CHAPTER 3

North-South Asymmetric Relationships: Does the EMU Business Cycle Affect Small African Economies?[1]

3.1 Introduction

A growing amount of literature has addressed the external effects of the EMU for developing countries in many aspects. For example, on the real side, Ruhashyankiko (1999) studied the link between the volatility of European currencies exchange rates and the economic performance in the Middle East and North Africa, while Levy Yeyati and Sturzenegger (2000) and Benassy-Quéré and Larèche-Révil (2000), on the monetary side, investigated the implications of the euro for the Latin American financial sector and the anchorage of the Central and Eastern Europe currencies, respectively. Some theoretical papers (Hadjimichael and Galy, 1997; Konate, 2001; Nyembwe, 2003) have tried to assess the implications of the advent of the euro on the African countries. But, as far as we know, there is no study devoted to a rigorous empirical analysis of the relationships between the EMU and Sub-Saharan Africa (SSA), despite the importance of the European Union as the main trading partner of African countries.

Since the EMU is the main importer of African exports and the main supplier of African imports, its economic activity fluctuations are likely to have a substantial impact on the SSA economic activity. There is an extensive body of literature that provides the empirical evidence of a European business cycle (EBC) and national business

[1]This chapter is a joint work with Konstantin Kholodilin.

cycles "convergence" in the EMU. See for instance Angeloni and Dedola (1999), Artis and Zhang (1999), Holmes (2002) and Artis et al. (2003). The "convergence" we are interested in means the degree of synchronicity of national business cycles. Combining this evidence with the linkages that are thought to exist on theoretical grounds between the EMU and the SSA, one may wonder whether the EMU business cycle affects African countries. The answer to this question depends on whether we will be able to show empirically that the two regions are actually linked to an extent that allows for economic interactions. If links are evinced with data, a deeper convergence of European economies — if changes in the magnitude and the speed of economic fluctuations occurs in EMU — will be likely to matter for SSA's countries.

Both EMU and African economic series are going to be used to compute cross-correlation coefficients for several leads and lags as well as to perform Granger causality tests, following in this Agénor et al. (2000). The use of cross-correlation coefficients is largely accepted in the empirical business cycle literature (see also Kydland and Prescott, 1990; Fiorito and Kollintzas, 1994). But, as Agénor et al. (2000) recognized, these coefficients do not imply causal relationships. In our study, we consider different types of results. First, an evidence provided by a maximum correlation coefficient suggesting a leading effect of a European variable will be accepted if it is either accompanied by a significant contemporaneous correlation coefficient or confirmed by the Granger causality test result. Secondly we will also accept the evidence provided by the case of synchronous cycles of European and SSA's country variables, when the contemporaneous correlation is significant at 10% level (at least). Indeed, the Granger test does not consider the contemporaneous correlation.

In order to capture the EMU economic activity we use either a classical Euro area variable or a Stock & Watson indicator whenever it is possible. We attempt to use the linear dynamic factor model (Stock and Watson, 1989) methodology to build indicators of the EBC. Since the GDP series of European economies we obtained are cointegrated, we simply used a classical GDP series of EMU to capture the cyclical behavior of European GDP. The linear dynamic model is then used only for European wholesale and consumer prices.

The usual Stock and Watson indicator of economic activity is estimated for various relevant variables of a national economy, especially industrial production, real personal income, real manufacturing and trade sales and finally, total employee-hours in non-agricultural establishments. This composite index is interesting in the sense that it appears to be a common component featuring the various series used. Thus, we consider that this "common component" is, to some extent, the implication of business cycles

convergence if its impact on national series is significant. We then fit composite indexes with similar variables of EMU country-members' economies instead of various series of only one national economy. We then capture the common component of the economic activity in EMU which is insulated from idiosyncratic components.

This is why such a common component could be, to some extent, more interesting than a classical Euro area variable. Indeed, classical aggregate series — for example Euro area GDP — are weighted by the economic size of various countries. This is of less interest for us in the sense that we look for only the common component from various European economies. Conversely, one can argue that using the common component means a loss of information because the various economies do not symmetrically influence each other, the big economies having a greater impact on the EBC. It also needs to be noticed that the European cycle is correlated with those of other industrialized economies, namely the United States economy. Insulating the specific European component from the others is widely outside the scope of this study and deserves further research.

The originality of our study is twofold. On one the hand, it extends the empirical literature on business cycle to specific SSA's countries, despite the scarcity of reliable data to build business cycles indicators of African economies. The issue is tackled by identifying possible theoretical channels of transmission in order to study the correlation between the EBC indicators and some variables of transmission for which we can obtain appropriate data. The task here is to answer the question whether the empirical evidence on the external impact of the developed country's economic activity could be confirmed when considering individually small SSA's countries. For example, Kose and Riezman (2001) found a weak but positive impact of industrial country GDP on some middle income DCs, while Hoffmaister et al. (1998a) showed that the "North" greatly influences the GDP of an aggregate "South". On the other hand, we contribute to the growing body of literature on the EMU by adding a piece of work that treats the external effects of economic activity in Europe on the small African developing countries.

Agénor et al. (2000) have empirically tested the relationship between a common business cycle of industrial countries and those of some middle-income DCs and found that, regardless of the detrending method used, a weak but positive robust correlation holds and indicates a relatively rapid transmission of output fluctuations in industrial countries to developing country's economies. While Kouparitsas (1996) found that the South is affected by shocks originating in the North, Hoffmaister et al. (1998a) argued

that the resilience of the South[2] to the industrialized countries' business cycle is mainly due to Asian economies than to the "Other South". This finding is consistent with the results of Kose et al. (2003) who found that the correlations of output growth rates of DCs and their composite measure of world output declined in the nineties. Moreover, among DCs, the decline is more pronounced for the more financially integrated group of economies, i.e. "the emerging markets", than for the less financially integrated group.

What is also interesting to note from the existing literature is the fact that, as the comovements of business cycles can theoretically be explained by trade and financial linkages (Kose and Yi, 2001; Kose et al., 2003), Kose et al. (2003) found that their (empirical) effect on output correlations appears to be stronger for industrial countries than for developing countries. Calderon et al. (2002) also found that trade linkages have a more important impact on the comovement of business cycles in advanced countries than in DCs.

All the results are presented either for DCs as a whole or for various groups of DCs. Thus, it is interesting to examine whether the SSA's countries, individually considered, are sensitive to the economic fluctuations of their main trading partner — the EMU.

The choice of SSA's countries we retain in our study is due to the availability of data. But most of these countries are located in Western and Central Africa. Moreover, many of them belong to the zone franc that we sometimes call CFA zone. It follows that our group of African economies retained is quite homogeneous. Let us keep in mind that when invoking the SSA's countries, we are referring to a limited group of Sub-Saharan African countries.

The rest of the chapter is organized as follows: in section two, we highlight the plausible theoretical channels of transmission, basing ourselves on previous studies. We also review the empirical literature devoted to the EBC in order to determine the extent to which the convergence of business cycles in Europe deserves our attention. Section three presents the data while Section four describes the methodology we use to investigate the empirical link between the European economic activity and selected African economies. In the fifth section we build cyclical economic activity indicators and we perform correlation analysis and Granger causality tests before the final section concludes through a summary of our findings.

[2]Hoffmaister et al. (1998a) split up the South in two components in order to refine their empirical investigation of North-South economic interactions. On the one hand, they considered Asia, and, on the other hand, the rest of developing countries they called *Other South*.

3.2 North-South Linkages and Business Cycles in the EMU

This section is devoted to identifying the plausible economic linkages between EMU and SSA in order to highlight the possible EBC's channels of transmission to SSA's economies. We provide some key demand and supply-side spillover channels that are likely to explain the trade and financial markets-induced transmission of business cycles. It will then be possible to determine which relationships could be empirically investigated, as quarterly data time series on Africa's economic activity are scarce. On the other hand, we investigate the empirical EBC literature to ascertain the extent to which the business cycle in the Euro area deserves our attention.

3.2.1 North-South Asymmetric Interactions: Channels of Transmission to the Sub-Saharan Africa

Despite the increasing economic interdependence between industrial countries and developing countries (Vines and Currie, 1995), the economic interactions between Sub-Saharan economies and the EMU remain a one-way dependence. The reason is twofold: on one hand, the increasing importance of the South in the world economy is mainly due to the development in Asian and Latin American economies rather than the growth in African countries (Hoffmaister et al., 1998a)[3]. Even if some of these countries are oil-exporters, — notably Angola, Cameroon, Gabon and Nigeria — their importance as price makers in the petroleum industry is insignificant. On the other hand, the development of the financial integration that increased interactions between the North and the South (Hoffmaister et al., 1998a) is almost non-existing in SSA. The emerging financial markets, which become increasingly important for Northern financial markets, are located outside of Africa.

Therefore, it is easy enough to describe a framework of interaction between the EMU economic activity and the Sub-Saharan economies. We will disentangle various channels of transmission with the help of existing theoretical and empirical studies on the North-South economic interdependence, in order to determine the economic links which will be tested empirically.

[3]Hoffmaister et al. (1998a) found the evidence of a structural break in the North-South relationships. Since 1988, the South has become more resilient to the North business cycle, while the latter has become more sensitive to growth of the former.

Direct Demand Shock to the Exports

This channel is largely invoked in the literature. Increased output in the industrialized countries is likely to increase the demand of DCs exports, leading to a greater correlation of outputs and then a comovement of business cycles (Kose et al., 2003). It follows that this channel of economic shocks transmission implies an unambiguously positive correlation of BCs. But, as stressed by Kose and Yi (2001) and Kose et al. (2003), trade linkages can, on the other hand, induce a decrease of the degree of business cycles comovement, when considering the supply side. Indeed, if stronger trade linkages lead to an increased specialization of production, the subsequent inter-industry pattern that is expected — according to the classical trade theory — will cause economies to be differently affected by industry specific shocks. This is likely to decrease the degree of business cycles comovements.

The SSA's economies are open and are hence sensitive to the changes in the value of exports and imports. Analyzing a sample of 22 African economies including 18 SSA's economies, Kose and Riezman (2001) highlight that the average Exports/GDP ratio is 30.8%. They also note that average Imports/GDP and (Imports+Exports)/GDP ratios are respectively 40.4 and 71.1. Accordingly, we argue that fluctuations of economic activity in the EMU are likely to have an impact on SSA's country's GDP in a Keynesian-like framework if the European demand for imports is affected. Indeed, the EU is the main trading partner of most SSA's countries for its share in the total SSA's exports is either the largest or major.

The Role of Terms of Trade and Relative Prices

The terms of trade (TT) or relative prices changes act also as channels through which the economic activity abroad affects the economies of developing countries. As there could be an export supply response to changing export prices, the impact of TT could also work through an income effect that could lead to changes in the domestic demand[4] (see Kouparitsas, 1996). Thus, an improvement of a country's TT is expected to induce an improvement of net exports and GDP.

On the other hand, since capital goods and inputs compose the main part of SSA's imports, a price increase of one of these goods will act like a negative shock on the output. Hoffmaister et al. (1998b), for example, stresses that an increase in the price of intermediate inputs is similar to a negative technological progress. The variable

[4]It has to be noticed that an improvement of TT caused by a decrease of import prices is likely to induce an increase of imports instead of the domestic production.

of interest to capture this channel of transmission is the ratio of imported foreign inputs and capital goods prices to domestic producer prices since we are interested in looking for the possible impact of a shock in the prices of these imported goods on SSA's economies. In our study, classical TT — ratio of export price to import price — are not suitable to investigate this channel of transmission because SSA's countries essentially export primary goods that are not produced for domestic consumption. An increase of domestic relative producer prices, i.e. the decrease of relative foreign prices of inputs and capital goods, is expected to induce an increase of the African economy production.

Whether the GDP of EMU affects positively the Sub-Saharan African country GDPs through this channel depends on the procyclical or the countercyclical behavior of prices in EMU. In fact, there is in the economic literature, a lasting debate on the cyclical behavior of prices. There is no clearcut consensus since both the countercyclical and the procyclical behavior of prices in industrial economies are documented through a substantial literature (See Agénor et al., 2000, and references therein).

Using a variance decomposition method, Kose and Riezman (2001) found that the trade shocks account for approximately 45% of the variation in the aggregate output of many African countries. This impact works through changes in the relative prices of capital goods (almost 25%) and in the relative prices of intermediate goods (less than 20%). In addition, they found that these shocks largely explain the variability of aggregate investment in Africa. This is because the imported capital goods represent the bulk of investment goods in the primary good production sector. Additional evidence of the impact of terms of trade is provided by Hoffmaister et al. (1998b) who found that terms of trade have some impact on the output of Sub-Saharan African countries, even if this impact is stronger in CFA franc country group than in the non-CFA group. Thus, the TT could be considered as a relevant candidate for a channel through which economic fluctuations in the EMU area are transmitted to SSA's economies. These constitute the *imported* supply shock side of business cycles in Africa — see also Kouparitsas (1996) for a link between prices of Northern capital goods and the Southern imports and production.

The Role of Interest Rates

An increase in the world interest rates is likely to induce a decline of output in developing countries, as it could imply a heavier debt burden. On the other hand, if African countries were integrated enough in the world financial market, an increase of the world interest rates could result in capital outflows that would lead to a decrease

in investments. Hoffmaister et al. (1998b) argue, for example, that an increase in the world interest rates "...tends to have a contractionary effect on total GDP..." because of the equality between the capital/labor ratio and the world interest rate assumed in the classical framework under perfect capital mobility.

Hoffmaister et al. (1998b) provided some evidence of world interest rate impact on African countries of the CFA zone, while Agénor et al. (2000) found a positive relation between some middle-income developing country economies and a weighted index of interest rates in industrial countries[5]. Contrary to the preceding empirical results, Kose and Riezman (2001) found no significant impact of the shocks in the world real interest rate on African economic activity. Their study suggests that the world real interest account for less than 1% of output volatility. But as they argued, this result could be due to the use of a model with an incomplete asset market or due to the small size of the sample they used. Depending on the extent of financial integration of EMU and African countries, it could be expected that EMU interest rates are likely to have an impact on SSA's economies.

Monetary Links and Business Cycles

It is known that a pegging country policymaker looks for credibility through the adoption of a fixed exchange rate regime. In this case, the discretion of conducting monetary policy is lost since the targeted inflation becomes that of the anchor country. Abandoning the exchange rate as a stabilizing macroeconomic tool leads to a conformity of monetary policy. Thus, asymmetric shocks tend to diminish (De Grauwe, 1997), as shocks could be transmitted from one economy to another. The monetary integration is then likely to create a convergence of business cycles. Considering this possible implication of monetary integration and the European project to form a monetary union, many authors have undertaken to investigate the possible link between exchange rate regimes and the synchronization in business cycles. In the next section we provide references on the empirical evidence of the European business cycle existence.

There are 14 Sub-Saharan African countries belonging to the franc zone which form two monetary unions whose currencies — two different currencies both called *franc CFA* — are pegged to the euro. Two other African countries (Comoros and Cape Verde) have separately linked their currencies to the euro through a fixed exchange rate regime. Additionally, there is another group of Western Africa's countries engaged in a process of monetary integration with some franc zone members — influenced by the

[5] Agénor et al. (2000) argued that an expected negative effect could have been muted by the indirect opposite impact of aggregate activity in industrial economies as the interest rates are procyclical.

EMU monetary policy — in order to form a new monetary union (Masson and Patillo, 2001a). Thus, we retain here the exchange rate regime — or monetary policy — as a possible channel of the Euro area business cycle transmission to African economies.

3.2.2 Empirics of Business Cycles in EMU

Before addressing the issue of a possible impact of the EBC — or simply economic activity — on small African countries, it makes sense to inquire about the existence of a common Eurozone cycle and to check whether a convergence is really taking place or not. As these issues are somewhat outside the scope of our study, we limit ourselves to reviewing the existing empirical literature devoted to the EBC and the convergence issue. In our study we stick to two broad definitions of business cycle — a classical cycle and a growth cycle. Following Massman and Mitchell (2003) we call "classical cycles" the cycles that are defined in terms of turning points in the original series while "growth cycles" mean "deviations" from a trend.

Table 3.1: Summary of empirical studies on EBC and convergence

	Existence of EBC		Convergence of BC	
	Yes	No	Yes	No
1. Classical cycle (including growth rates based cycles)				
Artis et al. (2003)	x			x
Dueker and Wesche (1999)			x	
Harding and Pagan (2001)		x		
Krolzig (2001)	x			
Massman and Mitchell (2003)			x	
Ormerod and Mounfield (2002)	x		x	
2. Growth cycle				
Artis et al. (2003)	x		x	
Artis and Zhang (1999)	x		x	
Agresti and Monjon (2001)	x			
Harding and Pagan (2001)		x		x
Holmes (2002)	x		x	
Inklaar and de Haan (2001)				x
Krolzig (2001)	x			
Massman and Mitchell (2003)			x	
Artis & Zang(1997)	x		x	
3. Miscellani				
Angeloni and Dedola (1999)	x		x	

Note: Harding and Pagan (2001) found a very weak correlation between European business cyles. We interpret their finding as a lack of robust evidence of the classical EBC existence.

Table 3.1 shows that almost all the studies reviewed admit the existence of the EBC, and most of them conclude that a convergence of country specific business cycles is or has been in place.

It appears from the empirical evidence that the emergence of a EBC is justified

by data and we could reasonably expect the European economies to further converge. Finding any empirical evidence of the EBC indicators' impact on African economic variables means suggesting that further convergence of European country cycles could matter for Africa; as we are going to interpret these indicators as measures of the common component of the converging European country economies.

3.3 Data

In this chapter, we consider the relationships between the real and monetary sectors of the European and African economies. On the "real side" we have GDP, relative wholesale prices, terms of trade, income terms of trade[6] and real exports, whereas on the "monetary side" we have the consumer price index; it is used as an indicator of monetary policy. The economic relationships that we will examine are summarized in Table 3.2.

While looking for a possible BCs comovement, one of the accurate correlations to study is that of GDPs. But the lack of quarterly GDP series of SSA's countries make us consider second best solutions. First, we analyze the interactions between annual GDPs of the EMU and some SSA's countries for which data are available. Then, we simply focus on some channels of transmission for which available data are found to provide appropriate proxies. The analysis based on quarterly data turns out to be an empirical investigation of the various channels we highlighted above. As noticed in the preceding section, the expected sign of some studied relations is ambiguous because the behavior of some variables of interest can be either procyclical or countercyclical.

Table 3.2: Directions of analysis

Europe		Africa	sign
Annual series			
Real GDP	→	Real GDP	+/−
Wholesale prices (relative)	→	Real GDP	−
Quarterly series			
Real GDP	→	Terms of trade	+/−
Real GDP	→	Income terms of trade	+/−
Real GDP	→	Real exports	+
Consumer prices	→	Consumer prices	+

We do not take into account the interest rates we considered as a possible channel

[6]Income terms of trade here are the nominal African exports divided by the European export price index.

of transmission because using the various measures usually encountered as proxies for world real interest rates will not add any information in comparison with the existing literature. Blankenau et al. (2001) stress that there is no consensus on a good proxy for the ex-ante world interest rate. The LIBOR, for example was found to be highly correlated with the US 3-month T-bill rate and a weighted average of several countries T-Bill rates (Blankenau et al., 2001). Moreover, we face a data restriction as long and usable series of investment and debt service of African economies are not available. Tables 3.3 and 3.4 show the availability of the data for each of the countries included in our analysis.

Table 3.3: Availability of the data: African countries

Country	Available data					
	Real GDP	TT	ITT	Real exports	Nominal exports	CPI
Angola	—	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	—
Benin	1970-2000	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	—
Burkina Faso	1978-2002	—	1981:1-2000:3	—	1981:1-2000:3 2002:2-2002:4	1983:4-2001:4
Cameroon	1969-1997	1980:1-2000:3	1981:1-2000:3	1980:1-2000:3	1980:1-2000:3	1970:2-2002:4
Congo	1960-2000	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	—
Ivory Coast	—	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	1970:2-2002:4
Gabon	—	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	1970:2-2000:4
Gambia	—	—	1981:1-2000:3	—	—	1970:2-2001:1
Ghana	1968-1997	—	—	—	—	1970:2-2002:4
Guinea	—	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	—
Madagascar	1968-1997	—	1981:1-2000:3	—	1980:1-2000:3	1970:2-2002:4
Mali	—	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	—
Niger	—	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	1970:2-2002:4
Nigeria	1969-2001	—	1981:1-2000:3	—	1981:1-2000:3	1970:2-2001:2 2001:4-2002:4
Rwanda	1968-2001	—	—	—	—	—
Senegal	1968-2001	—	1981:1-2000:3	—	1981:1-2000:3	1970:2-2002:4
Sierra Leone	1971-2000	—	1981:1-2000:3	—	1981:1-2000:3	—
Togo	1970-2000	1980:1-2000:3	1981:1-2000:3	1981:1-2000:3	1981:1-2000:3	1970:2-1994:4 1995:3-2002:4

Source: see Appendix A.1.

Table 3.4: Data used for European countries

Country	Available data			
	Real GDP (annual)	Wholesale prices (annual)	Real GDP (quarterly)	CPI
Austria	1970-2002	1965-1998	1980:1-2000:2	1970:2-2003:3
Belgium	1970-2002	-	1980:1-2000:2	1970:1-2003:3
Finland	1970-2002	1965-1998	1980:1-2000:2	1970:2-2003:3
France	1970-2002	1965-1998*	1980:1-2000:2	1970:2-2003:3
Germany	1970-2002	1965-1998	1980:1-2000:2	1970:2-2003:3
Italy	1970-2002	-	1980:1-2000:2	1970:2-2003:3
Ireland	1970-2002	1965-1998	1980:1-2000:2	1970:2-2003:3
Netherlands	1970-2002	1965-1998	1980:1-2000:2	1970:2-2003:3
Portugal	1970-2002	-	1980:1-2000:2	1970:2-2003:3
Spain	1970-2002	1965-1998	1980:1-2000:2	1970:2-2003:3
Euro area	1970-2002	-	1980:1-2003:3	1971:1-2002:4

* :For France, wholesale prices are replaced by export unit value series.
Source: see Appendix A.1.

Details on data sources are provided in Appendix.

3.4 Methodology

We investigate the economic relations of interest by conducting the cross-correlation and Granger-causality analysis with the economic variables mentioned in Table 3.2.

The cross-correlation analysis implies estimating the cross-correlation coefficients $\rho(j)$, between the European ($X_{t\pm j}$) and African (Y_t) economic variables at different lags and leads ($j \in 0, \pm 1, \pm 2, ...$). Following for example, Fiorito and Kollintzas (1994) and Agénor et al. (2000), we plan to figure out the lagging ($j > 0$) or leading ($j < 0$) relationships between the variables in question[7]. Since significance tests can not be performed for the maximum cross-correlation coefficient, we choose to accept a leading effect only when the lag (negative) is accompanied by a significant contemporaneous correlation coefficient.

Of course, "lead" does not mean "cause". We then perform a Granger causality tests in order to either confirm or invalidate (when the sens of causality is the opposite of what is expected) the leading impact of European variables. However, when the lag of the maximum correlation coefficient is "0", and this coefficient ($\rho(0)$) is significant at at least the 10% level, we conclude that the European and the African variable cycles are synchronous, the leading impact of the European variable being possible. Indeed, the Granger causality test does not capture the contemporaneous relationships of variables.

The aim of the Granger-causality analysis is to gain knowledge about the causality mechanisms linking the European and African economies. We are eager to know which European economic variables cause the African economic variables, and what is the delay between the "cause" and the "effect".

The Granger causality is defined in the following way: a variable, Y_t, is said to be Granger-caused by another variable, X_t, if we can improve the forecasts of the former by using the latter as a regressor and not only the past values of the former variable. There can be a two-way Granger causality when both variables cause each other. The formal test of the Granger causality hypothesis requires estimating the following linear regression equation. Suppose we regress variable Y_t on its own past values and on the past values of X_t:

[7] A drawback of this methodology is that the results are likely to depend on the number of lags included in the analysis. That is why the choice of this number has to be consistent with an acceptable economic view.

$$Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \ldots + \alpha_p Y_{t-p} + \beta_1 X_{t-1} + \ldots + \beta_p X_{t-p} + \varepsilon_t, \tag{3.2}$$

where $\alpha_0, \alpha_1, \ldots, \alpha_p, \beta_1, \ldots, \beta_p$ are the regression coefficients, p is the lag order and ε_t is the error term.

The Granger causality test then amounts to testing the following hypothesis: $\beta_1 = \beta_2 = \ldots = \beta_p = 0$. The null hypothesis states that there is no Granger causality. In the same way we can test whether Y_t Granger causes X_t. To make a decision about the existence or absence of the Granger causality, we estimate the bivariate vector autoregressions (VARs), using the 10% significance level.

Of course, the concept of causality is a very rich one and is by no means limited to Granger's definition. Among other definitions of causality we can mention that of Dufour et al. (2004) and that of Breitung and Candelon (2004). Dufour et al. (2004) test the hypothesis of non-causality at various forecasting horizons, not just one, as in the standard Granger causality definition. Breitung and Candelon (2004) test the hypothesis of causality at different frequencies. Both approaches are very promising, especially the former one, which permits the determination of the delays at which the policy in one country causes changes in the economy of other country. However, the severe lack of sufficiently long data series does not allow us to take advantage of these two approaches.

Besides the time series of the individual countries, we construct the corresponding aggregates at the European level in order to see the general impact of European countries — represented as a single economy — on the African economies. For the variables for which it was possible, the European aggregates, i.d. the composite economic indices, were built using the linear dynamic factor model methodology. Below we describe this model in some detail.

The linear dynamic factor model,used as a tool of constructing the composite economic indicator, was adopted by Stock and Watson (1989). We will denote it simply as CEI. It is expressed as follows:

$$\Delta Y_t = \gamma(L)\Delta C_t + u_t \tag{3.3}$$

$$\Delta C_t = \mu + \sum_{i=1}^{p} \phi_i \Delta C_{t-i} + \varepsilon_t \tag{3.4}$$

$$\Psi(L)u_t = \eta_t \tag{3.5}$$

where Δ is the first-order difference operator, Y_t is the $n \times 1$ vector of the observable time series, C_t is the dynamic common factor in levels, u_t is the $n \times 1$ vector of the idiosyncratic components, ε_t are the normally distributed residuals with unit variance and zero mean while μ and ϕ_i $(i = 1, 2, ..., p)$ are the common factor's state-dependent intercepts and autoregressive coefficients, respectively.

The lag polynomial matrices of the specific factors, Ψ_j $(j = 1, ..., q)$, are diagonal. The shocks to the specific factors are assumed to be serially and mutually uncorrelated and normally distributed with unit variances and zero means: $\eta_t \sim NIID(O_n, \Sigma_\eta)$, where O_n is the $n \times 1$ vector of zeros and Σ_η is a $n \times n$ diagonal variance-covariance matrix.

Here we estimate the linear model without intercept. This is admissible because the data are previously demeaned.

To identify the model, Stock and Watson set the variance of the common factor equal to one and assume that the lag polynomial matrices Ψ_j $(j = 1, ..., q$, where the q is the maximum autoregressive order of the specific components) are diagonal, thus excluding any causality relationships between the idiosyncratic components.

3.5 Empirical Investigation

We recall that the relationships we are interested in are tested through two methods, i.e, the (cross-)correlation coefficients and the Granger causality tests. We admit a robust comovement of cycles when Euro area and African country series are significantly correlated. The leading effect of EBC is robust when the sign of maximum cross-correlation (coefficient) is confirmed by Granger causality tests. The maximum cross-correlation lag alone does not provide a robust evidence because significance tests can not be performed the related coefficients. But, a (negative) lag for the maximum cross-correlation coefficient, accompanied by a significant coefficient of contemporaneous correlation, is accepted as a good indication of the EBC leading effect. From now on, we will sometimes use the term "lag" in its general sense as in the headers of the table columns. It will also refer to "lead" (positive lag).

3.5.1 Real Links

In this section, we will consider the relationships between the real economic indicators — such as GDP, exports, relative wholesale prices, income terms of trade and terms of trade — of Europe and Africa. Unfortunately, concerning the African countries, we only have annual GDP series. Therefore, we are firstly bound to investigate the links between the annual real European and African GDP on the one hand, and on the other, between annual European wholesale prices and African GDP. Secondly, the links between the European quarterly real GDP and the African quarterly terms of trade, income terms of trade and real exports to Europe are examined. These latter links are rather the indirect measures of the interdependence between the European and African economies. However, they capture some of the important mechanisms of transmission of the European economic events to the African economies.

European GDP versus African country GDPs

As an indicator of the European real GDP we used the Euro area GDP provided by the OECD. The construction of the composite economic indicator was impeded by the cointegration relationships between the component series, that is, the real annual GDP of the member countries. We have found that the growth rates of these real GDP were cointegrated, what makes the estimation of the dynamic factor model virtually impossible. At least, for the moment, the literature does not propose any solutions to the problem. On the other hand, we have the real GDP of the nine African countries: Benin, Cameroon, Congo, Ghana, Madagascar, Nigeria, Rwanda, Senegal, and Togo. The sample covers the period 1970-2000.

Let us start by examining the time profiles of the variables of interest. Figure 3.1 in Appendix A.3 compares the growth rate (first-order difference of the natural logarithm) of Euro area real GDP, denoted as dEuro, to growth rate (first-order difference of the natural logarithm) of the real GDP in several European countries, which were used as the component series.

Roughly speaking, the Euro area GDP displays a seemingly similar pattern with the GDPs of at least France, Germany and Italy even though there are lags and leads at some periods. To a lesser extent, the same similarity is also observed with the GDP of Austria and Spain, however, only since the end of the seventies for the latter. We then can consider that the EMU GDP is able to capture in a satisfactory way a common component of the economic activity in the various country members. The failure to build a composite economic indicator is then compensated by the use of the EMU GDP.

The relation of the European GDP with the GDP of other European countries is more complicated, especially with Finland.

Figure 3.2 shows the growth rates of the African real GDPs compared to that of the European real GDP. All the African countries, except Rwanda[8], seem to have growth rates whose volatility decreases over time. This is not the case of the European GDP. There is no clear pattern of relationship between the European and African real annual GDPs. Only Madagascar, Nigeria, Senegal, and Togo at some periods fluctuate in the same direction — sometimes with a lag or lead — as the European GDP. This predicts a weak evidence of empirical relations. The common feature for these countries is that their growth rates are more volatile than those of the Euro area GDP.

Let us start the quantitative analysis. First, we calculated the coefficients of the maximum cross-correlation and the contemporaneous correlation between the growth rate of the Euro area GDP and the GDP growth rates of various African countries across different lags varying from -5 to 5. The same was also done between the growth rate of France GDP and that of the same African countries.

The maximum correlation coefficients and lags, which correspond to these coefficients, are reported in Table 3.5. The maximum attained at the negative lags means that the Euro area real GDP is leading with respect to the corresponding African country.

Table 3.5: Cross-correlation between the annual growth rates of Euro area real GDP and African countries real GDPs

Country	EMU GDP			French GDP		
	Contempor. correlation	Maximum correlation	Lag	Contempor. correlation	Maximum correlation	Lag
Benin	-0.117	-0.306	2	-0.149	-0.320	-1
Cameroon	-0.235	0.283	5	-0.099	0.295	5
Congo	-0.103	-0.454	1	0.068	-0.298	1
Ghana	0.429**	-0.492	-3	0.303	-0.451	-3
Madagascar	0.066	-0.338	-5	0.089	-0.381	-4
Nigeria	0.315***	0.404	2	0.238	0.394	2
Rwanda	0.054	0.346	-1	0.091	0.332	-1
Senegal	-0.100	-0.360	-1	0.021	0.257	2
Togo	0.367**	0.390	-3	0.333***	-0.398	-3

Note 1: "Lag" stands for lag corresponding to maximum correlation.
Note 2: "*", "**" and "***" denote the contemporaneous correlation coefficients which are significantly different from zero at respectively 1, 5 or 10% level.

The results obtained for the European GDP and the French GDP in terms of

[8]There is an outlier in the real GDP series of Rwanda in 1994-1995.

maximum correlation lags are consistent to a some extent. Negative lags are found for Ghana, Madagascar, Rwanda, Senegal and Togo. In all these cases, except those of Rwanda and Togo, the correlations are negative. The highest (in absolute value) correlation coefficient is achieved for Ghana. Notice that on average the absolute values of the correlation coefficients are rather low, the highest being 0.49. As these maximum correlation coefficients do not allow us to draw reasonable conclusions, we will take into account the suggested leading or lagging effects that are accompanied either by the presence of significant contemporaneous coefficients or by a confirming Granger test result.

The contemporaneous correlation coefficients show that only the GDP movements of Ghana, Togo and Nigeria are positively correlated to that of the Euro area. Combining this evidence with the possible leading effect of the Euro area GDP mentioned above, we can conclude that the EMU business cycle is significantly leading those of Ghana and Togo. In the case of Ghana, this leading effect is complex as the maximum and the contemporaneous correlations are of different signs.

The next step is to figure out the Granger-causality links. To do this, we have estimated the bivariate VARs for the growth rates of the Euro area GDP and French GDP, on the one hand, and the growth rates of the GDP of the nine African countries, on the other hand. Each VAR included 4 lags.

Table 3.6: Granger-causality links between Euro area and African real GDP

Country	EMU GDP	French GDP
Benin	×	×
Cameroon	×	×
Congo	×	×
Ghana	×	×
Madagascar	←	←
Nigeria	×	×
Rwanda	×	×
Senegal	→	×
Togo	×	×

Note: → is the one-way Granger causality going from the variable in row to the variable in column (the former causes the latter); ← is the one-way Granger causality going from the variable in column to the variable in row; ↔ is the two-way Granger causality; × no Granger causality.

From the observation of Table 3.6, it turns out that the European and French GDP "Granger cause" only the GDP of Madagascar. The two are not affecting the gross product of the countries which belong to the Franc zone. Other countries appear to have economic dynamics which are not strongly influenced by the European economy.

This is true at least at the annual level and for the overall measure of the economic activity. Interestingly, the fact that EMU "Granger causes" Madagascar confirms the leading effect suggested by the lag of the maximum cross-correlation.

Thus, the interaction between the North and the South found at the aggregate level (Hoffmaister et al., 1998a) and with a calibrated model of a representative small country (Kouparitsas, 1996) can not be confirmed with all SSA's country data. Only the Ghana, Madagascar and Togo GDPs are influenced by the EMU GDP. Nigeria and EMU GDPs are significantly correlated but the former do not appear to be led by the latter.

European Relative Wholesale Prices Versus African GDP

The European composite index of wholesale prices was constructed using a linear dynamic factor model with the following seven component series: Austria, Finland, France, Germany, Ireland, Netherlands and Spain. The limitation of the number of series used is due to the lack of data. The estimated parameters of the static version of the model[9], along with their standard errors and p-values, are reported in Table 3.18 of Appendix A.3. The EMU relative WPIs were built by dividing the composite index-based European WPI by the consumer price index (a proxy of the WPI) of each of the following seven African countries — Cameroon, Ghana, Madagascar, Nigeria, Rwanda, Senegal, and Togo —, all being expressed in dollar. Furthermore, we have the real GDP of the afore mentioned African economies. The sample starts in 1971 and finishes in 1997.

We start again from examining the time profiles of the variables of interest. Figure 3.3 compares the growth rate (first-order difference) of the composite index of the European wholesale price, denoted as dEurope, to growth rate (first-order difference of the natural logarithm) of the wholesale prices in the European countries. The latter served as the component series of the composite indicator.

The composite index shows a high degree of synchronicity with respect to most wholesale price indices of the 7 European countries. It is especially true in the case of Austria, Finland, France, and Germany, where the indices almost coincide.

Figure 3.4 shows the growth rates of the African real GDP compared to those of the composite index of the European wholesale price indicator. There is no clear pattern of relationship between the European relative wholesale prices and African real annual

[9]Because of the reduced number of observations, we estimated a static version whose parameters were used to build a composite index–based EMU relative WPI in dollar. The common factors derived both from the dynamic and from the static version of the model are very similar.

Table 3.7: Cross-correlation between the European relative wholesale price index and the real GDP of the African countries

Country	EMU relative WPI			French relative WPI		
	Contempor. correlation	Maximum correlation	Lag	Contempor. correlation	Maximum correlation	Lag
Cameroon	-0.278	-0.338	4	-0.214	-0.321	4
Ghana	0.214	0.338	1	0.209	0.348	1
Madagascar	0.061	-0.370	-4	0.121	-0.300	-4
Nigeria	-0.014	-0.327	4	-0.023	-0.305	4
Rwanda	0.591*	0.591	0	0.570*	0.570	0
Senegal	-0.090	-0.359	3	-0.114	-0.302	3
Togo	0.268	-0.748	1	0.351***	-0.662	1

Note 1: "Lag" stands for lag corresponding to maximum correlation.
Note 2: "*", "**" and "***" denote the contemporaneous correlation coefficients which are significantly different from zero at respectively 1, 5 or 10% level.

GDP. Cameroon appears to follow the motions of the European wholesale prices with some lag.

When doing the formal analysis we first found the maximum cross-correlation between the growth rate of the European and French wholesale price indicators, on the one hand, and the growth rates of the GDP of various African countries, on the other hand, across different lags varying from -4 to 4. The maximum correlation coefficients and lags, which correspond to these coefficients, as well as the contemporaneous correlations are reported in Table 3.7.

The European relative wholesale price index seems to lead the real GDP of Madagascar with the expected negative sign and is coincident with that of Rwanda, lagging the real GDP of the other African countries. But, at this stage, the leading effect on the real GDP of Madagascar remains a simple indication to be confirmed by a causality test as the contemporaneous correlation is not significant. There is only one contemporaneous coefficient which is significantly different from zero, namely that of Rwanda. The GDP of the latter is synchronous with the EMU relative wholesale prices, confirming that the Rwanda's economic activity is positively and contemporaneously correlated with EMU relative wholesale prices contrary to the theoretical relationships.

The next step is to figure out the Granger-causality links reported in Table 3.8. In order to do this, we have estimated the bivariate VARs for the European relative WPI and the French relative wholesale prices, on the one hand, and the growth rates of the GDP of seven African countries, on the other hand. Each VAR included 4 lags.

It turns out that the European relative wholesale prices "Granger cause" Madaga-

Table 3.8: Granger-causality links between European relative wholesale prices and African real GDP

Country	EMU Relative WPI	French Relative WPI
Cameroon	×	×
Ghana	×	×
Madagascar	⟵	⟵
Nigeria	×	×
Rwanda	⟷	⟷
Senegal	×	×
Togo	⟶	⟶

Note: → is the one-way Granger causality going from the variable in row to the variable in column (the former causes the latter); ← is the one-way Granger causality going from the variable in column to the variable in row; ↔ is the two-way Granger causality; × no Granger causality.

scar, confirming the indicative leading effect suggested by the maximum cross-correlation coefficient analysis. Moreover, Rwanda's GDP seems to be "Granger caused" by the European relative WPI as suggested by correlation analysis. Surprisingly, the European relative price index is "Granger caused" by the fluctuations of the real GDP of Togo. This probably means that the economy of this country is positively correlated with factors like international prices of primary goods which make prices move in EMU.

According to this, we can cautiously conclude that only two African countries' GDP in our sample, namely Madagascar and Rwanda, could be affected by wholesale price fluctuations in Europe and are likely to be affected by business cycle convergence in the EMU.

European GDP Versus African Terms of Trade

This subsection tries to investigate the relationships between the European GDP and the African terms of trade (TT). The latter are defined as a ratio between the index of the export prices of each African country and the index of the European export prices. The European export price index is a weighted average of the indexes of 11 European countries: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Spain and UK[10]. The weight is the share of each particular country in the total European exports to Africa. All the data are available at the quarterly frequency. The sample starts in the first quarter of 1980 and ends in the third quarter of 2000.

As regards the Euro area GDP we have two series of data. First, we have access

[10]The UK wholesale prices are highly correlated with those of the EMU country members.

Table 3.9: Cross-correlation between the Euro area GDP and African terms of trade

Country	Euro area GDP			French GDP		
	Contempor. correlation	Maximum correlation	Lag	Contempor. correlation	Maximum correlation	Lag
Angola	0.212	0.250	-7	0.136	0.350	-6
Benin	0.126	0.266	4	-0.011	0.180	7
Cameroon	0.258	0.260	-1	0.213	0.312	10
Congo	0.200	0.254	-7	0.122	0.346	-6
Ivory Coast	0.194	0.217	1	0.074	0.172	-6
Gabon	0.222	0.248	-7	0.143	0.334	-6
Guinea	0.411**	0.420	1	0.331***	0.341	1
Mali	0.125	0.233	3	0.014	0.151	-7
Niger	0.400**	0.406	1	0.313***	0.320	1
Togo	0.425**	0.425	0	0.272	0.272	0

Note 1: "Lag" stands for lag corresponding to maximum correlation.
Note 2: "*", "**" and "***" denote the contemporaneous correlation coefficients which are significantly different from zero at respectively 1, 5 or 10% level.

to two series of the quarterly real GDP of the Euro area countries, namely: the official EMU GDP in euros with the base year 2001 (available for the period 1980:1-2003:3) provided by the OECD and the Euro area real GDP (available for the period 1980:1-2002:4) derived from the Euro Area-Wide Model (AWM) which has been constructed by the staff of the Econometric Modelling Division of the ECB (see Fagan et al., 2001). In addition, we have attempted to estimate a composite index of the European GDP using the linear dynamic factor analysis model. However, as explained above, this attempt have failed because some series are cointegrated. There is a remarkable similarity between the year-on-year growth rates of the two European GDP series. That is why we are only going to use the official Euro area's real GDP series (the first differences of natural logarithms) through the rest of the real side analysis.

As usually, we computed first contemporaneous and the maximum correlation coefficients and the corresponding lags in Table 3.9. The lags in the cross-correlation analysis vary within the interval of [-10,10]. As the values of these correlation coefficients are low, it is also noticeable that these are all positive.

When considering the lags of maximum coefficients, the probable leading effect of the quarterly European GDP is possible for the TT of four African countries: Angola, Cameroon, Congo, and Gabon. But the absence of significant contemporaneous correlation between the European GDP and the TT of these countries will mean the rejection of the possible leading effects if we fail to find clearcut Granger causality evidence below.

Table 3.10: Granger-causality links between Euro area GDP and African terms of trade

Country	European GDP	French GDP
Angola	×	×
Benin	×	×
Cameroon	×	×
Congo	×	×
Ivory Coast	×	×
Gabon	×	×
Guinea	×	×
Mali	×	×
Niger	×	×
Togo	×	×

Note: $\rightarrow$ is the one-way Granger causality going from the variable in row to the variable in column (the former causes the latter); $\leftarrow$ is the one-way Granger causality going from the variable in column to the variable in row; $\leftrightarrow$ is the two-way Granger causality; $\times$ no Granger causality.

From the observation of the contemporaneous correlations, we note that the EMU is significantly correlated to the TT of three African countries, namely Guinea, Niger and Togo, the latter being synchronous with the EMU business cycle. The lags of maximum correlation for the three countries suggest that the cycles of their TT lead the EMU business cycle.

To conduct the Granger-causality analysis reported in Table 3.10, we used the bivariate VARs with 6 lags. The significance level for the rejection of the null hypothesis of no Granger causality was established at 10% level. Neither European GDP nor the French GDP appear to "Granger cause" the TT of the African countries included in our analysis.

Thus, the investigation of this channel of transmission does not reveal any leading or causal effect of the EMU business cycle on SSA's country TT. Nevertheless, the TT of Togo are likely to be influenced by the EBC because of the synchronicity observed above.

European GDP Versus African Income Terms of Trade

In this subsection, the relationships between the European GDP and the African income terms of trade (ITT) are examined. The ITT is the African nominal exports divided by the European exports price index. It, thus, measures the quantity of goods and services the African countries could buy in Europe using the revenues from their exports. As in the previous section, the European export price index is computed as a weighted average of the indexes of 11 European countries (see above). All the data are available

at the quarterly frequency. The sample covers the period of 1981:1-2000:3.

In Table 3.11 we report the highest cross-correlations and (the corresponding lags) between the OECD's indicator of the Euro area real quarterly GDP, on the one hand, and the income terms of trade of some African countries, on the other hand. As it can be observed, only ITTs of five countries are significantly and contemporaneously correlated with the EBC. As the Angola ITT cycle is synchronous with the EBC, only that of Gambia and Togo seem to be led by the EBC when combining the evidence of significant contemporaneous correlation and the information of maximum cross-correlation coefficients.

Table 3.11: Cross-correlation between the Euro area GDP and African income terms of trade

Country	Euro area GDP			French GDP		
	Contempor. correlation	Maximum correlation	Lag	Contempor. correlation	Maximum correlation	Lag
Angola	0.426**	0.426	0	0.309***	0.309	0
Benin	-0.110	-0.282	4	-0.150	-0.388	3
Burkina Faso	-0.049	0.484	7	-0.016	0.534	8
Cameroon	0.370**	0.384	1	0.127	0.193	1
CAR	0.210	-0.282	7	0.210	0.336	-1
Chad	0.115	-0.280	-8	0.048	-.196	-2
Comoros	0.191	0.373	-7	0.209	0.334	-1
Congo	0.026	0.318	-4	-0.011	0.142	7
Ivory Coast	-0.019	-0.403	-9	-0.152	-0.326	-9
Gabon	0.517*	0.556	1	0.452*	0.467	1
Gambia	0.381**	0.443	-1	0.394**	0.438	-1
Guinea	0.165	-0.227	-6	0.021	0.189	-10
Guinea-Bissau	-0.035	-0.206	8	-0.074	-0.246	10
Madagascar	0.009	-0.216	-5	0.072	0.184	-2
Mali	0.212	0.212	0	0.221	0.221	0
Mauritania	0.196	0.233	1	-0.050	0.203	-4
Niger	0.107	0.243	9	0.190	0.247	9
Nigeria	0.079	-0.298	9	-0.030	-0.276	-8
Sao Tome & P.	0.003	0.373	8	0.107	0.275	8
Senegal	0.022	0.411	7	0.193	0.436	-3
Sierra Leone	0.176	0.352	8	0.153	0.480	-8
Togo	0.300***	-0.349	-5	0.228	-0.265	-5

Note 1: "Lag" stands for lag corresponding to maximum correlation.
Note 2: "*", "**" and "***" denote the contemporaneous correlation coefficients which are significantly different from zero at respectively 1, 5 or 10% level.

The causality analysis confirms these findings. Table 3.12 shows the direction of Granger causality (when it exists) between the Euro area (the indicator of the OECD) and French GDP, on the one hand, and the income terms of trade of several African countries, on the other. It is easily noticeable that only the results related to Gambia and Togo are consistent with the correlation analysis of Table 3.11. Similarly, the cyclical behavior of the Euro area GDP "Granger causes" the ITT of Benin, Burkina Faso and Cameroon.

Thus, our analysis provide a clearcut stylized fact in regard of the impact — the leading effect — of European economic activity on the ITT of the studied SSA's countries. The ability to finance imports of Benin, Burkina Faso, Cameroon, Gambia and

Table 3.12: Granger-causality links between the Euro area GDP and African income terms of trade

Country	EMU GDP	French GDP
Angola	×	×
Benin	←	→
Burkina Faso	←	→
Cameroon	↔	↔
CAR	×	×
Chad	×	×
Comoros	×	×
Congo	×	×
Ivory Coast	×	×
Gabon	→	→
Gambia	←	←
Guinea	×	×
Guinea-Bissau	→	→
Madagascar	×	×
Mali	×	×
Mauritania	×	×
Niger	→	×
Nigeria	×	×
Sao Tome & Principe	×	×
Senegal	×	×
Sierra Leone	×	×
Togo	←	←

Note: → is the one-way Granger causality going from the variable in row to the variable in column (the former causes the latter); ← is the one-way Granger causality going from the variable in column to the variable in row; ↔ is the two-way Granger causality; × no Granger causality.

Togo will raise if the Euro area GDP increases. This ability will also raise in Angola; but this will happen simultaneously with the Euro area GDP's increase.

European GDP Versus African Real Exports

This subsection analyzes the relation between the European GDP and the African real exports to Europe. The link between the African exports and the GDP of France — which appears to exert an important influence on the African economies — is also examined.

Figure 3.5 compares the year-on-year growth rates of the European real GDP to those of the African real exports to Europe. The visual inspection of this figure reveals no readily visible similarity between the European real GDP and the real exports of the African countries. The African real exports appear to evolve in their own way. Moreover, one cannot see any similarities between the African real exports themselves when observing their patterns.

Table 3.13 reports the outcomes of the cross-correlation analysis. The maximum correlations between the OECD's Euro area GDP and French GDP, on the one hand, and the GDP of 10 African countries, on the other hand, together with the related lags or leads, are presented. The lags vary from -10 quarters to 10 quarters.

If one considers the maximum cross-correlation pattern, it will be noticed that

Table 3.13: Cross-correlation between the European GDP and the real exports of different African countries

Country	Euro area GDP			French GDP		
	Contempor. correlation	Maximum correlation	Lag	Contempor. correlation	Maximum correlation	Lag
Angola	0.317***	0.317	0	0.227	0.227	0
Benin	-0.114	-0.305	4	-0.139	-0.395	3
Cameroon	0.232	0.254	1	-0.015	0.103	4
Congo	-0.065	0.243	-4	-0.076	-0.202	7
Ivory Coast	-0.092	-0.397	-9	-0.179	-0.310	2
Gabon	0.347***	0.378	1	0.319***	0.362	1
Guinea	-0.082	-0.251	9	-0.165	0.216	-10
Mali	0.195	0.218	-1	0.213	0.223	-1
Niger	0.045	-0.202	-8	0.138	0.219	9
Togo	0.198	-0.272	-5	0.153	-0.228	-5

Note 1: "Lag" stands for lag corresponding to maximum correlation.
Note 2:"*", "**" and "***" denote the contemporaneous correlation coefficients which are significantly different from zero at respectively 1, 5 or 10% level.

a leading effect of European real GDP, to more deeply investigate, is possible on the real exports Cameroon, Ivory Coast, Mali, and Togo. However, these correlations are weak and in most of the cases are of the "wrong" sign; and no significant contemporaneous correlation support the possible leading effects. Although, the EBC is synchronous with real exports cycle of Angola. The positive correlation coefficient is consistent with the theoretical link.

Table 3.14: Granger-causality links between European GDP and African real exports to Europe

Country	EMU GDP	French GDP
Angola	×	×
Benin	→	×
Cameroon	↔	→
Congo	×	×
Ivory Coast	×	↔
Gabon	×	×
Guinea	×	×
Mali	×	×
Niger	×	→
Togo	×	×

Note: → is the one-way Granger causality going from the variable in row to the variable in column (the former causes the latter); ← is the one-way Granger causality going from the variable in column to the variable in row; ↔ is the two-way Granger causality; × no Granger causality.

Once again the bivariate vector autoregressions were used to check the hypotheses of Granger causality between the European and French GDPs, on the one hand, and the real exports of the African countries, on the other hand. The significance level is 10%. Table 3.14 reports the results.

The European real GDP appears to "Granger cause" the real exports of Cameroon whose real exports exhibit a mutual "Granger causation" relationship with the EBC. In the case of France there is a two-way causality with Ivory Coast. In sum, the European countries seem to exert little influence on the real exports of the African countries as synchronicity is only observed with real exports of one country of our sample; and Granger causality is also significant for one country.

3.5.2 Monetary Links

We are going to study the monetary links between Europe and Africa using the following data: the inflation rates for 10 African countries (Cameroon, Gabon, Gambia, Ghana, Ivory Coast, Madagascar, Niger, Nigeria, Senegal, and Togo) and 11 European countries (Austria, Belgium, France, Finland, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal and Spain). The sample begins in the second quarter of 1970 and ends in the last quarter of 2002. Consumer prices are chosen as proxies of monetary policy indicators in order to readily compare the European and the African policies; because the comparability of other data like interest rates is limited[11].

We have estimated a dynamic factor model of the inflations of the 12 EMU members, namely: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain. The common factor is treated as an aggregate of the European consumer price growth rate or, in other words, the aggregate of the European inflation rate. The estimated parameters of the common dynamic model of the European CPI are reported in Table 3.19 of Appendix A.3.

Our composite indicator ($Euro_CI$) has been compared to the year-on-year growth rate of the Harmonized Index of Consumer Prices provided by the current Euro area AWM ($Euro_HICP$) on Figure 3.6. The similarity is striking: the levels are different, but the ups and downs of both indices are synchronous. This gives an additional support to our indicator.

Next the year-on-year differences — that is, the value of inflation of the first quarter of year t minus the value of inflation of the first quarter of year $t-1$ of the factor as well as the inflation rates of all the 21 countries were calculated. Figures 3.7 and 3.8

[11]The specific treatments of data are documented in Appendix A.2.

Table 3.15: The cross-correlations between the European aggregate of inflation and the annual inflation rates in the African countries

Country	Euro area CPI			French CPI		
	Contempor. correlation	Maximum correlation	Lag	Contempor. correlation	Maximum correlation	Lag
Cameroon	0.636*	0.644	-1	0.685*	0.686	-1
Gabon	0.689*	0.730	-3	0.646*	0.687	-3
Gambia	0.068	0.344	-10	0.080	0.364	-10
Ghana	0.411**	0.530	-6	0.437**	0.507	-7
Ivory Coast	0.597*	0.597	0	0.616*	0.638	3
Madagascar	0.327***	0.338	2	0.357**	0.363	-1
Niger	0.595*	0.599	-1	0.559*	0.575	6
Nigeria	-0.170	-0.428	10	-0.239	-0.336	-8
Senegal	0.673*	0.693	-1	0.642*	0.681	-2
Togo	0.369**	0.372	-1	0.314***	0.318	-1

Note 1: "Lag" stands for lag corresponding to maximum correlation.
Note 2: "*", "**" and "***" denote the contemporaneous correlation coefficients which are significantly different from zero at respectively 1, 5 or 10% level.

compare the year-on-year rates of the European composite CPI, representing the European inflation, to the annual inflation rates in several European and African countries, respectively. We can see that there is a synchronicity of the aggregate European CPI and most of the European countries CPIs.

Figure 3.8 shows that the inflation in Africa exhibits a declining trend like the European CPI, suggesting that the European disinflation policy has been transmitted to Africa. In addition, despite the fact that the African CPIs seem more volatile than that of European Union, the variability of their cyclical components appear to decrease over time.

Then we computed the cross-correlations between the European aggregate and the annual inflation rates in each African country with the lags varying from -10 to +10. The results of the cross-correlation analysis between Europe and the African countries, on the one hand, and between France and the African countries, on the other hand, are summarized in Table 3.15. In order to get some idea about the impact of the outliers in 1994-1995 on the cross-correlations, we have put the correlations estimated for the data with outliers in the parentheses near to the correlations estimated for the data without outliers. The main result is that the European monetary policy leads the SSA'countries one, especially for CFA zone members. Indeed, it could be noticed that the European CPI leads the inflation in Cameroon, Gabon, Ivory Coast, Niger, Senegal and Togo which are CFA zone members and Ghana. Among CFA zone members, only Togo has

a correlation coefficient less than 0.5.

Table 3.16: Granger-causality links between the European, the French, the US and the African inflation series

Country	European CPI	French CPI	US CPI
Cameroon	←	×	×
Ivory Coast	←	×	←
Gabon	←	←	×
Gambia	×	×	×
Ghana	←	←	←
Madagascar	×	×	×
Niger	←	×	×
Nigeria	×	×	×
Senegal	←	←	←
Togo	×	×	×

Note: → is the one-way Granger causality going from the variable in row to the variable in column (the former causes the latter); ← is the one-way Granger causality going from the variable in column to the variable in row; ↔ is the two-way Granger causality; × no Granger causality.

The Granger causality tests confirm that the European CPI causes the CPIs of Cameroon, Ivory Coast, Gabon, Niger , Senegal and Ghana which is not a CFA zone member[12] (see Table 3.16). The lags of maximum correlation suggest that African countries have the possibility to leave their inflation above the European inflation before adjusting it. For CFA zone members that peg their single currency to the euro, this is possible because of the *operation account mechanism* (Nyembwe, 2003). We can, thus, conclude that a transmission of economic shocks from the EMU to the SSA's countries is possible but it will probably be delayed as long as an operation account–like mechanism holds.

The same exercise was conducted with the European aggregate of inflation replaced by the French inflation rate.

3.5.3 A "Country Specific" Digression

The above analysis shows that only a few African country GDPs and other economic variables are likely to be affected by the EBC. Here we attempt to do a "transversal reading" of the collected evidence in order to highlight the extent to which each concerned country is affected through the various variables we took into account. Unfortunately, the lack of data does not allow the observation of all the studied correlations for each country.

[12]For the sake of comparison, we included in our analysis the US inflation indicator.

When considering annual data, we notice that only the GDP of Ghana, Madagascar and Togo seem to be led by the EMU GDP. For Ghana, one channel through which this correlation works is the monetary policy. The EMU monetary policy seems to lead the one of Ghana even though monetary authorities of the latter did not commit themselves to peg the domestic currency to the euro.

As regards Togo, the synchronicity of the EBC with the TT we highlighted by the way of cross-correlation analysis suggests that the TT are a channel of transmission of EMU economic activity impact. It is also interesting to notice that the ITT are led by the EBC. Thus, an increase of economic activity in EMU causes Togo's ability to finance import to raise. Considering that real exports are not affected at all by the EBC, we can conclude that for Togo, the supply side factors, namely TT, appear to be the main channel of transmission of the EBC. The monetary policy of EMU is another channel of transmission as the CPI of Togo is led by that of EMU.

Madagascar also deserves a bit of attention. The impact of the EMU GDP on its GDP seems to work through the EMU wholesale prices. This GDPs' correlation is probably negative when considering the maximum cross-correlation coefficient in line with the negative impact of EMU relative WPI. The income terms of trade do not appear to be the way by which the EMU GDP fluctuations have an impact on the GDP of Madagascar.

Cameroon is an interesting case in the sense that it is included in all the samples we have. Despite the absence of GDPs' relationships evidence, the EBC appears to be correlated with the ITT and the real exports when considering either the cross correlation or the Granger causality test results. Nevertheless, it does not seem to have any clearcut EBC leading effect on Cameroon's variables as the interpretation of the various results is not easy. Finally, the monetary policy appears also to be a channel of transmission of monetary shocks to Cameroon, even if the evidence of its impact on the GDP is not available.

3.6 Conclusion

In this study, we have empirically examined the relationships between the European Union economic activity and SSA's countries, as the newly born EMU is their main trading partner. The aim is to be able to answer the question whether the emergence of a European business cycle (EBC) — that is the result of convergence of national business cycles in the EMU — is likely to matter for these African countries. Answering the question could be given by the investigation of the empirical impact of EBC on

SSA's economic variables.

Relying on the existing literature that shows the existence of a EBC, we have assumed that a common feature of the EMU members' economic variables is an accurate expression of the underlying convergence process. Adapting the Stock and Watson method to estimate composite economic indicators whose components are similar variables of the various EMU members' economies, we have estimated composite indexes of real GDPs, wholesale and consumer prices. Unfortunately, the composite index of the European real GDPs was not possible to construct. To replace it, the European area GDP provided by the OECD has been used. It appears to exhibit an annual pattern quite similar to those of EMU members' GDPs.

In this study, each theoretical link confirmed both by the cross-correlation and the Granger causality is robust. The evidence provided either by the cross-correlation analysis when the contemporaneous coefficient was significant or by the Granger causality tests is also valid. After highlighting the theoretical channels of transmission, we tested them and obtained the following results:

- The analysis made with annual data shows that only GDP of Ghana, Madagascar and Togo appear to be influenced by the EBC. This relation is complex in the case of Ghana, as the leading effect is initially negative before becoming positive.
- The cyclical component of European relative wholesale prices seems to lead only the one of Madagascar GDP while it is correlated with that of Rwanda GDP.
- The EBC seems to have no leading effect on any African country terms of trade (TT), but it is synchronous with TT of Togo and positively correlated with Guinea and Niger. The cycle of the two latter seems to lead the EBC.
- In regard to the income terms of trade, the EBC has a leading impact on Gambia and Togo — whose correlations are very robust — and is synchronous with that of Angola. The ITT of Benin, Burkina Faso and Cameroon are "Granger caused" by the EBC.
- There is no robust leading effect of the EBC on real exports of SSA's countries, except for Angola whose exports cycle is synchronous with EBC.
- Apart from Nigeria and Gambia cases, it exists a correlation between the European and the studied Sub-Saharan African countries' inflations. This link is robust for Cameroon, Ivory Coast, Gabon, Ghana, Niger, and Senegal. It is also acceptable for Togo

We can therefore conclude that the cyclical component of economic activity in the EMU is likely to have only a limited impact on a few African countries. On the monetary side, there is a robust link between some SSA's countries and European monetary policies but, because of the lagged impact, it is reasonable to think that these countries are somewhat insulated from immediate impact of monetary shocks in Europe. As far as CFA zone countries are concerned, a reason of this situation is the existence of the operation account mechanism that allows to peg the domestic currency to the euro while the inflation pattern differs momentarily from the anchor country's one. Hence, according to the available data and methods used in our study, it is reasonable to suggest that a further convergence of national business cycles in Europe, if it occurs, could matter for a few African countries.

Appendix

A.1 Sources of Data

Here are the sources of data we have used.

- The quarterly real GDP indexes of European countries are taken from Thomson Data Stream (TDS) while the quarterly Euro area GDP series are obtained from OEDC.

- Annual GDPs for African countries come from the IMF data collected by the TDS. They are obtained with the code *Country code*_I99BVPH. The European countries real GDP series are provided by the ODCE.

- The European producer prices, wholesale prices and unit value of exports, for France, are obtained from the IMF IFS (June 2001). The country names and the related codes are respectively Austria,12263...ZF; Belgium, 12463...ZF; Finland, 17263...ZF; Germany, 13463...ZF; Greece, 17463...ZF; Ireland, 17863...ZF; Italy, 13663...ZF; Netherlands, 13863...ZF; Spain, 18463...ZF; France, 13274...ZF. They are used as proxies of export prices.

- The value exports of African countries series expressed in dollar are obtained from the IMF, Direction of Trade (DOT) CD-ROM of June 2001. The prices of African exports are constructed as a combination of commodity prices (by groups) obtained in the DTS and the commodity groups shares in total exports of African countries. The latter are provided by the UNCTAD handbook of Statistics.

- African quarterly series of consumer price indexes (CPI) are obtained from the TDS with the code *Country code*164...F while European CPI are obtained from the IMF (IFS of February 2004).

A.2 Treatment of Data on Monetary Links

There is in data an important but short-lived shock for the countries of the Franc zone and for Madagascar related to the adjustments of their currencies' exchange rates. We had to use the dummy variables in order to eliminate the effects of this shock. Each dummy was defined in the following way: $F_t = 1$, if there is a shock, $F_t = 0$, otherwise. The dates for each country, when the shock occurred, are indicated in Table 3.17. The linear regressions were estimated with a single regressor — the dummy variable. The

Table 3.17: The dates of the outliers for the countries of the Franc zone and Madagascar

Country	Dates
Cameroon	1994:1-1995:2
Gabon	1994:1-1995:2
Ivory Coast	1994:1-1995:2
Madagascar	1994:1-1996:2
Niger	1994:1-1995:1
Senegal	1994:1-1995:1

residuals of these regressions are the transformed series (without the outliers), which we are going to use below.

In the six cases there are missing observations, namely: Cameroon 2002:1-2002:4, Gabon 2001:1-2002:4, Gambia 2001:2-2002:4, Nigeria 2001:3, and Togo 1995:1-1995:2. In the case missing observations are in the beginning or in the end of the sample, we have used only the data after or before the missing ones. As regards Togo, we replaced the missing observations by the average value computed for the first differences of the inflation rate for the period 1971:2-1994:4. It is somewhat arbitrary, but acceptable as a first approximation.

A.3 Tables and Figures

Table 3.18: Estimated parameters of the annual composite index of European wholesale prices 1965-1998. Log-likelihood: -194.61

Parameters	Coefficient	St. error	t-stat	p-value
γ_{Aus}	0.979	0.122	8.04	0.0
γ_{Fin}	0.770	0.143	5.39	0.0
γ_{Fra}	0.940	0.126	7.44	0.0
γ_{Ger}	0.978	0.122	8.02	0.0
γ_{Ire}	0.903	0.131	6.92	0.0
γ_{Neth}	0.977	0.122	8.01	0.0
γ_{Spa}	0.860	0.135	6.37	0.0
σ_{Aus}	0.0105	0.005	2.26	0.018
σ_{Fin}	0.377	0.094	4.01	0.000
σ_{Fra}	0.086	0.023	3.78	0.000
σ_{Ger}	0.013	0.005	2.53	0.010
σ_{Ire}	0.155	0.039	3.96	0.000
σ_{Neth}	0.015	0.006	2.75	0.006
σ_{Spa}	0.231	0.006	4.00	0.000

Note: "St. error" is the standard error of the estimated coefficient, "t-stat" is the t statistic of the estimated coefficient, "p-value" is the probability of the estimated coefficient.

Table 3.19: Estimated parameters of the quarterly composite index of European CPI 1970:1-2002:4. Log-likelihood: -1688.8718702

	Coefficient	St. error	t-stat	p-value
γ_{Aus}	0.401	0.068	5.88	0.0
γ_{Bel}	0.177	0.073	2.42	0.009
γ_{Fin}	0.349	0.079	4.41	0.0
γ_{Fra}	0.544	0.078	6.97	0.0
γ_{Ger}	0.326	0.083	3.92	0.0
γ_{Gre}	0.019	0.101	0.19	0.425
γ_{Ire}	0.393	0.064	6.14	0.0
γ_{It}	0.392	0.077	5.10	0.0
γ_{Lux}	0.416	0.074	5.65	0.0
γ_{Neth}	0.104	0.070	1.48	0.071
γ_{Port}	0.278	0.078	3.59	0.0
γ_{Spa}	0.175	0.066	2.66	0.005
ϕ	0.687	0.079	8.75	0.0
ψ_{Aus}	-0.038	0.130	-0.30	0.384
ψ_{Bel}	0.035	0.178	0.20	0.421
ψ_{Fin}	0.032	0.227	0.14	0.445
ψ_{Fra}	0.296	0.107	2.76	0.003
ψ_{Ger}	0.218	0.090	2.41	0.009
ψ_{Gre}	0.261	0.088	2.96	0.002
ψ_{Ire}	-0.168	0.099	-1.70	0.046
ψ_{It}	0.295	0.093	3.19	0.001
ψ_{Lux}	0.091	0.099	0.91	0.182
ψ_{Neth}	-0.018	0.179	-0.10	0.461
ψ_{Port}	0.142	0.090	1.59	0.058
ψ_{Spa}	-0.081	0.087	-0.94	0.176
σ_{Aus}	0.686	0.094	7.32	0.0
σ_{Bel}	0.933	0.116	8.05	0.0
σ_{Fin}	0.755	0.102	7.38	0.0
σ_{Fra}	0.417	0.073	5.72	0.0
σ_{Ger}	0.782	0.102	7.68	0.0
σ_{Gre}	0.921	0.113	8.18	0.0
σ_{It}	0.682	0.093	7.32	0.0
σ_{Ire}	0.591	0.082	7.22	0.0
σ_{Lux}	0.665	0.092	7.25	0.0
σ_{Neth}	0.972	0.119	8.15	0.0
σ_{Port}	0.830	0.106	7.82	0.0
σ_{Spa}	0.927	0.115	8.06	0.0

Note: "St. error" is the standard error of the estimated coefficient, "t-stat" is the t statistic of the estimated coefficient, "p-value" is the probability of the estimated coefficient.

Figure 3.1: European CEI vs. GDP of European countries. Annual growth rate, 1970-2000

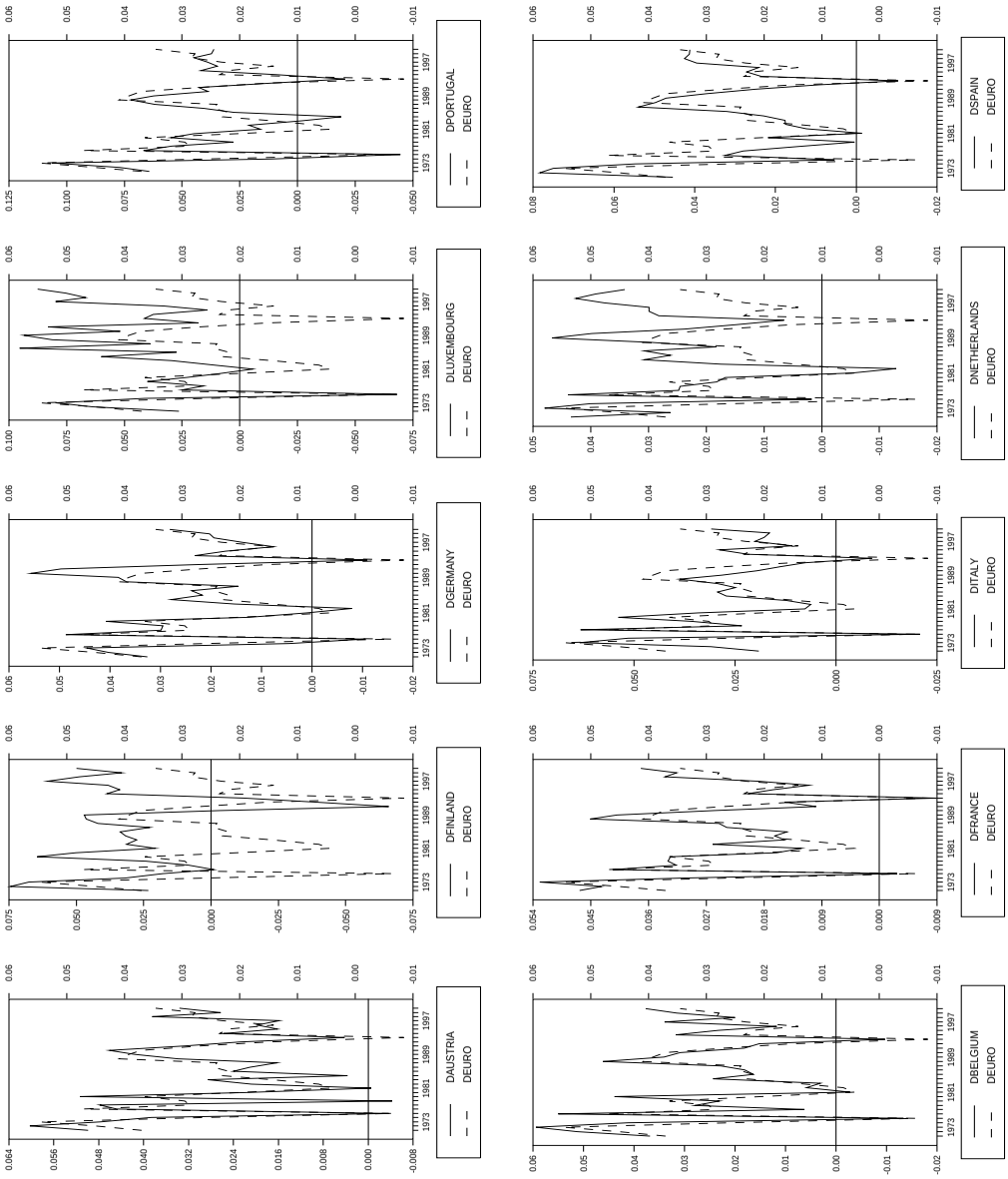

Figure 3.2: European vs. African real GDP. Annual growth rate, 1970-2000

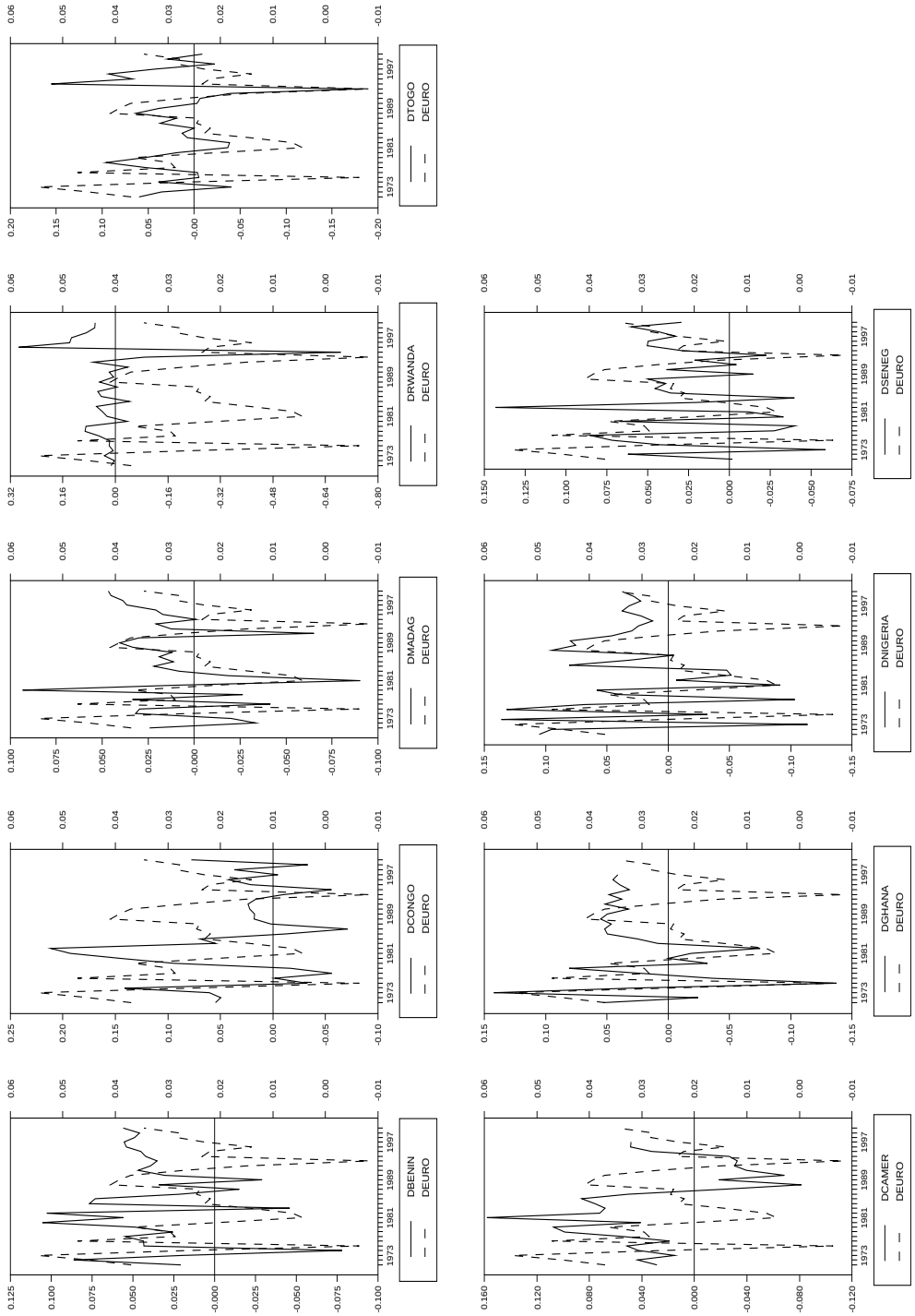

Figure 3.3: European composite index vs European country wholesale price indexes. Annual growth rate, 1971-1997

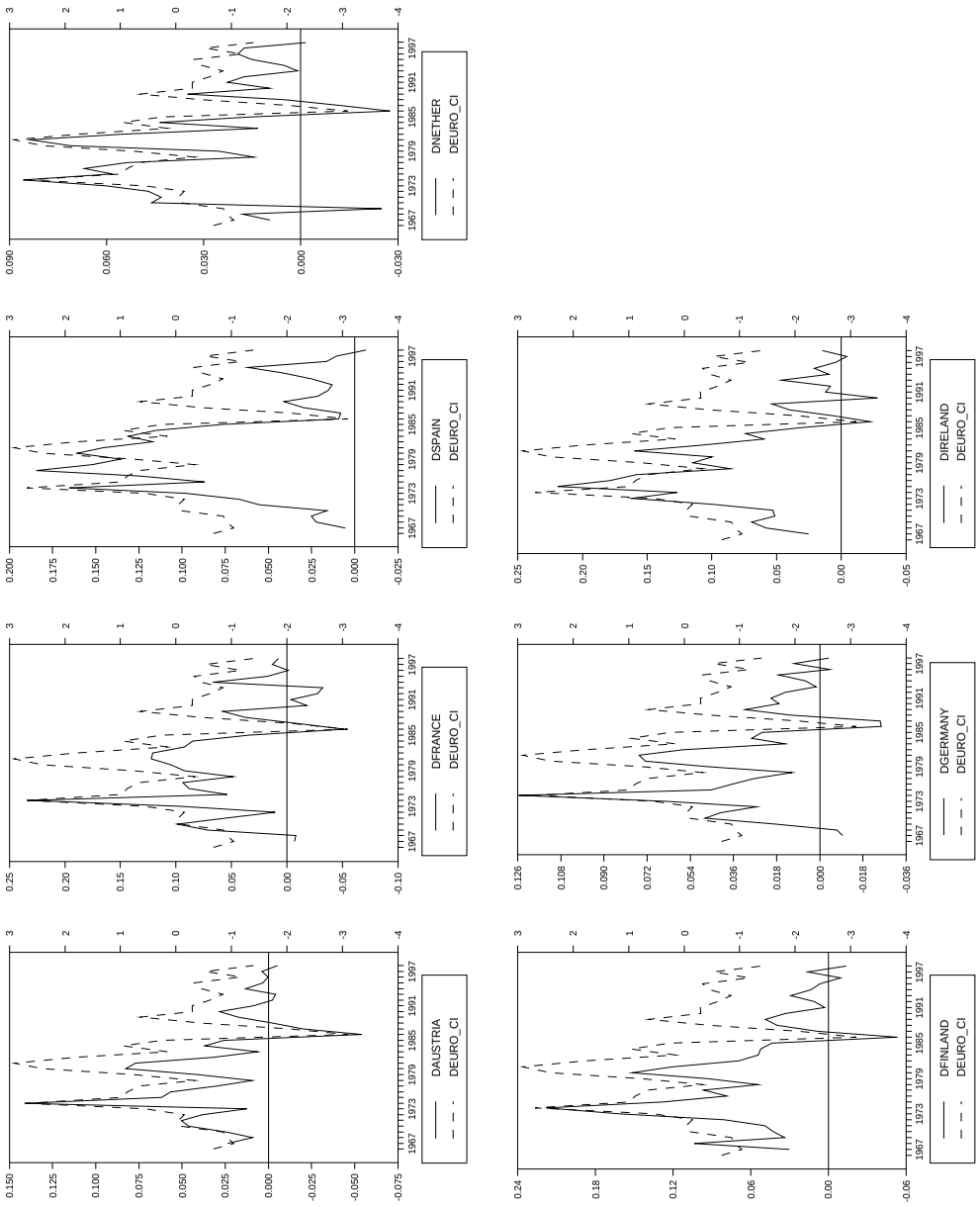

Figure 3.4: European relative wholesale price vs. African real GDP. Annual growth rate, 1971-1997

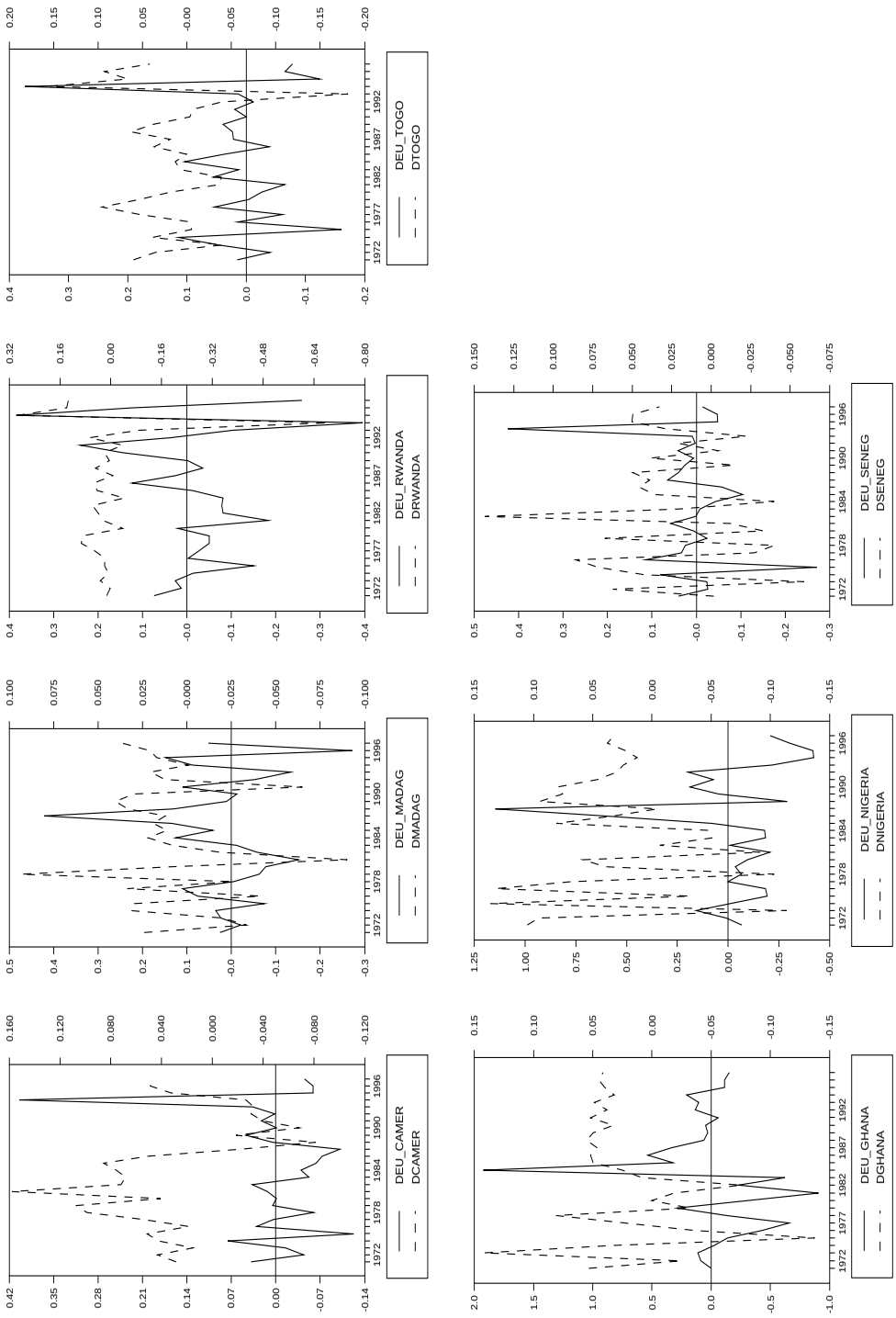

Figure 3.5: European GDP vs. African real exports. Year-on-year growth rate, 1982:1-2000:3

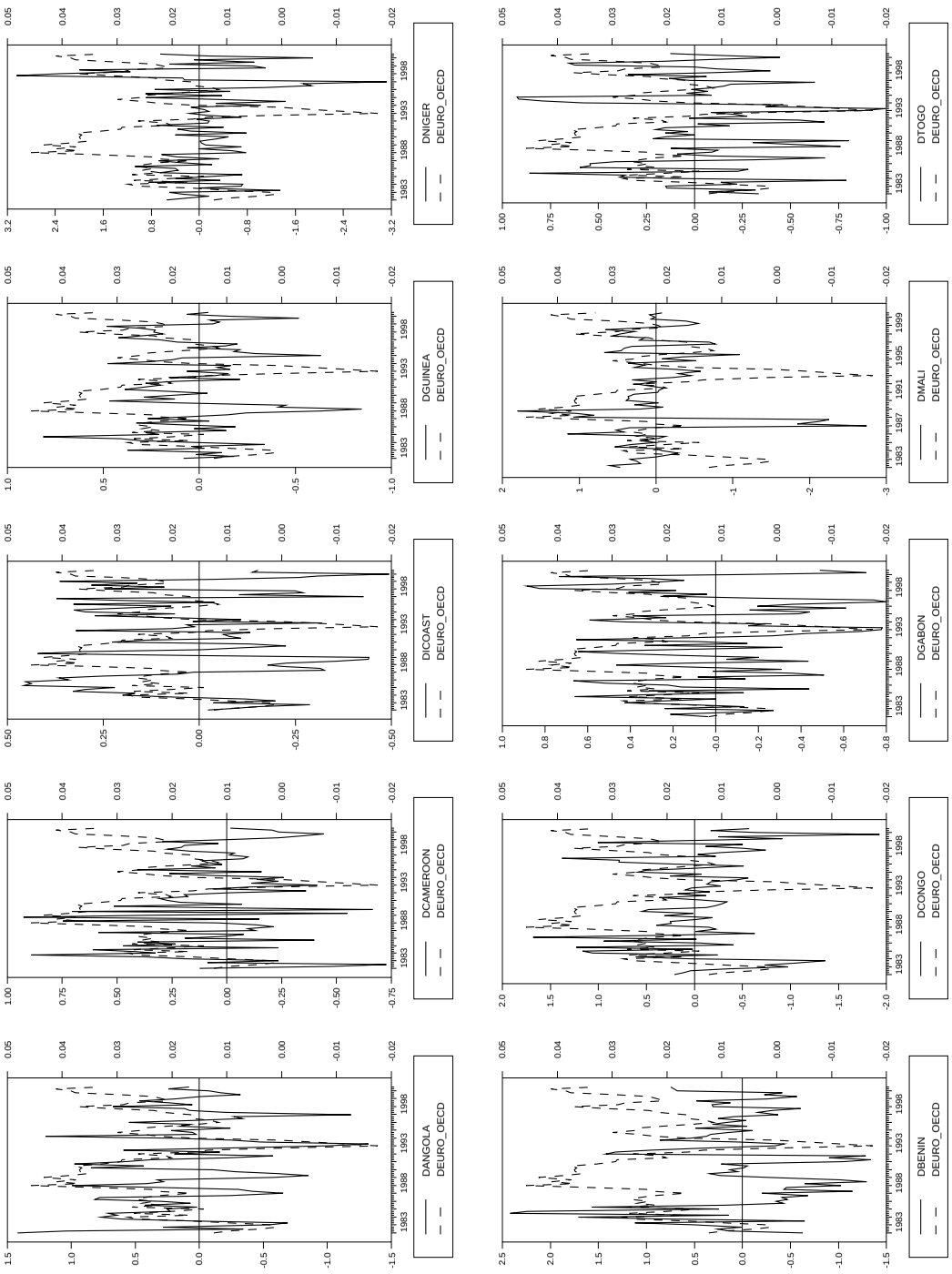

Figure 3.6: Comparison of the growth rate of HICP of the Euro area (AWM) and the composite indicator of inflation, 1971:1-2002:4

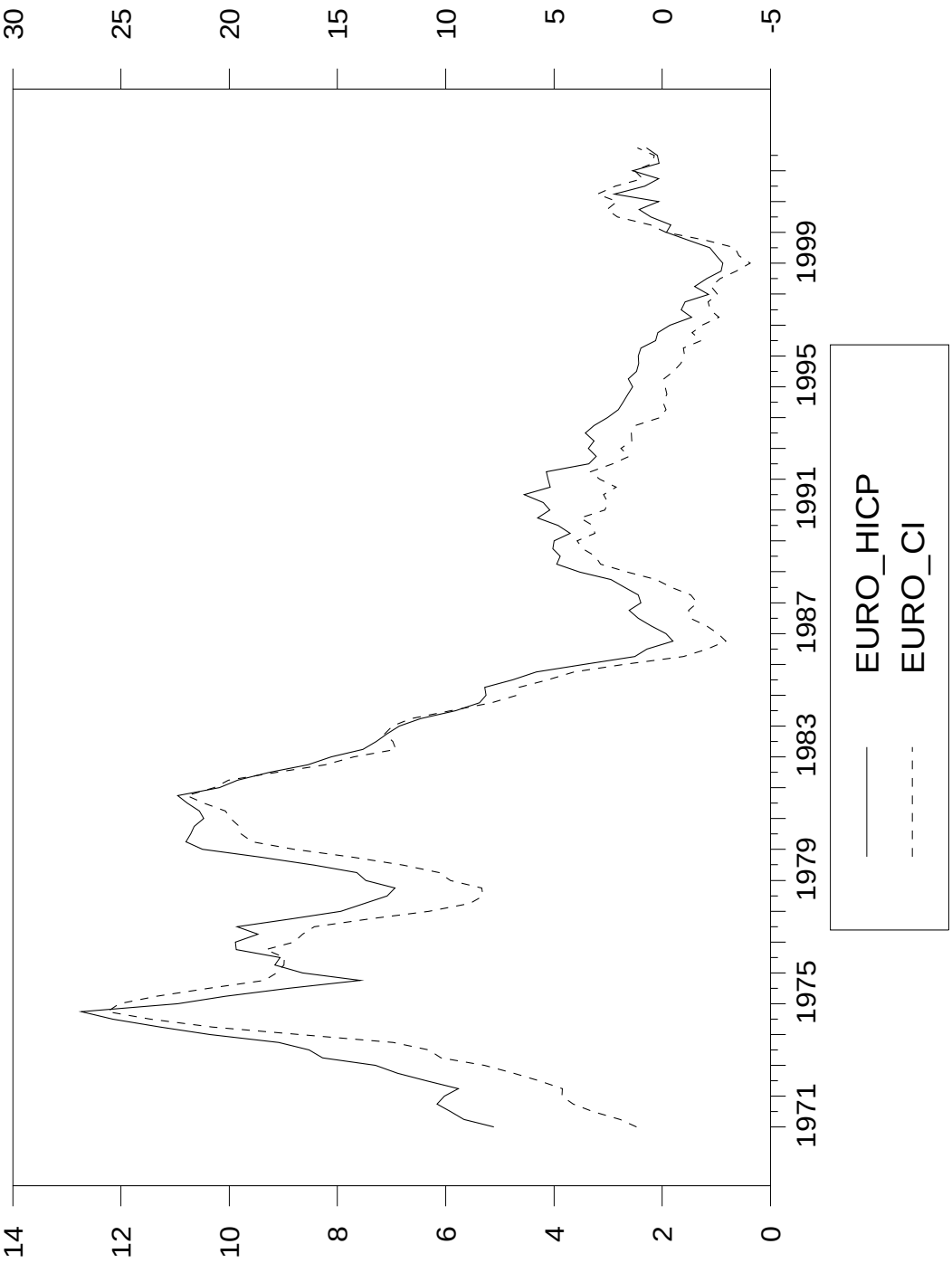

Figure 3.7: European composite CPI vs. CPI in various European countries. Year-on-year growth rate, 1971:3-2002:4

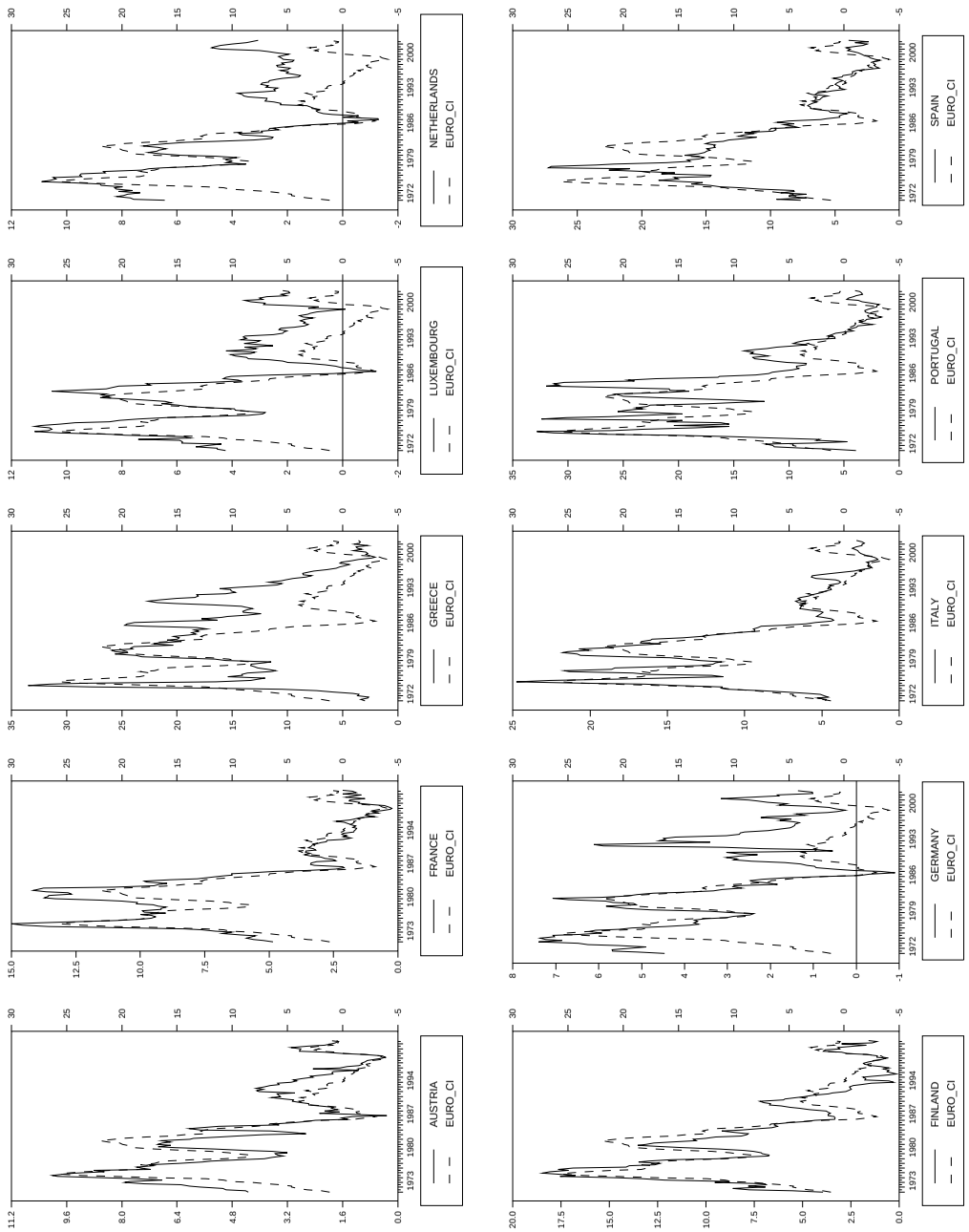
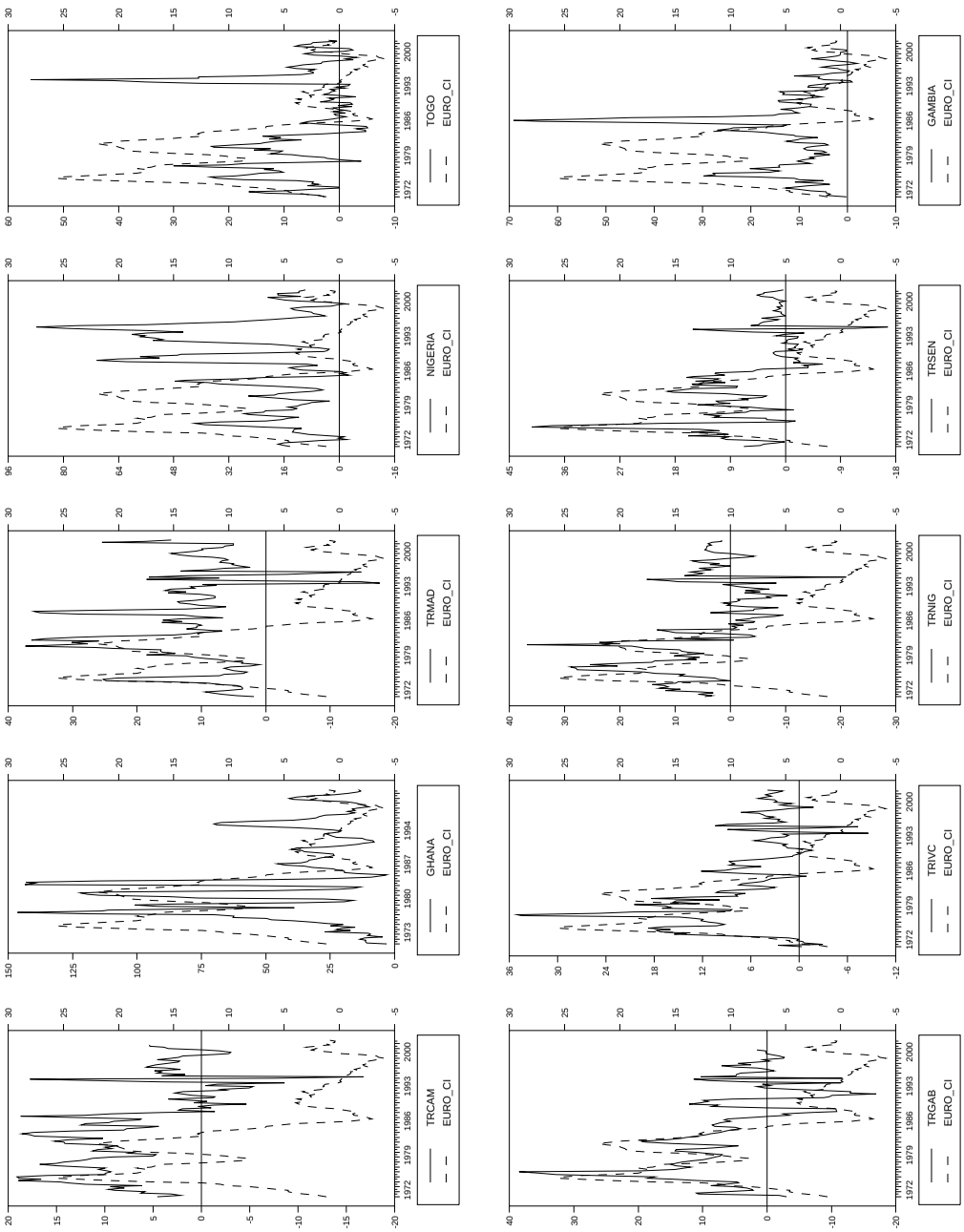
Figure 3.8: European composite CPI vs. CPI in various African countries. Year-on-year growth rate, 1971:3-2002:4