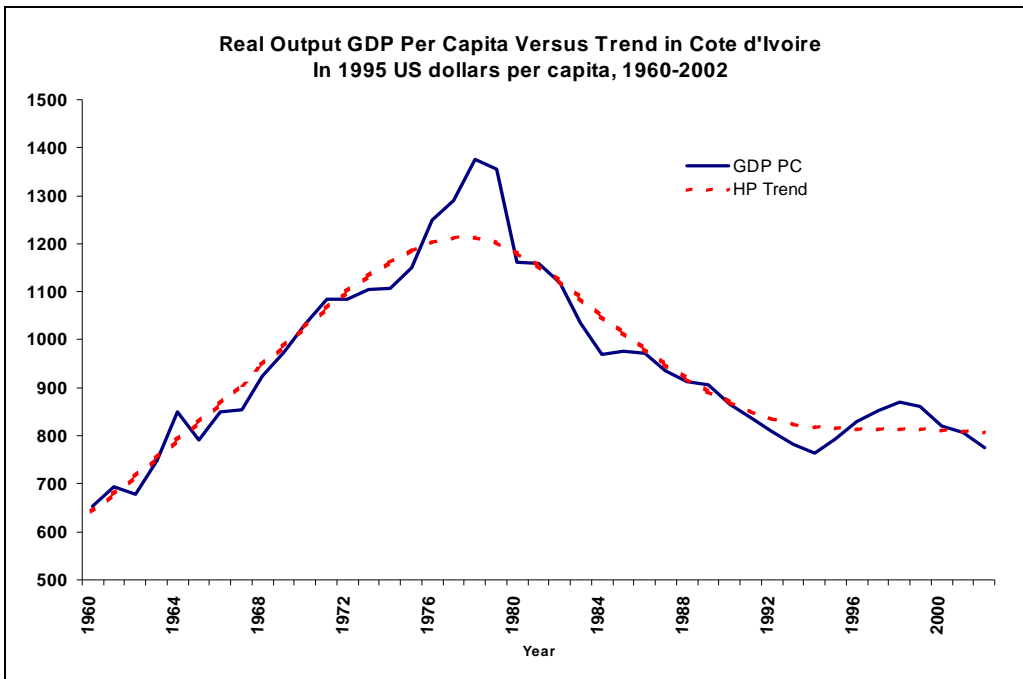
[1] Hoderick & Prescott, 1997. Note that for many years an earlier working paper by the same authors circulated widely, and the technique is very familiar to macroeconomists who study business cycles

Output Measures and Trends

Figure 1 presents the time series of annual inflation-adjusted GDP per capita in1995 US dollars, as compared to the trend variable produced by an application of the HP filtering process. Per capita output tracked the long run trend fairly closely until the early 1970s, oscillating around the trend, but climbed well over trend in the productivity peak of 1976-1980. Annual output and trend fell rapidly thereafter, with output continuing to cycle across the trend periodically. In 1994, the year of CFA devaluation, output per worker began to climb and then rose over the trend. But by 2001. it crossed trend, and was well under trend by 2002. Capital stock per worker exhibits a very similar pattern, both in the annual levels, and in the trends.

Trade Indicators and Trends

We use two trade indices. The terms of trade (TOT) is conceptually the relative price of exports to exports, approximated by price indices of exports to imports. The real exchange rate or real equilibrium exchange rate ("RER" or "REER") conceptually is the relative price of traded goods on world markets versus non-traded ("home") goods. The RER is often approximated with a foreign price index at the nominal exchange rate, divided by the local consumer price index[2]. The effects of the 1994 devaluation are apparent in both.

Figure 2 Logarithm of Terms of Trade Versus Trend in Cote d'Ivoire

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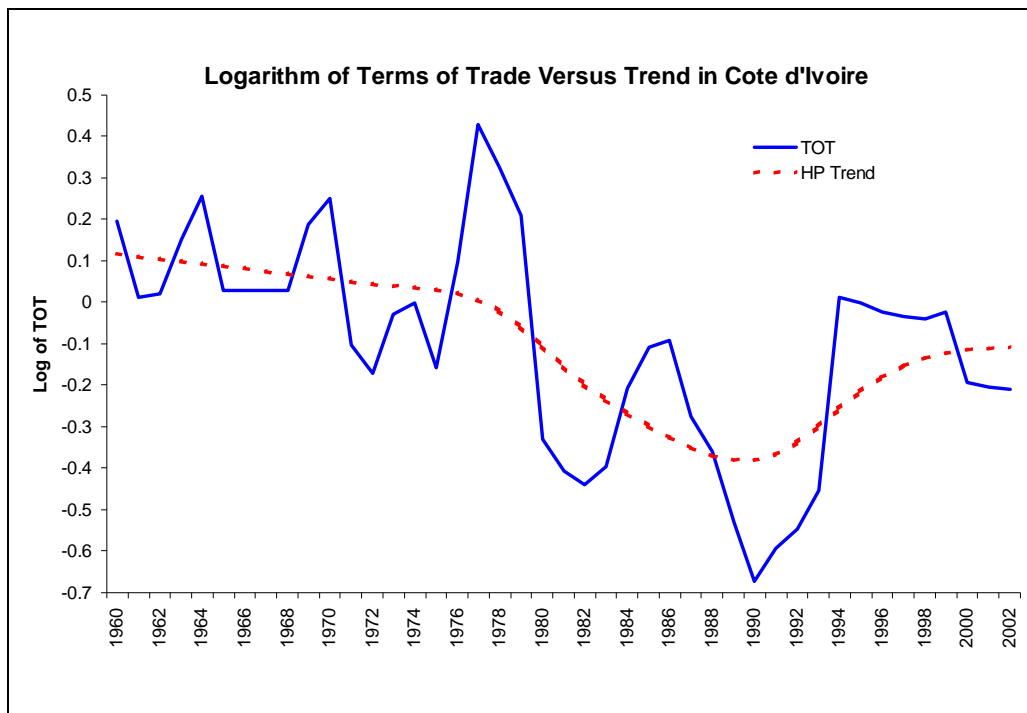
[2] Or vice versa if the IMF definition is used. We used Sebastian Edward's definition rather than that of the Fund, the two are inverse to each other.

Figure 2 (above) depicts the terms of trade versus trend in logarithms. Early in the study period the real relative prices of Cote d'Ivoire's agricultural commodity exports was high, so the terms of trade were favorable, and GDP grew rapidly. After the peak of the late 1970s, those commodity prices fell, and so did Cote d'Ivoire's terms of trade. The terms of trade trough occurred during the extended depression of the late 1980s and early 1990s. The devaluation of the CFA in 1994 coincided with a surge in cocoa and coffee prices, and the terms of trade accordingly increased, only to slide below trend in about 2000.

Figure 3 Real Exchange Rate Between Cote d'Ivoire Versus France, Versus Trend
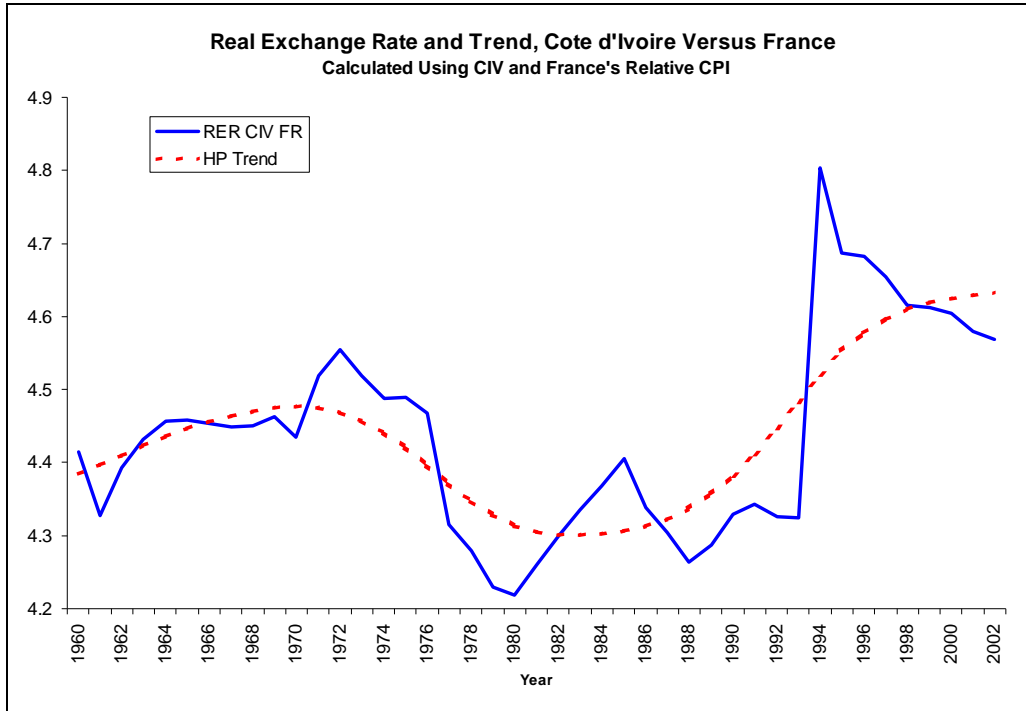
While a single measure of terms of trade applies for each individual country, measures of real exchange rates are trade-partner dependent. We consider here the bi-lateral real exchange rate of Cote d'Ivoire with France, the major trade partner and reference currency.[3] (Figure 3). During the rapid growth of the 1970s, Cote d'Ivoire had a favorable RER, but in the peak of the late 1970s the RER fell below trend. In the period leading up to devaluation it was below trend, then shot up in 1994 and was above trend (favorable) until 1998, when it slipped beneath trend.

Commodity Time Series and Trends

Figure 4 shows inflation-adjusted world cocoa prices in logarithms (which changes the scale of the prices.) These are spot prices on New York commodity exchange markets. The apparent resemblance of this commodity price times series to output per capita is very remarkable. The trend rises in the 1960s and early 1970s, with actual prices cycling

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[3] The CFA was pegged to the French Franc, then to euro. Here, a high value indicates a large number of CFA per dollar and indicates "competitiveness", while a low value indicates an overvalued currency.

around the trend. During the peak years of Cote d'Ivoire's productivity, 1976 to 1980, cocoa prices soared over trend. They crashed thereafter, and actual prices and the trend fell precipitously. In nominal (unlogged) dollars, cocoa prices rose to over $3,000 per metric ton in 1980, then fell to about $1,000 by 2000. In constant 1995 (unlogged) dollars, adjusted by the US CPI, real prices declined to one-seventh of their peak price over twenty years to 2000.

Figure 4 Natural Logarithms International Real Cocoa Prices, 1960-2003
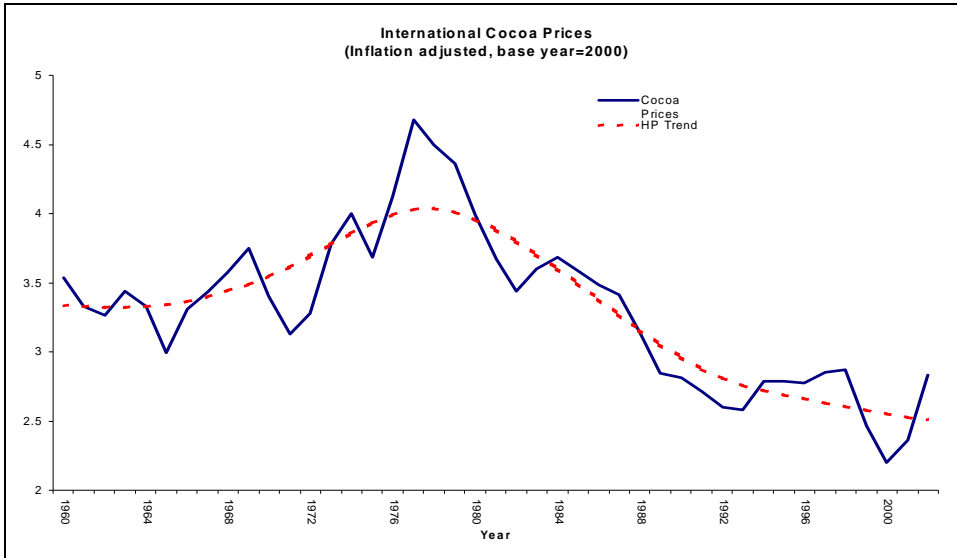
Figure 5 : Cocoa Production Versus Trend in Cote d'Ivoire, 1961-2002

Figure 5 depicts total national cocoa production in Cote d'Ivoire, in millions of metric tons. It grows dramatically over time. Annual coca output cycles across trend, with the oscillations at least somewhat co-incident with the oscillations of cocoa price around

trend, and per head GDP. Output was above trend in the 1979-1980 peak, then below trend during the period when the CFA was over-valued in the 1980s. Following the1994 devaluation, it spurted over trend, only to fall beneath trend following the outbreak of turmoil in 2000.

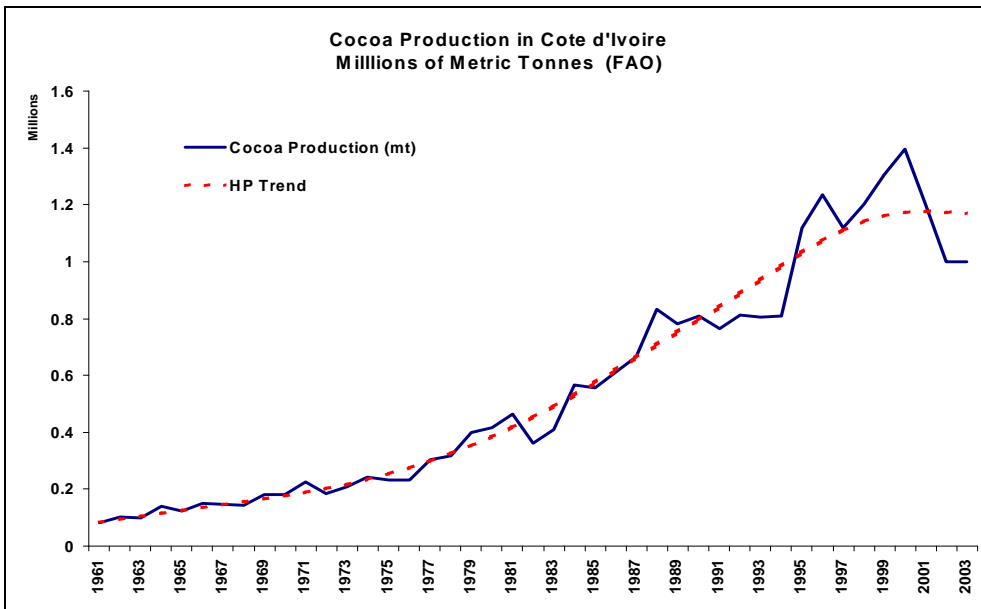The pattern of interest here is those points where annual times series cross the trend lines. These would seem to be one point from which to measure cycles. Or, one could measure peak-to-peak, or trough –to-trough. In the next section, we re-cast the variables to focus more on the *cyclical* patterns made apparent by the de-trending HP filtering process.

Cyclical Patterns In Deviations From Trend

To better observe and compare the co-movements in the cycles of key variables, it is useful to normalize them in scale, abstracting from units and magnitude. Next, we look at the ratio of the natural logarithms of the annual time series divided by the natural logarithm of the trend[4]. The advantage of this approach is that a "cycle" becomes readily apparent.

We provide three sets of three figures each, to permit the reader to visually compare cycles in the 1) macroeconomic indices, 2) trade indices, and 3) cocoa prices.[5] These series are all "normalized" by the trend.[6]

Output, capital stock and cocoa prices share a common cyclical pattern. Figure 6 depicts the cycles around trend of output per worker and capital stock per worker, and coca prices. In the four years leading up to the peak of Cote d'Ivoire's boom of 1979-80, the economy experienced positive "productivity shocks", with output as much as 12% over trend. In those four years, cocoa prices were also well over trend, by as much as 35% to 65%.

In the years leading up to devaluation, per worker output and capital were below trend, as were international cocoa prices. Upon devaluation of the CFA in 1994, things turned around, and the three series of Figure 6 began to climb above trend. The big drop in 2002 output coincides with a jump in world cocoa prices, breaking the pattern, possibly due to the fact that Cote d'Ivoire's production was disrupted. In general, the three series cycle together around trend during most of the 1961-2002 time period, with movements in world cocoa prices and Cote d'Ivoire output tending to coincide, and cycles in capital stock per worker apparently lagging the others by some extent but otherwise moving in a similar pattern.

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[4] This is mathematically equivalent to the difference of logs of the actual series versus HP trend. This rate of deviation from trend corresponds to percentage deviation from trend (where 0.01 = 1.0%, and so forth).

[5] In the Annex we show data on Cote d'Ivoire's second most important agricultural export crop, coffee. Coffee is correlated with cocoa, and shows very similar cyclical patterns.

[6] The scales on the Y-axis are not identical, so in these sets of three "illustrations" the amplitude of the cycles or magnitudes of the deviations from trend are not directly comparable. In the Annex, we provide illustrations of cycles on the same graph, holding constant the vertical axis.

Figure 6: Per Worker Output, Capital Stock, & Real World Cocoa Prices - Deviations from Trend
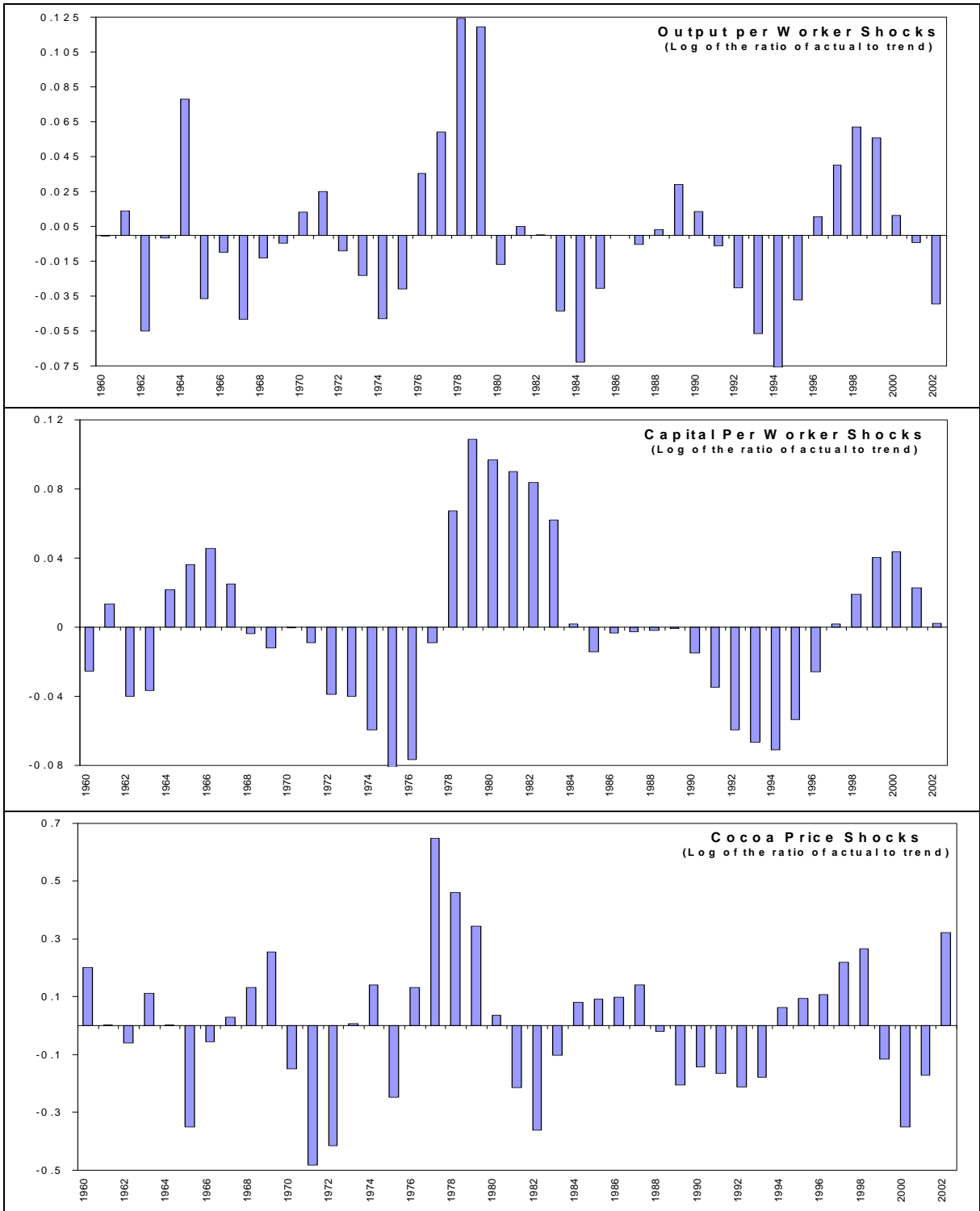
Figure 7: Terms of Trade, Real Exchange Rate & Real Cocoa Prices - Deviations from Trend
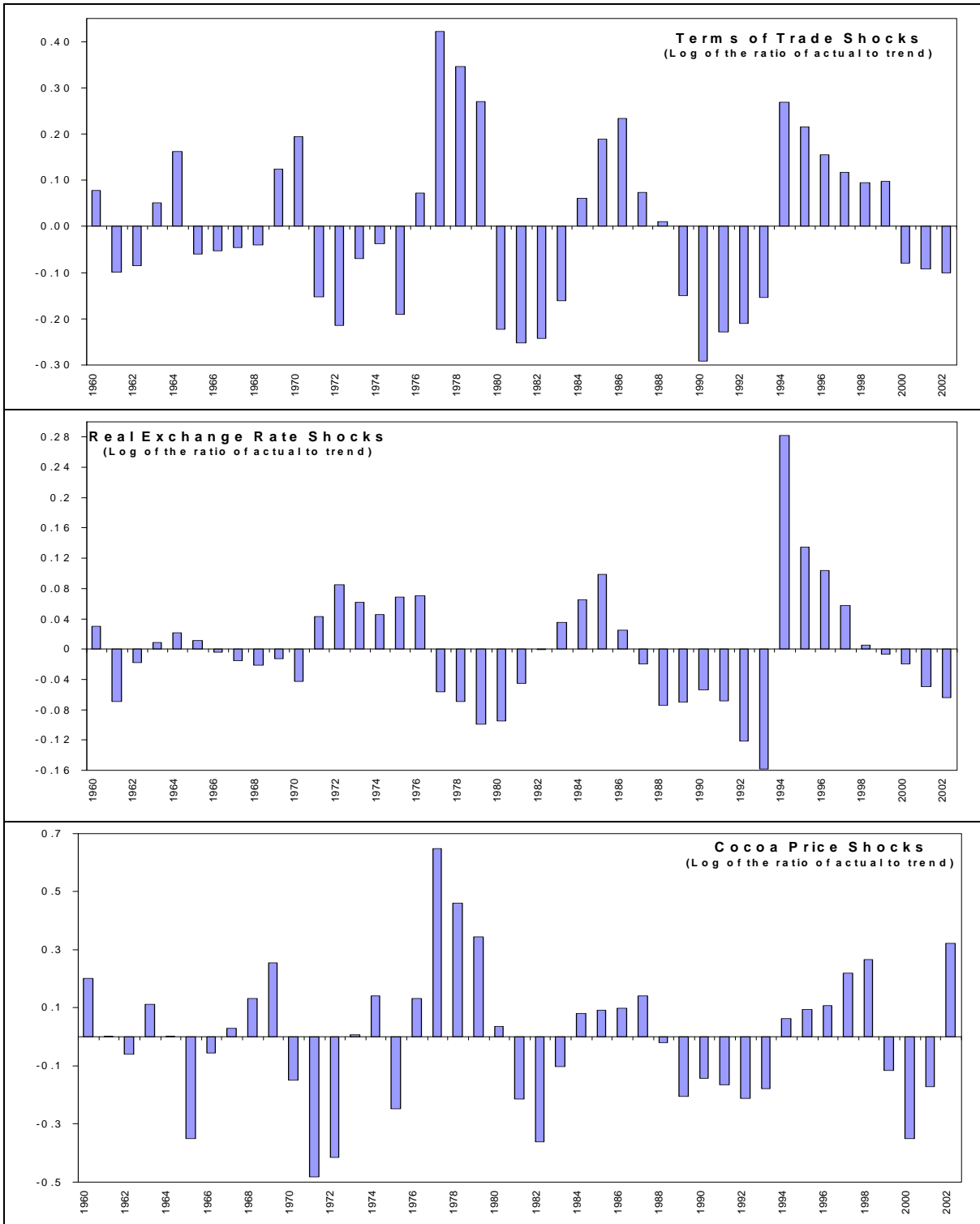
Figure 8: Cocoa Prices, Production & Yields – Deviations From Trend

Cocoa Price Shocks
(Log of the ratio of actual to trend)

Cocoa Production Shocks
(Log of the ratio of actual to trend)

Cocoa Yield Shocks
(Log of the ratio of actual to trend)
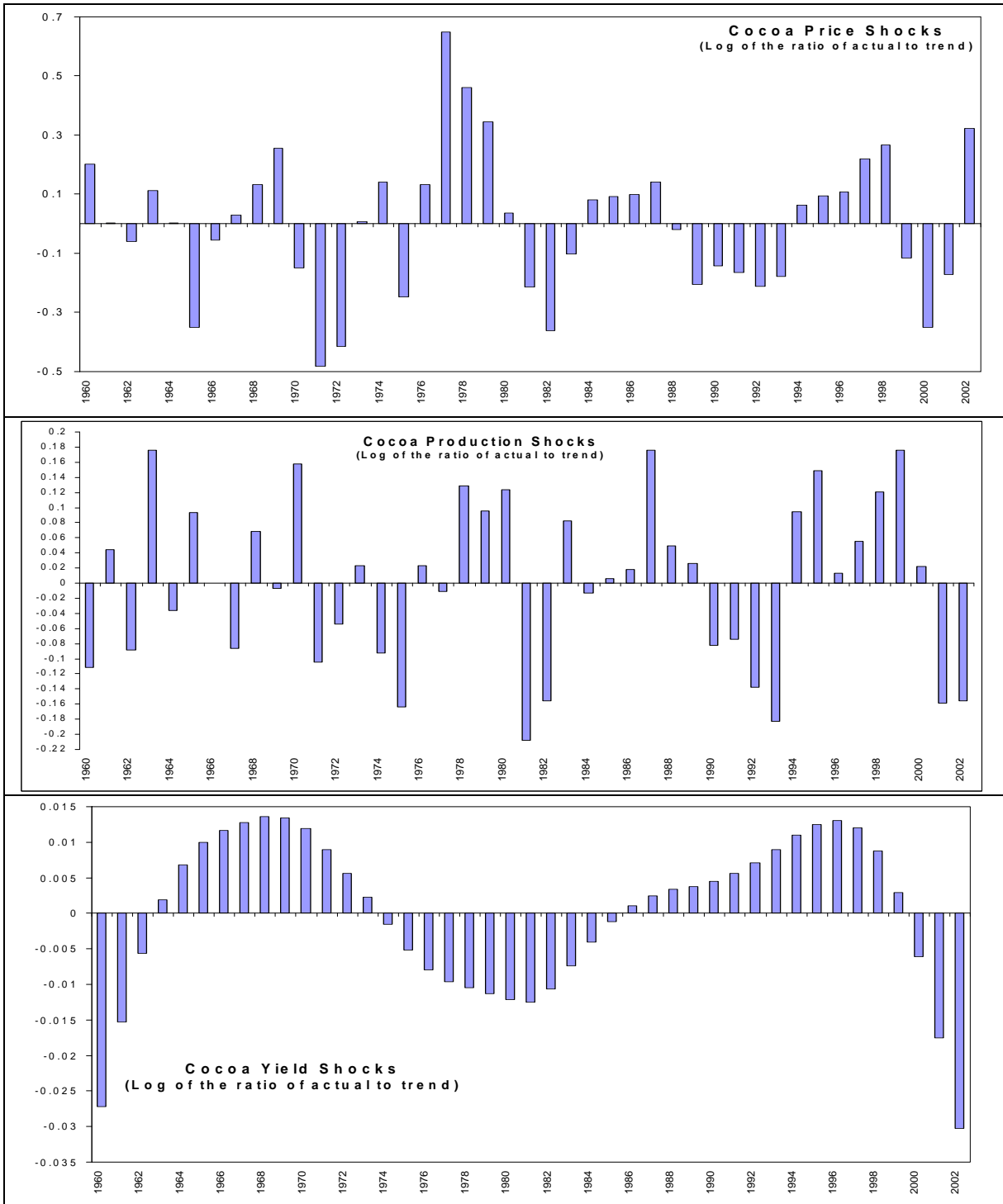
Trade indices share a cyclical pattern with cocoa prices. Figure 7 shows cycles around trend of the trade indices and cocoa prices. Cycles in all three exhibit a very similar pattern, post-1980. Cocoa price cycles move closely with the terms of trade cycles throughout the study period (except for 2002), which is not surprising as cocoa prices are an important part of the index of export prices from which the TOT measure is created. Cycles in the real exchange rate measure move against the cycles in TOT and cocoa prices before the 1980s. From 1971 to 1976, the RER cycle was above trend, while the TOT cycle was below; and in 1976-79 TOT was above trend while RER was below. By the 1980s, both RER and TOT cycles were moving together, and moving with cocoa price cycles.

Cocoa world prices, Cote d'Ivoire's production and yields also share a common cyclical pattern. Figure 8 show data on cycles in the cocoa markets. Cocoa production cycles in physical units in the Cote d'Ivoire have often moved with international real cocoa price cycles. Prices above trend in 1976 to 1980 coincided with production above trend in 1978 to 1980, and thereafter the world price and Cote d'Ivoire production cycles around trend move together. This may suggest a feedback or "cobweb" mechanism. Above-trend real world prices may stimulate above-trend output by local producers (keeping in mind that real prices tended down over the study period while physical production trended upwards.). Output was down sharply in 2001 and 2002 due to conflict. The cycle in cocoa yields per hectare moves from above trend in 1963-1974, to below trend during Cote d'Ivoire's boom and subsequent crash in 1975-1986, to above trend from 1987 through 1999. Yields have fallen precipitously from 2000 on, probably due to conflict.

Coffee prices correlate with cocoa prices, and prices, output and yields also share a pattern much like that of cocoa. See Annex II.

While not perfectly correlated, the descriptive patterns brought out by HP filtering reveal considerable co-movement in the deviations from trend of output, trade indices, and cocoa and coffee prices in Cote d'Ivoire. This suggests a strong relationship between macroeconomic productivity, trade, and commodities in Cote d'Ivoire. Examination of this data strongly indicates that regular cyclical patterns have appeared in the economic times series, and the pattern is shared by output, trade and cocoa variables. In the next section, we evaluate these inter-relationships more rigorously.

2. TRANSITIONS AND BREAK POINTS

Based on a review of the data, we first tentatively identify two transition periods in the recent macroeconomic history of Cote d'Ivoire, "break points" where the fundamental inter-relationships among key economic variables seem to change. We then econometrically test the hypothesis that a break-point occurred in the mid-1970s, related to the major turnaround and long term decline in cocoa prices identified in the accompanying paper (Bogetic, Noer, and Espina, 2007a).

Transition Points in the Economy of Cote d'Ivoire

An inspection of the time series trends and cycles suggests two main transition points, one, well-known in 1994, and the other in 1976-77. Descriptive statistics presented in the previous section suggests apparent *common* break points in these time series. These break points define major eras in the recent economic history of Cote d'Ivoire.

The CFA devaluation coincides with a trade-related break-point in 1994. The year of CFA devaluation appears to be a break point in the economy, and evidence of this appears in an inspection of the cycles and trends in the data. The reasons for this are apparent, and well documented in the literature (e.g., Berg and Pegatienan, 2001). Reviewing the data, we note that in or around 1994:

- Both the terms of trade and the real exchange rate moved well above trend, towards competitiveness, the very reasons that the devaluation was undertaken.
- Both output and capital per worker began to move upward.
- There was a supply response: coca production began to increase, moving over trend, as did that of coffee (another desired and expected consequence of devaluation)
- Interestingly, both cocoa and coffee world prices moved above trend. That is, upturns in world commodity prices helped Cote d'Ivoire's post-devaluation economic recovery.

The 1994 turning point and its explanation is well recognized, having to do with CFAF overvaluation prior to 1994 and the beneficial effects of devaluing the CFA franc from 50 to 100 French francs. In the remainder of the paper we focus on the earlier 1976-77 turning point, which is unique to Cote d'Ivoire, and does not seem to be well-recognized nor well explained in the development literature.

A break point for cocoa price series occurs in or around 1976-77. Several factors suggest this as a break point:

- Before 1977, per capita and per worker GDP were growing in Cote d'Ivoire; thereafter they fell for many years.
- GDP per worker moved above trend in 1976 and hit an all time high above trend in 1977.
- The real world price of raw cocoa hit an all-time in 1976. Coffee price moved above trend in the same year.
- The terms of trade index (as reported in SIMA, series reported by the IMF) hit an all time peak of 153 in 1977, then fell, to 66 by 1981.
- Before 1977, the terms of trade index and the bilateral real exchange rate moved "against" each other; thereafter, they moved "with" each other.[7]
- Harmonious and pronounced cyclical patterns became evident in the mid 1970s, with output and trade indices moving with cocoa time series

Chow test provides preliminary econometric evidence of a break point in 1976-77. We conducted a Chow test of the relationship between growth in per-worker output in Cote d'Ivoire, and capital, terms of trade, and commodity prices; essentially a one-line augmented Cobb-Douglas productivity function regression specification. We tested the hypothesis that there was a break in the relationship in 1976. The result: the F-test testing the null hypothesis that that the vector of regression coefficients estimated on the two sub-samples are identical is F = 2.29, versus a critical value of 1.93 at the 10% level. We therefore reject the null, and accept the alternative hypothesis that the fundamental relations between the dependent variable and the explanatory variables changed, and are different in the two time periods.

Since 1976-77, Cote d'Ivoire has developed considerable market power in the world cocoa market and movements in domestic output exert strong influence on world cocoa prices. We looked at world nominal and real cocoa prices on world markets, and Cote d'Ivoire's output and world market share, shown in ANNEX II on Figure 21. Prices peaked in 1977 in nominal and, especially, real terms. From 1960 to 1976, world cocoa prices grew strongly. From 1977 to 2000, cocoa prices fell. During the 1970s Cote d'Ivoire's cocoa output grew strongly, and its share of world output more than doubled, as it moved to become the world's leading producer. We, therefore, tested the hypotheses that Cote d'Ivoire has moved from being a price-taker to price-maker on world cocoa markets, and that the transition may have occurred during the 1970s. We were interested in the identifying the precise time period of this transition from a "small" to "major" producer of cocoa in the global scene. The implications are that Cote d'Ivoire's economy may have become extremely dependent upon cocoa during that time period of transition; and that the 1976-77 peak and the subsequent decline in world cocoa prices must have had considerable impact on the country's economy. In the next section we test the first two of these hypotheses.

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[7] Recall that to calculate real exchange rate measures we use the definition used by Sebastian Edwards and others, which moves in the opposite direction of the measure commonly used by the International Monetary Fund. In our definition, the local currency appears in the numerator, so a "high" REER indicates more depreciated REER and higher export competitiveness.

Fully Modified Least Squares Model of Cocoa Prices and Output

We evaluated the impact of Cote d'Ivoire's output on world cocoa prices, to explore whether the country is a price-maker, and to find analytic evidence of a break in the time series process. To do so, we require the use of a more sophisticated approach than is usually adopted. Traditional Ordinary Least Squares (OLS) is inefficient, and can fail, in the presence of serial auto correlation, endogenity between the explanatory and explained variables, and breaks in the statistical process generating the variables. All three problems are present in this case. In particular, we observe a serial correlation, we believe that a break in the process occurred, and we hypothesize that the country has, over time, developed market power so that prices and quantity are related.

To properly estimate the marginal impacts of Cote d'Ivoire's cocoa production on world cocoa price, we applied a "Fully-Modified Least Squares" (FMLS). This procedure was first proposed in 1990[8] and recently used by Cashin[9] et al when investigating commodity price impacts on the macro-economy of developing countries. Table 1 summarizes the FMLS model results. FMLS allows us to estimate this parameters in an efficient and consistent way, as it takes into account not only the structural break in the series but it also corrects the estimation for serial autocorrelation and endogeneity.[10]

FM-OLS provides evidence that Cote d'Ivoire, indeed, has developed market power in cocoa. In the market for cocoa regression, the FM-OLS results show that *world cocoa prices decrease an average of 7% when Core d'Ivoire's cocoa production increases by 10%.*[11] The world cocoa price is, therefore, highly sensitive to changes in Cote d'Ivoire's cocoa output. Moreover, the Cote d'Ivoire cocoa production data explains almost 50% of the variance in the world prices. Also, we find that Cote d'Ivoire's output "Granger-causes" world prices, itself an evidence that Cote d'Ivoire has market power[12]

The model provides clear evidence that the structural break occurred in 1976. The estimation method[13] is to run a series of 43 regressions, moving the dummy variable forward one year at each iteration, and identifying the break-point based on a sophisticated goodness-of-fit criteria based on the ADF test[14].

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[8] See three articles by Hansen & Phillips, all in1990.

[9] Cashin et al, 2002, and Cashin, 2002.

[10] This FMLS estimation procedure is not available in econometric packages, so co-author Carlos Espina coded it in mathematical software, Gauss.

[11] Recall that Cote d'Ivoire produced between 8% and 41% of world output over the sample period. So a one percent increase in Cote d'Ivoire's output corresponds to a much smaller percent increase in world output, depending on market share. In the later part of the study period, a 1.0% change in Cote d'Ivoire's output corresponds to 0.2 to 0.4 percent increase in world output, post 1976.

[12] That is, innovations in Cote d'Ivoire's output "explain" subsequent world price changes.

[13] See Phillips and Hansen, 1990.

[14] The Hansen-Phillips tests is based on an ADF test, for which they provide a distribution.

Table 1: FMLS Regression Model of the Relationship Between Cote d'Ivoire Cocoa Production and World Real Prices; Parameter Estimates and Measures o Goodness-of-Fit

FMLS ESTIMATORS

Model:

$$\ln COCOAPRICE_t = \alpha + \beta \ln CocoaPROD_t + \gamma dummy_t + \varepsilon_t \qquad\qquad t = 1,....,N$$

PARAMETER ESTIMATES:

Constant: 13.241469

LnCocoaProduction: -0.744556

Dummy (value 0 after 1975): -0.860411

Dependent Variable: lnCocoaPrices

STATISTIC OF THE JOINT SIGNIFICANCE TEST for ALL VARIABLES:

18.429302   p-value: 0.000100

STATISTIC OF THE INDIVIDUAL SIGNIFICANCE :

(distributed as Chi-squared)

 Regressor: Constant   Statistic: 29.266227 p-value: 0.000000

Regressor: lnCocoa Production Statistic: 16.743357 p-value: 0.000043

Regressor: Dummy   Statistic: 7.636649 p-value: 0.005719

 STRUCTURAL BREAK year for cocoa prices: 1976, according to the Hansen-Phillips test for structural break of unknown timing.

3.   DYNAMIC ANALYSIS OF THE IMPACT OF SHOCKS

Having identified and documented the importance of cocoa prices (and their structural breaks) for Cote d'Ivoire's economy, we now turn to dynamic interactions of the major macroeconomic shocks using vector auto regression (VAR) statistical approach. We describe the particular methodology used here in greater detail in Annex I. We use a reduced form approach, not specifying a particular structural model. This approach implies nothing about causality of interactions, only inter-correlation between variables.

Derived impulse-response functions (IRFs) describe how one variable can be expected to respond in future if a "shock" is applied to another variable in the model. The IRF shock response is over "baseline", that is, in addition to or on top of an unconditional VAR "baseline" forecast. Below, we present a summary of the IRF results.

Impulse Response Function Results

World cocoa prices and trade indices prices impact Cote d'Ivoire's productivity. First, we now present evidence on the *dynamic* interactions and impact of real world cocoa prices and trade indices on Cote d'Ivoire's productivity. Figure 9 depicts the orthogonalized impulse response function (IRF) of three standardized, small-order positive impulses of the percentage rate of change in:

(1) Terms of trade
(2) Real exchange rate
(3) Real GDP per worker

Upon the rate of growth of output per-worker, over and above the baseline.

The impact of a positive cocoa price shock on the terms of trade is very strong, causing the terms of trade to increase *in the first year* by four percentage points (over 0.04 above baseline), before declines in the second and third year. This is unsurprising, as raw cocoa prices appear directly in this measure[15]. The cocoa price shock sets up strong oscillation in the forecast profile of the terms of trade, which then goes on to fall about –1.5% in the second year out, below –3.0% in the third year, and then upward to about positive 2% sixth years.

In response to a positive cocoa price shock, the bilateral real exchange rate with France moves downward (appreciates) about –1.5%, then moves upward

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[15] Cocoa prices are the largest single commodity price component in Cote d'Ivoire's terms of trade index and appear in the numerator of that index.

(depreciates) to about +0.4% two years out, then oscillating downward again. The oscillation and the response of the bilateral RER is less pronounced than that of the terms of trade. The particular measure of the real exchange rate used here is built with the consumer price indices of France and Cote d'Ivoire respectively, and the (fixed) official exchange rate. The Ivoirian CPI appears in the denominator, and raw cocoa prices do not appear directly anywhere in this measure. (There is probably a very small share for chocolate in the CPIs and hence in the measure.). This response may be the result of a "wealth effect". A high cocoa price raises Cote d'Ivoire wages and incomes, bidding up the local price level relative to that of France, resulting in a loss of competitiveness and a dip (appreciation) in the real exchange rate measure. This explanation is also consistent with a time lag in the transmission of the effect. The oscillation seems to be related and inverse to the oscillation in the terms of trade.

Figure 9: Vector Auto Regression Impulse Response Functions: Impacts of a Shock of World Cocoa Prices on Cote d'Ivoire's Terms of Trade, Real Exchange Rate, and Real GDP per Worker
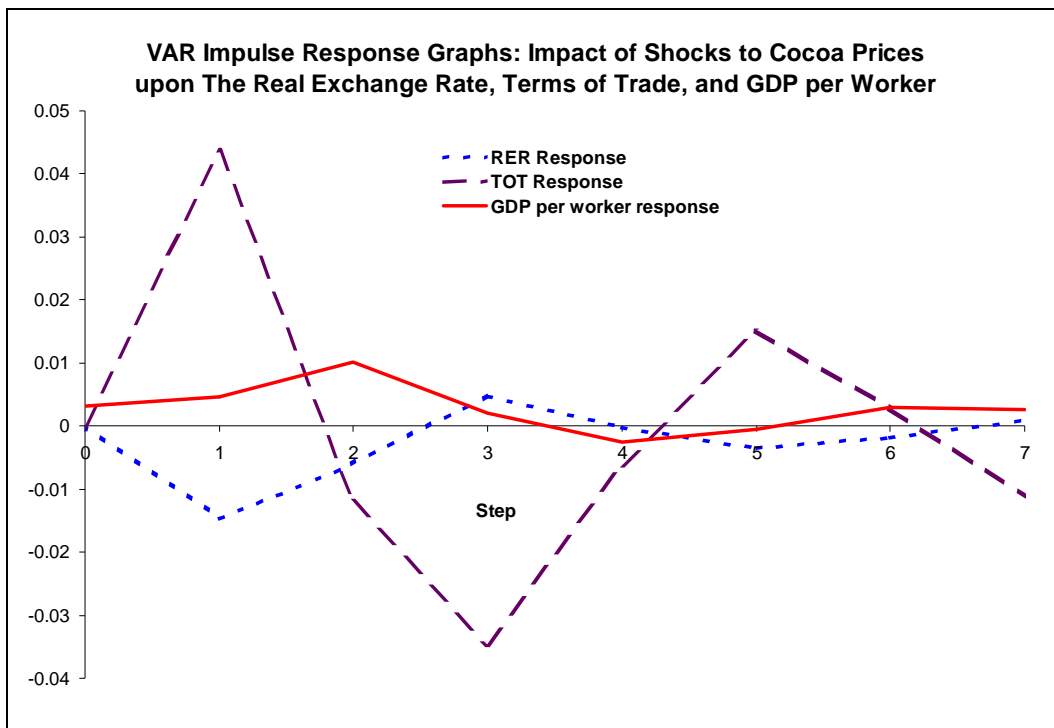
Shocks to cocoa prices have an immediate positive small impact upon GDP per worker. This impact continues to about plus-one-half-percent one year out, and then increases to about one percent two years out. The impact thereupon diminishes.

Overall, the VAR statistical evidence is that shocks to real world cocoa prices have a direct effect on Cote d'Ivoire's output, and an even stronger impact on two important measures of the country's trade environment. The total impact includes the direct impact on GDP plus the indirect impact via trade. Also, one-time cocoa price shocks are associated with wave-like oscillations in these variables, especially the trade indicators. The real exchange rate and terms of trade have a big impact on productivity in

Cote d'Ivoire. Now, referring to Figure 10, we turn our attention to the impact of shocks to the trade indices upon output per worker.

Figure 10: VAR Impulse Response Functions on the Impact of Shocks in the Terms of Trade and the Real Exchange Rate Upon GDP per Worker
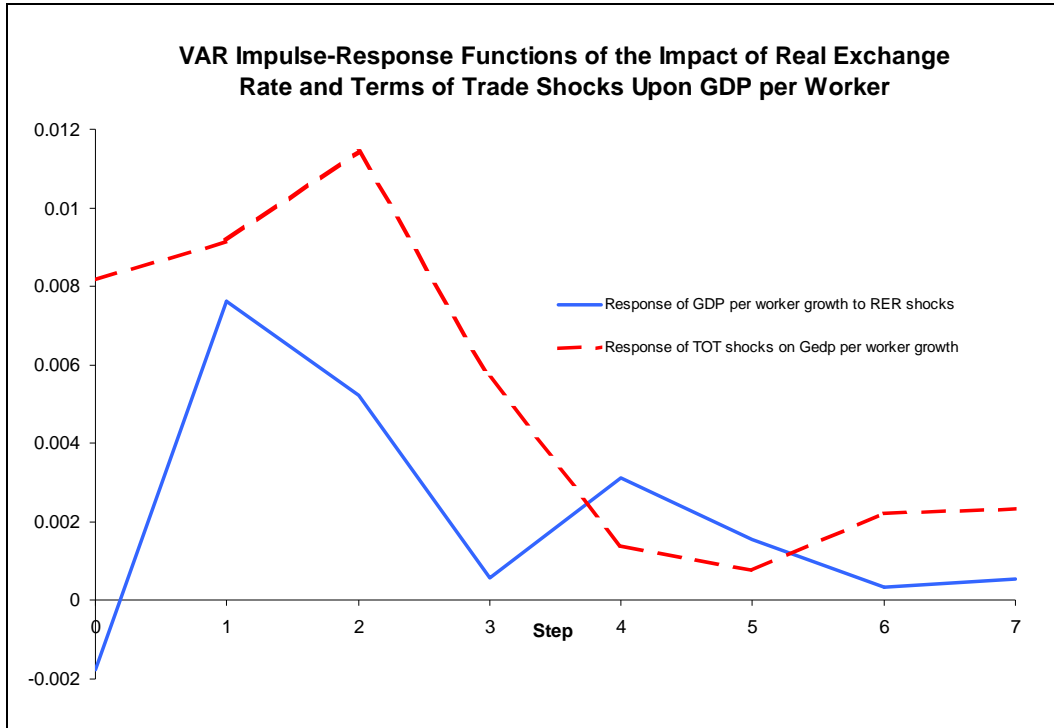
Positive shocks to the terms of trade are associated with an immediate improvement of eight-tenths of one percent in GDP per worker over baseline. This impact climbs to 1.2 percent improvement one year out, and continuing with improvement of six-tenths of one percent three years out and nearly two-tens percent improvement four years out. So, one-time improving "innovations" in the terms of trade have significant and persistent positive effects on per-worker GDP. The economy of Cote d'Ivoire is evidently strongly affected by world prices and, specifically, terms of trade.

Positive shocks to the real exchange rate (improving competitiveness) are associated with an improvement of about three-quarters of one percent in per-worker GDP one year out over baseline. The impact continues with an increase of one-half percent two years out. The TOT impact works faster than the RER impact, and is larger.

While Cote d'Ivoire's fixed exchange rate and monetary stability shelters it from the nominal shocks of inflations and exchange rate uncertainty, the same monetary-exchange framework does not provide cushion against real commodity price volatility and trade-induced shocks.

4.   VAR FORECAST: CONTINUING DECLINE

Using the identified, dynamic structure of interactions among key macroeconomic variables, we can develop unconditional growth baseline forecasts. The vector auto regression (VAR) impulse response functions (IRF) are deviations from a baseline VAR forecast, generated from all the variables to the number of lags specified (in this case, two). In our set-up, five variables are used: GDP per worker, capital per worker, terms of trade, real exchange rate, and world cocoa price, for a total of ten variables, using two lags. Of interest is our unconditional "baseline" forecast of output per worker, given its own first and second lags plus two lags for the other four related variables. Figure 11 shows the VAR baseline forecast for GDP per worker, and table below reports the values.

Figure 11: Vector Auto Regression Baseline Forecast for Growth in Real GDP per Worker. 2003 actual and four periods (years) ahead (2004, 2005, 2006, 2007).
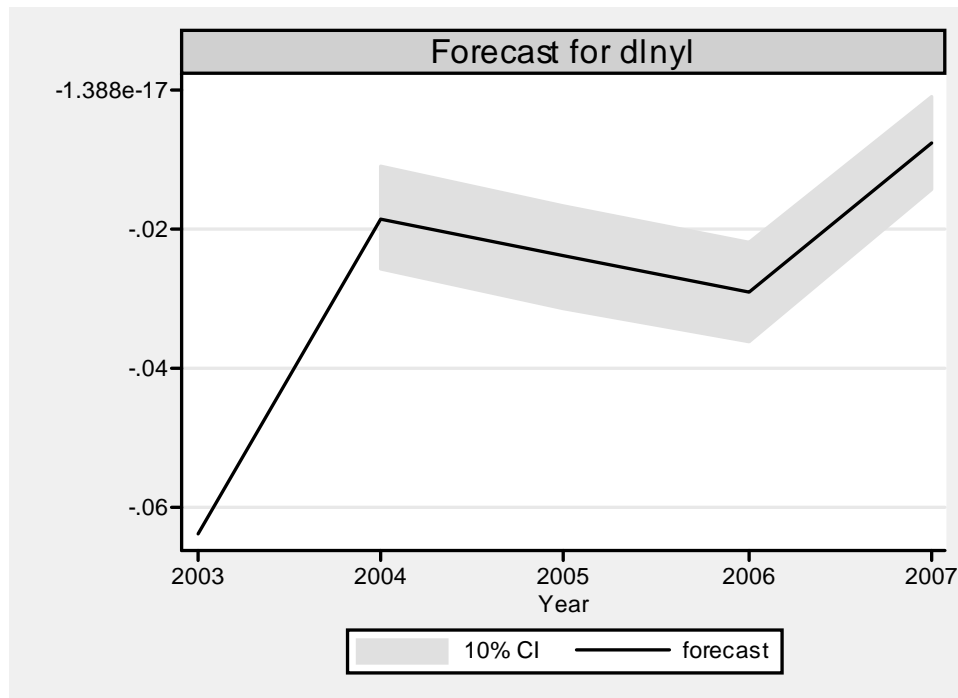
Year	D.lnyl	SE	Confidence Interval	
2004	-0.01841	.0573849	-0.02562	-0.01119
2005	-0.024	.05853188	-0.03136	-0.01664
2006	-0.02896	.05552499	-0.03594	-0.02198
2007	-0.00747	.05248643	-0.01407	-0.00088

2003 was a year of further output decline driven by uncertainties associated with the peace process, which exacerbated the well-established downward trend. Our model does not include explicit statistical information about the conflict, so it implicitly assumes a return to the normal (non-conflict) circumstances as experienced over most of the entire period. The unconditional, one step ahead VAR forecast for 2004 is a "recovery" to "only" –1.84% real growth, negative growth slightly less than the typical growth rate of the population and labor force. In 2005, the two-step-ahead forecast is –2.40%, and the three-step-ahead forecast for 2006 is –2.90%. It is only in 2007 that the decline in output seems to be slowing to only –0.7%.

The unconditional VAR baseline forecast indicates continued negative growth in real per-worker GDP in the near future. That negative growth continues at approximately historical rates as one moves forward into the future. Per worker output is expected to decline at roughly the same rate in absolute value as recent increases in the labor force and population growth. The implication is a stagnant economy, with continuing downtrend in income and consumption per capita. While this is a dismal result, it should be noted that prolonged uncertainty about the peace process or renewed hostilities would almost certainly exacerbate the down-trend in productivity, real output and further major increases in poverty. In sum, this empirical analysis strongly suggest that underlying dynamics of major macroeconomic variables and their interactions continue to be highly unfavorable, further exacerbated by the recent conflict and uncertainties about its resolution.

While of limited focus, the analysis and the growth forecast implies a need for major local and international effective efforts to turn around the highly unfavorable economic dynamics of Cote d'Ivoire. Simply put, the economy of Cote d'Ivoire has been on a downward roller-coaster for two and a half decade and the conflict related factors are pushing it further down. Unless political consensus and stable security is soon restored and economic management improved dramatically, the long-term economic forces and macroeconomic dynamics documented in this paper will tend to reinforce the downward spiral with detrimental consequences for the economy and people of Cote d'Ivoire and the subregion.

5. CONCLUSIONS

We set out to investigate sources of volatility that affect growth in Cote d'Ivoire. We have found evidence in support of the following results:

- GDP per worker, trade indices, and cocoa time series all share common cyclical patterns in Cote d'Ivoire.

- Two transition points define eras in Cote d'Ivoire's economic history:
    - A little-recognized cocoa-related break-point in 1976 and
    - The well-understood devaluation-related break in 1994

- Cote d'Ivoire has developed strong market power in cocoa, and the cocoa price-quantity relationship experienced a shift in 1976.

- World prices generally (TOT), real exchange rates, and cocoa prices specifically are a source of significant volatility to Cote d'Ivoire's economy with major impact on growth.

- Given the underlying macroeconomic dynamics, the downward trend in per-worker growth can be expected to continue in the immediate years ahead unless there is radical and immediate improvement in the political and security environment and economic management that could reverse the downward spiral.

ANNEX I: QUANTITATIVE METHODOLOGY

HP Filtering Technique

The macroeconomic literature on the business cycle is much concerned with quantifying "shocks" and studying short run deviations from long run trends. This literature sometimes employs various "smoothing" or "filtering" techniques, to distinguish between long-run underlying trends versus short-run deviations from those trends. The view of the world is that there are short run versus long run equilibriums, with unseen shocks producing swings either above of below long run underlying trends in the economy. We have borrowed techniques from this literature to study the development to Cote d'Ivoire.

Filtering or smoothing works as follows. For a given time series **X**, One uses a minimization algorithm to calculate a time series **S**. Values of time series S, or each S_t are each selected or calculated to trade off two objectives:

- *Trend should track the time series closely:* Minimize the discrepancy between **S** versus **X**, that is minimize the sum over t= 0 to T of the expression $(X_t – S_t)$
- *Trend line should be as smooth as possible:* Subject to the constraint that **S** is as close to a straight line as possible, usually involving an expression minimizing the local variation of **S** over time, written in the following form: $((S_{t-1} – S_t) – (S_t – S_{t+1}))^2.$

There is a lambda selected by the analyst representing the tradeoff between "lack of smoothness" of the trend versus close tracking of the original time series, and a set of first order conditions. The result is a smoothed or filtered time series of the "local central tendency" of the original time series. If the original unfiltered time series are weakly stationary with cyclical swings creating peaks and valleys, the filtered or smoothed time series will follow a path between the straight line trend and below the peaks and above the valleys.

Filtering is rather sophisticated from a statistical point of view but largely devoid of economic content. Some authors ascribe deep meanings to filtered times series, asserting that the trends represent long run equilibrium paths and the deviations of times series from calculated trends are quantifications of "shocks". We do not in this circumstance, although we find it useful. We therefore rely on filtering mainly as an exercise in descriptive statistics, helping us understand short run versus long run trends in the evolution of key time series describing the growth of Cote d'Ivoire's economy over time.

VAR Estimation Procedure

We use vector auto regression (VAR), a non-theoretical statistical "tool-kit" which focuses on variables as predictors of each other rather than parameter estimation or hypothesis testing. The series were all integrated of order one, and this model is in the first differences, using two lags. The series passed a stability test. Tests for Granger causality were inconclusive (and provide no empirical evidence about ordering). The model seems stable, and results do not change much consequent to various changes in specification (such as lags, ordering, etc.). Some notes on our estimation procedure:

- Using the AIC statistic we fitted the VAR with 2 lags and a constant.
- The Granger test didn't give much indication on causality. Our variables causing dln(Y/L) and the impulse-response functions were rather robust to the ordering.
- We ran the ADF test on the time series and ran the VAR in differences as every variable was integrated of order 1 ($I(1)$) .
- The innovations in the impulse response functions are orthogonal to each other with unit variance and pair wise uncorrelated.

For VAR models, it is customary to report the forecast error variance decomposition (FEVD). See Table 2: VAR Forecast Error Decomposition of the difference of the natural logarithm of GDP per worker in response to cocoa price shocks and real exchange rate shocks. Here we present two elements of the FEVD analysis, which pertain to two of the IRFs of interest. One pertains to the IRF for the impact of the cocoa price on output, while the other pertains to the IRF of a change in the real exchange rate on output. Interpretation: A one standard deviation shock to cocoa prices would account for %10.55 of the observed variability in the growth of GDP per worker one year out, reaching up to 25% in 3 or 4 years. A one standard deviation shock to cocoa prices would increase GDP per worker growth rate by 1.02% in the first year out, and 1.91% two years out, receding thereafter.

Table 2: VAR Forecast Error Decomposition of the difference of the natural logarithm of GDP per worker in response to cocoa price shocks and real exchange rate shocks.

Forecast Error Variance Decomposition (FEVD) Variable: D.LnYL			
Forecast Step	**Cocoa Price Shock**	**SE**	**OIRF**
1	10.55%	0.09	1.02%
2	13.83%	0.10	1.91%
3	24.98%	0.13	0.57%
4	25.64%	0.13	-0.20%
5	25.23%	0.13	0.08%
6	25.00%	0.13	0.51%
7	25.57%	0.13	0.40%

Forecast Error Variance Decomposition (FEVD) Variable: D.LnYL			
Forecast Step	**REER Shock**	**SE**	**OIRF**
1	0.16%	0.01	1.00%
2	4.49%	0.06	0.68%
3	5.49%	0.07	0.26%
4	5.62%	0.07	0.40%
5	6.06%	0.07	0.16%
6	6.08%	0.07	0.08%
7	6.03%	0.07	0.12%

Source: Authors' calculations. Each impulse variable was shocked by one standard deviation.

Further, we provide an illustrative summary linking the response of output to price ( ) and REER shocks ( ).

Figure 12: Summary, Response of growth rate to cocoa price and real exchange rate shocks

Impulse Variable	Shock Magnitude	Response of the Growth rate of GDP per worker (D.lnyl)		
		1	2	3
Cocoa Prices	**0.1627**	**0.96%** (0.007278)	**1.46%** (0.00768)	**0.21%** (0.005464)
Real Exchange Rate	**0.1233**	**0.67%** (0.006862)	**1.1%** (0.006794)	**0.48%** (0.004725)

Figure 13: VAR FEVD of GDP/worker in response to cocoa price and RER shocks

Impulse Variable	Shock Magnitude	Forecast Error Variance Decomposition of the Growth rate of GDP per worker (D.lnyl)		
		1	2	3
Cocoa Prices	**0.1627**	**0.5%** (0.013205)	**4.42%** (0.06099)	**11.5%** (0.097643)
Real Exchange Rate	**0.1233**	**0.18%** (0.008075)	**2.09%** (0.040829)	**6.2%** (0.069355)

Source: Authors' calculations. Each impulse variable was shocked by one standard deviation of the orthogonalized errors. The standard errors of the forecasts are shown in parenthesis.

ANNEX II: ADDITIONAL DATA AND INFORMATION

Time Series and Trends

Figure 14 shows data similar to that of Figure 1. Figure 14 shows the natural logarithms of GDP per worker in constant local currency units, that is logged 1995 CFA. We present this to make a few simple points. The time profile of GDP per capita and per worker are almost identical, as the labor force participation rate is very stable over time, so GDP per capita (an income measure) is (roughly) the same as output per worker (a productivity measure). The profiles over time of the logged data are the same as the un-logged profile, although the scale on the x-axis changes. And, data in constant CFA is very similar to data in constant dollars in this instance.

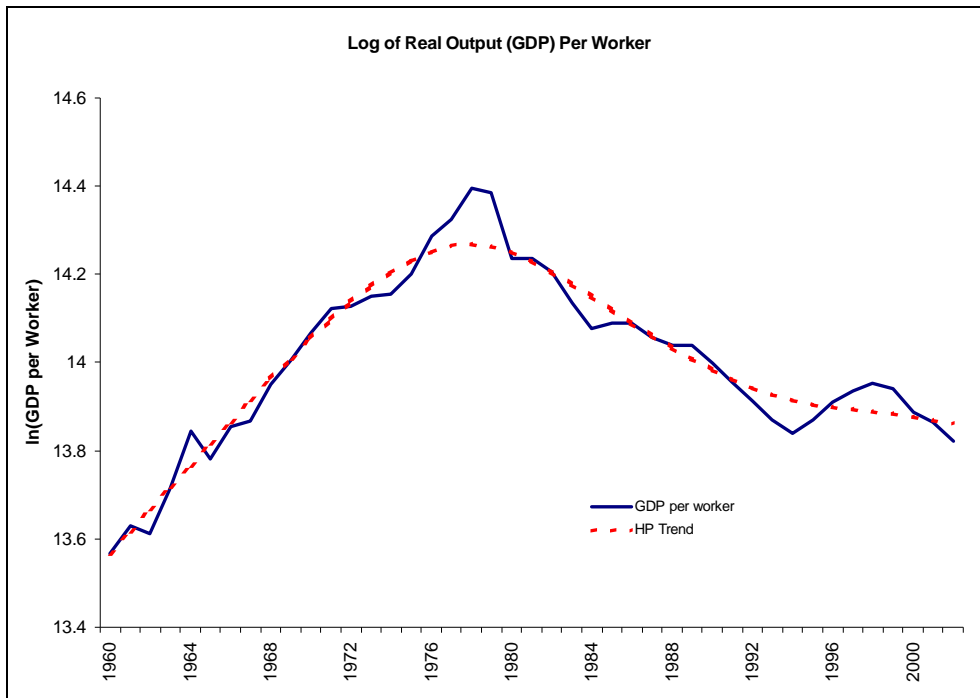**Figure 14 Output per Worker Versus Trend, in Logs, Cote d'Ivoire, 1960-2002**

Figure 15 show cocoa yields per hectare in Cote d'Ivoire over time, a measure of the productivity of land. Note that the trend in yields increased over time. By this measure of productivity or efficiency, Cote d'Ivoire does pretty well. The pattern of cycles, that is oscillations of annual yields across trend, at first glance seems different from the more general cycle observed in the macroeconomic, trade, a commodity price variables. While cycles in cocoa prices and output seem to be in harmony with the trade and output

variables, the cycles in yield seem less so, at least upon casual examination. Of course, yield shocks caused by weather and other factors may cause or contribute to cycles in output and prices.

Figure 15: Cocoa Yields per Hectare in Cote d'Ivoire, 1961-2002

Cocoa Yields in Cote d'Ivoire
(hg/ha) 1961-2002 (FAO)
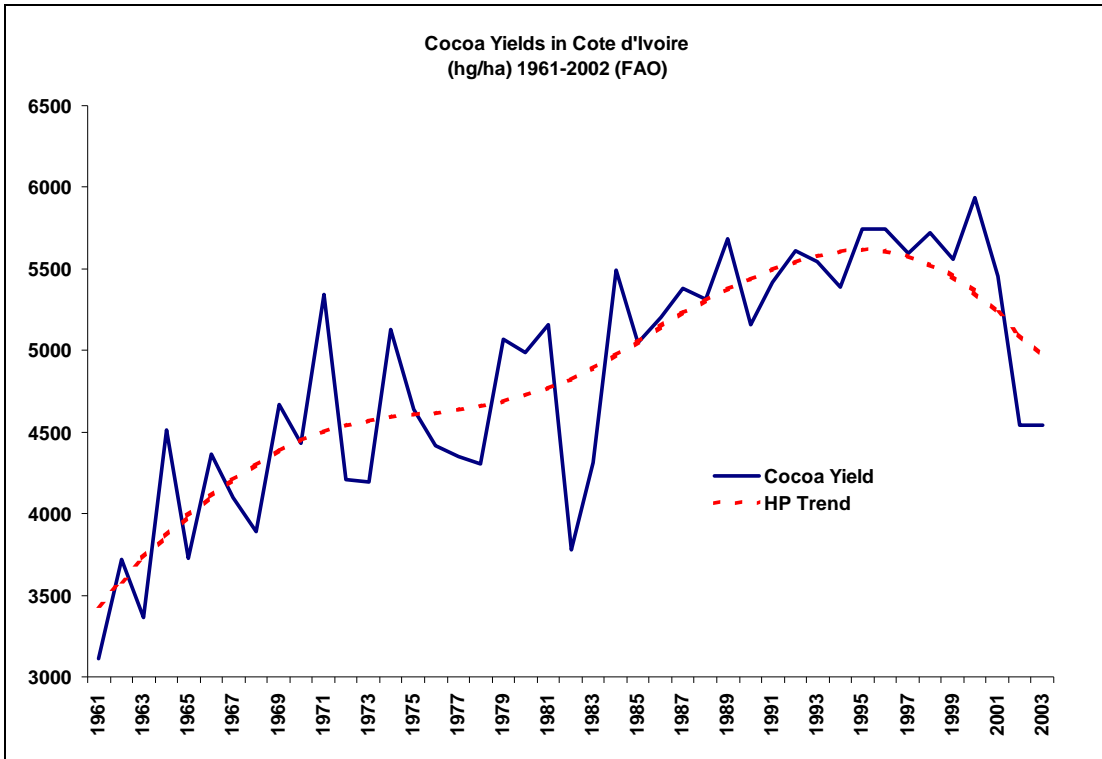
Cycles in Coffee Prices, Output and Yields

Figure 16 shows data on deviations from trend in coffee production, prices and yields, similar to data reviewed in section 2. Coffee, the second most important commodity in Cote d'Ivoire, shows a cyclical pattern much like cocoa, and moves together with cocoa.

Figure 16: Coffee Prices, Production and Yields – Deviations From Trend
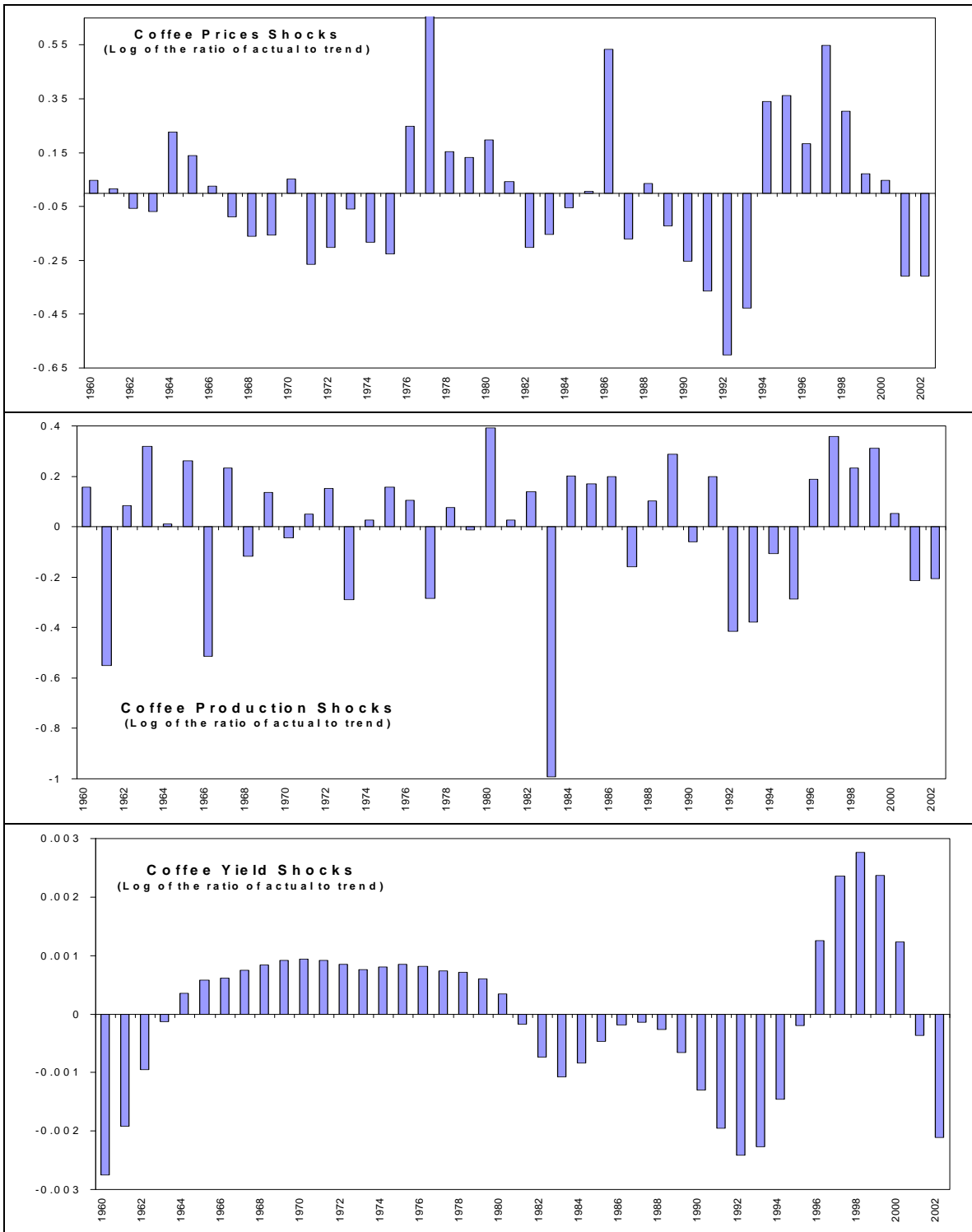
Figure 16 shows similar data on coffee real world prices, and Cote d'Ivoire production and yields. World price cycles around trend for coffee and cocoa have moved together, especially since the 1970s. Cote d'Ivoire production cycles around trend for both coffee and cocoa have also moved together. Coffee yields like cocoa yields first moved above trend, then below, then above. Casual empiricism suggests that coffee offers little benefit in terms of diversification from cocoa for Cote d'Ivoire, as cycles in both production and world prices for the two seem to correlate. And, price and output variability for coffee seems even worse than for cocoa. Coffee cycles seem to amplify rather than mitigate the cocoa cycle in the Cote d'Ivoire economy.

Figures 6, 7 8 and 19 did not hold the scale on the X-axis constant, and the deviation-from-trend series were plotted individually. The next two charts show first output and commodity price cycles on the same figure together, and then trade indices and cocoa prices together, to facilitate comparison.

 Figure 17 shows the cycles around trend of output, cocoa and coffee prices together. In the 1960s, cocoa and coffee cycles actually move against each other, but they have moved together ever since they crashed together in 1969. Both coffee and cocoa cycles peaked together at 75% and 65% percent over trend respectively in 1976, and then crashed together to 20% and 35% below trend in 1981, a huge downward swing which corresponds to the end of Cote d'Ivoire's post-independence growth spurt and the beginning of a long recession. Both commodity price cycles turned upward in the early 1990s, helping the post-devaluation recovery, and staying over trend until the late 1990s. The commodity price cycles are very volatile, exhibiting wide swings together. Above-cycle periods for commodity prices generally accompany rising cycles for output, while below-trend price cycles generally accompany falling output cycles.

Figure 18 shows cycles around trend of output per worker versus the terms of trade and real exchange rate. TOT exhibits much wider swings around trend than RER. In the late 1960a and the 1970s, cycles in TOT and RER moved against each other. Post 1980, they began to move together. Both reacted to the 1994 by moving strongly in the "right" direction. Post-devaluation both began to fall the "wrong way" almost immediately, and ominously both slipped below trend by 1999. The cycles in TOT and RER seem to lead the real output cycle somewhat.

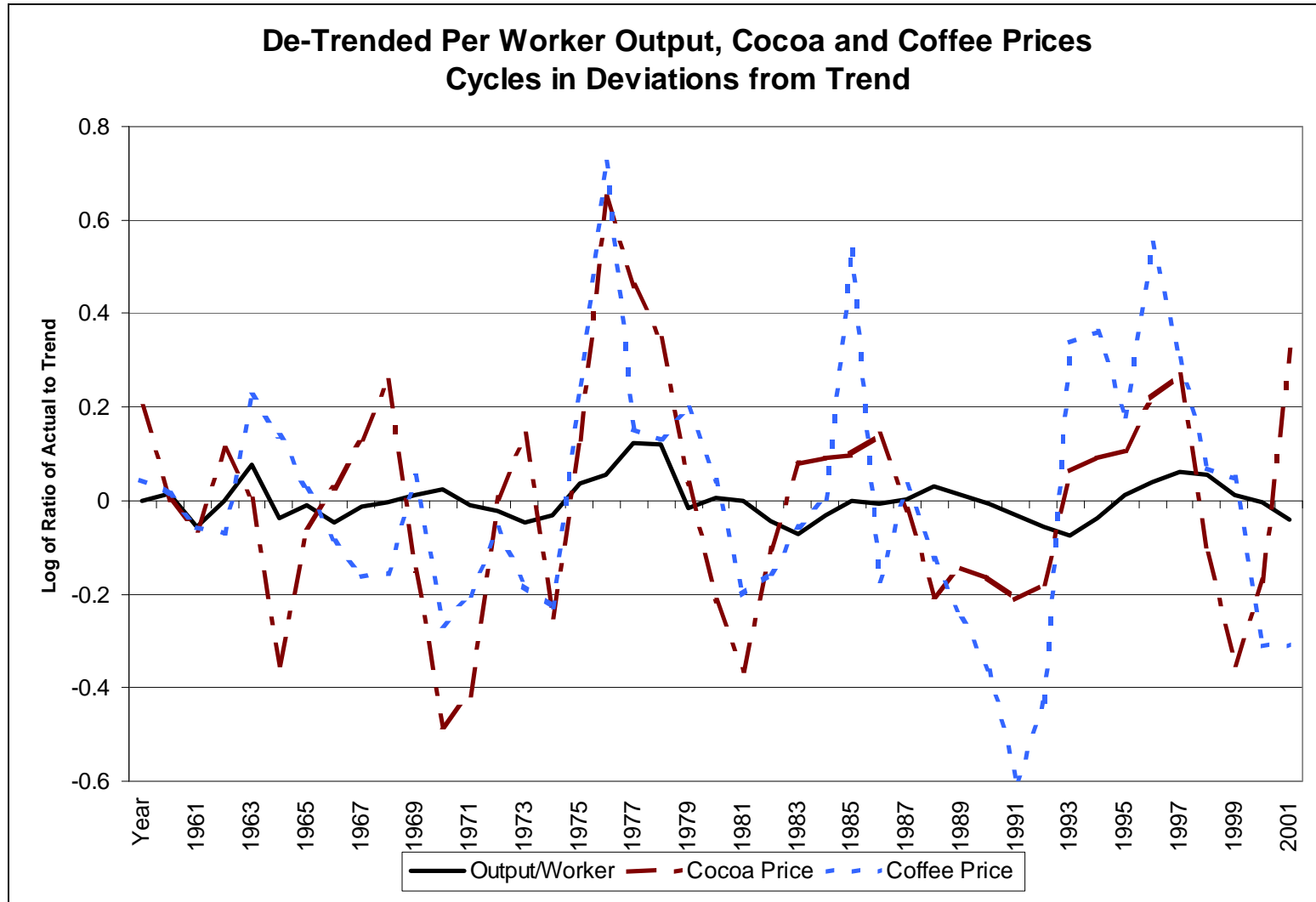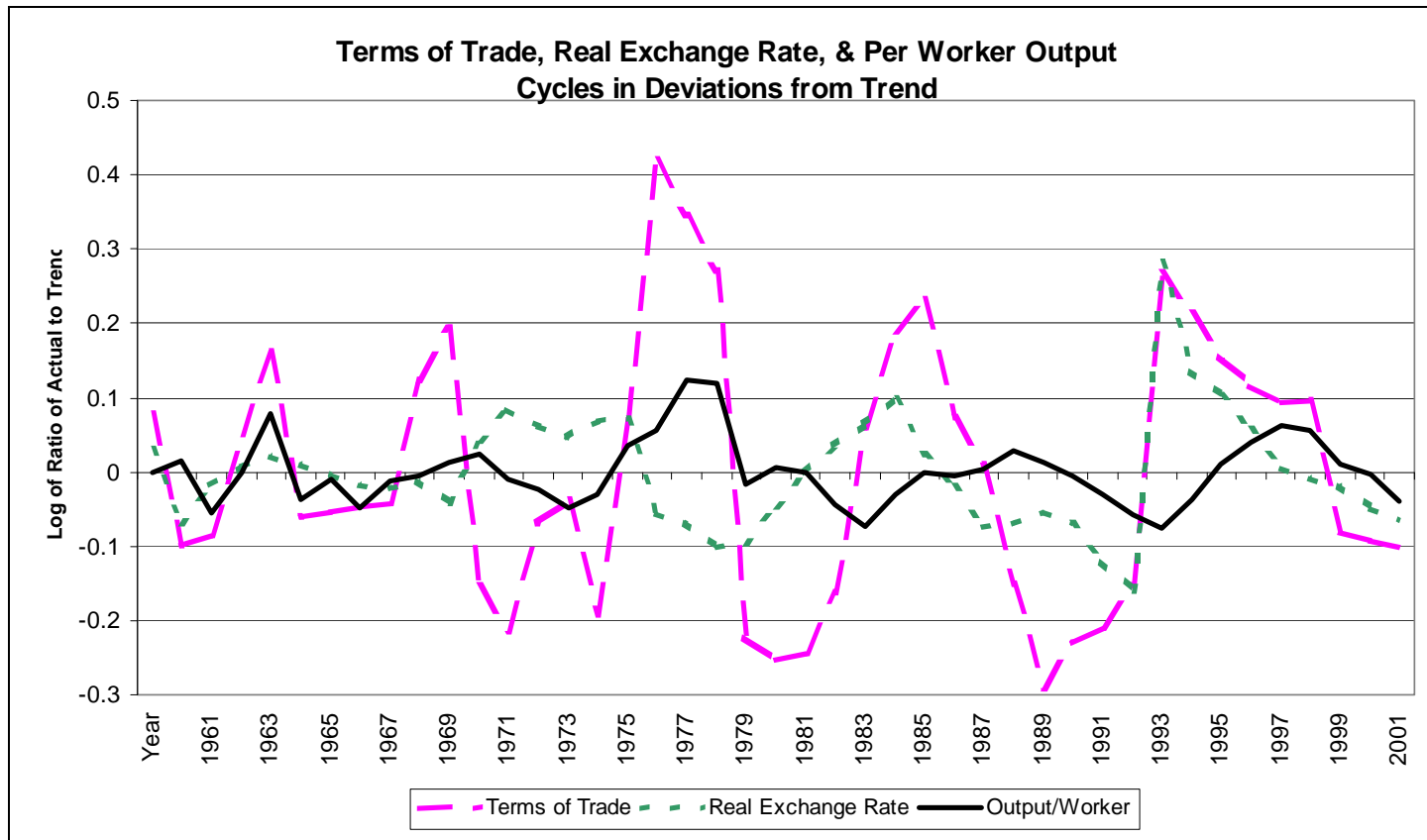**Figure 17:Cycles in De-Trended Output per Worker, Cocoa and Coffee Prices**

De-Trended Per Worker Output, Cocoa and Coffee Prices
Cycles in Deviations from Trend

Figure 18: Cycles in De-Trended Output per Worker, Terms of Trade, and Real Exchange Rates

Terms of Trade, Real Exchange Rate, & Per Worker Output
Cycles in Deviations from Trend

Cote d'Ivoire and World Cocoa Markets

To better articulate our characterization of the role cocoa in the economy of Cote d'Ivoire, we turn to a review of production and market share statistics. Figure 19 provides statistics of cocoa production in metric tons, while Figure 20 shows Cote d'Ivoire's percentage share of world output.

In 1970 Cote d'Ivoire produced 179,000 metric tons of cocoa, about 11.6% of world production. In 1980 Cote d'Ivoire produced 417,000 metric tons, about 25% of world output. So, sometime in the 1970s, the country began to dominate world cocoa output, and went on to produce over 41% of world output by 2000.

At the about the same time, physical cocoa production displaced coffee production as the leading commodity of Cote d'Ivoire in quantity. In 1970, Cote d'Ivoire produced 276,000 metric tons of coffee beans versus 179,000 MT of cocoa beans. In 1974 for the first time, cocoa production tonnage exceeded that of coffee, 241,000 versus 196,000. In 1976, Cote d'Ivoire's cocoa output tonnage moved permanently ahead of coffee. World coffee production greatly exceeds world cocoa production in volume.

Figure 19: Physical Production of Raw Cocoa in the World and Cote d'Ivoire
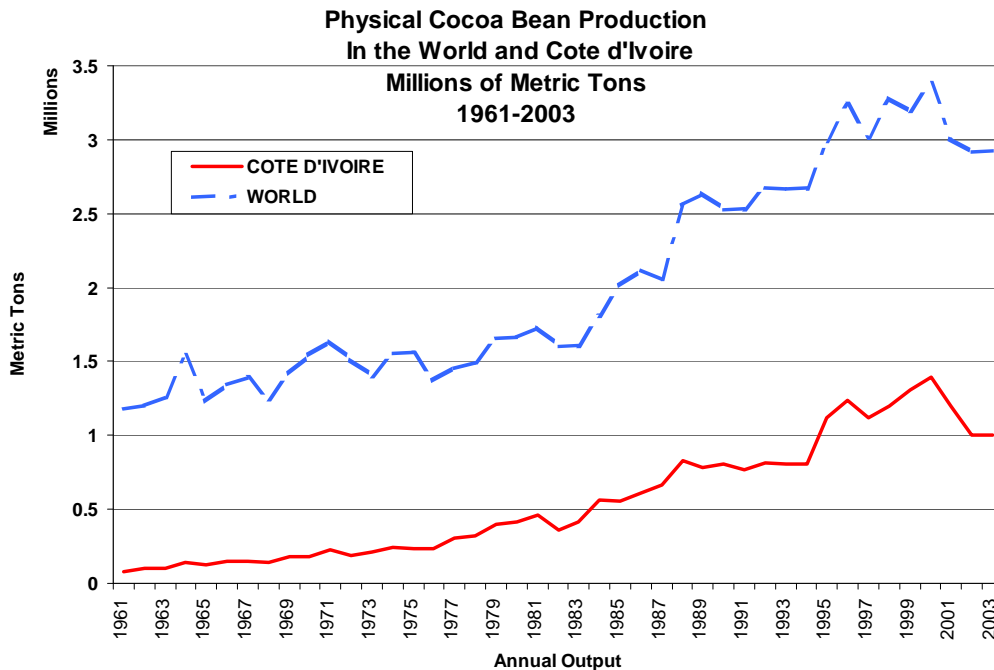
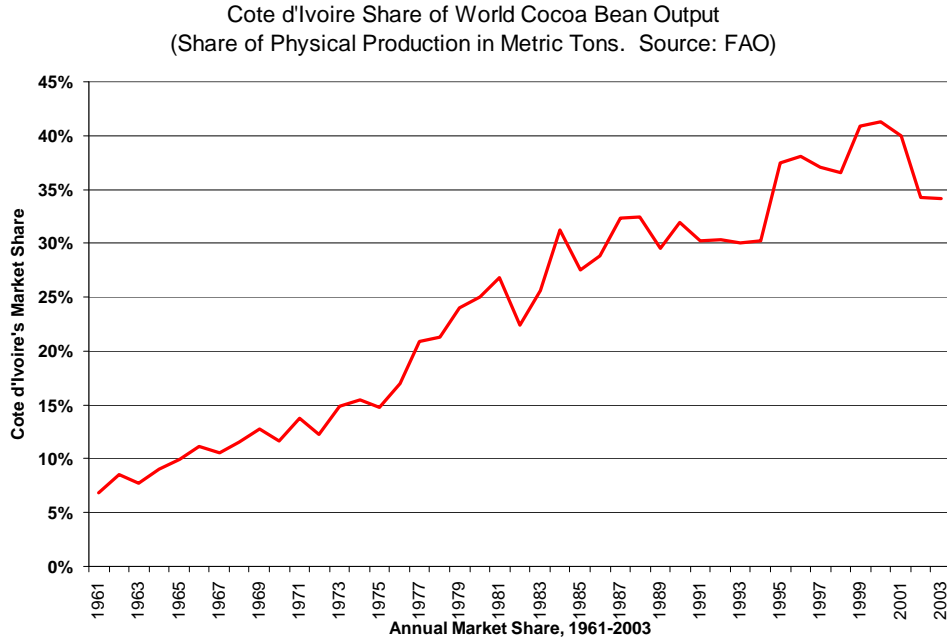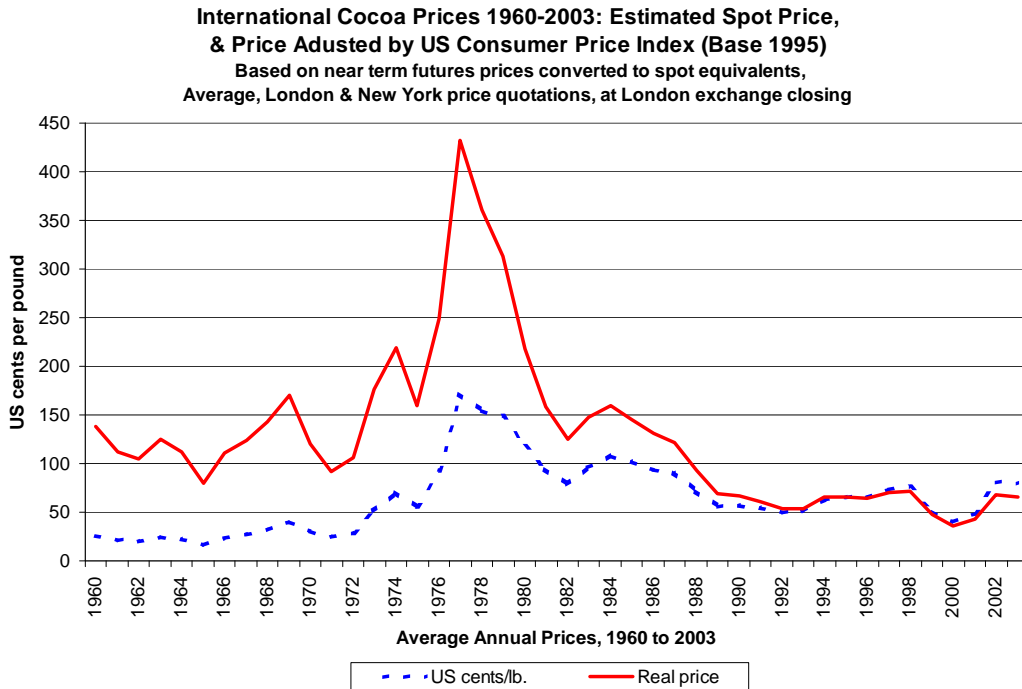**Figure 20: Cote d'Ivoire's Share of World Cocoa Production**

Cote d'Ivoire Share of World Cocoa Bean Output
(Share of Physical Production in Metric Tons. Source: FAO)

Figure 21: World Cocoa Prices

International Cocoa Prices 1960-2003: Estimated Spot Price,
& Price Adusted by US Consumer Price Index (Base 1995)
Based on near term futures prices converted to spot equivalents,
Average, London & New York price quotations, at London exchange closing

This descriptive data provides justification for our initial hypotheses that: a structural break occurred in or around 1976, that it was cocoa-related, and cocoa is important enough to influence the macro-economy of Cote d'Ivoire.

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