



Analysis of the synchronization of economic cycles: case of the economies of advanced countries and sub-saharan countries

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ABSTRACT: The combination of economic and geographical factors linked to international trade highlights a significant development towards an ever-greater integration of economies, which sufficiently demonstrates a strengthening of the dynamics of the globalization of commercial exchanges initiated many decades ago. The intensification of international trade, reinforced by the interconnection of financial markets and the appearance of common economic shocks are the elements that contribute to explaining the co-movements of advanced and sub-Saharan economies. In this study, it is a question of measuring the global cyclical synchronization of the economies referred to above, over the period going from 1981.Q₁ to 2021.Q₁, from the concordance index of Harding and Pagan (2006). Overall, this analysis shows that the level of cyclical synchronization between the economies of sub-saharan and advanced countries is high enough to justify the strong economic dependence between these two groups of countries.

KEYWORDS: synchronization, concordance index, economic dependence, co-movements.

I. INTRODUCTION

During several decades, the world economy has known a significant evolution towards greater integration, highlighting a consolidation of the globalization of trade. In this context, we are witnessing to the intensification of international trade flows, consolidated by a systematization and an interconnection of financial markets not only in industrialized countries, but also in emerging economies as well as some underdeveloped countries. This situation is especially reinforced with the phenomenon of synchronization of economic cycles, which beyond a cyclical correlation, highlights a similarity of the phases of economic cycles of activities between two or more economies (Elgahry, 2015). It is important to mention that the idea of a correlation of business cycles shows that the duration and importance of major changes in

economic activity seem increasingly identical between economies. In that case, we note that the synchronization of cycles constitutes one of the most important condition for the optimal functioning of a Monetary Union, even better, of a Regional Economic Community through the concordance of the phases expansive or recessive, therefore facilitating the application of common monetary and budgetary policy solutions (Gayer, 2007). Therefore, the concept of synchronization of economic cycles, beyond being systematic, suggests possibilities for total and partial decoupling of economic cycles, taking into account the specificities of the economies. Consequently, empirical work (Park and Shin, 2009; Fidrmuc and Korhonen, 2010; Lui and Liao, 2011) carried out after the occurrence of the financial crisis of 2008 made it possible to show, despite of the severity of this crisis, that certain emerging countries, like India and China, have maintained an appreciable and sustained level of growth. For this purpose, the discussion on decoupling is once again at the center of economic debates. As part of this study, we will endeavor to analyze the synchronization between the economic cycles of advanced countries and those of Sub-Saharan African countries.

II. LITERATURE REVIEW

The exponential increase of the level of trade and the significant integration of stock markets could have led to affirm that the consolidation of the synchronization of cycles between the main economies in the world results from this upward trend in international trade. Indeed, several empirical works allow us to nuance this argument relating to a systematization of cyclical synchronization between economies.

For this purpose, the controversy surrounding questions relating to the convergence or decoupling of economic cycles between economies in the world has undergone numerous changes (constantly evolving economic integration, increase in international commercial and financial links as well as the rise in power emerging economies) in



recent years (Elgahry, 2015). It is in this context that Kose et al. (2008) stated that: "... In the last twenty years alone, the total volume of world trade has more than tripled, while cross-border capital movements have increased more than ninefold....". In general, it should be noted that the concept of "economic convergence (divergence)" refers globally, according to Nachtigal et al. (2002), to a reduction (increase) in disparities and diversity linked to the standard of living, the economic level as well as the performance of certain countries or regions.

In the framework of setting up of the concept of cyclic synchronization, Kose et al. (2008) specify that the globalization of trade in recent decades has made it possible to strengthen economic interdependence as well as the convergence of fluctuations in economic cycles. They further emphasize that greater openness to trade and financial flows, through several channels for transmitting cyclical fluctuations, contributes to making economies more sensitive to exogenous shocks and to increasing the level of synchronization of business cycles.

Furthermore, the hypothesis on the notion of decoupling highlights the concept according to which the business cycles of emerging economies have become, over the years, more independent of the business cycles of advanced economies (Elgahry, 2015). From this point of view, the work which confirms the decoupling hypothesis has shown that the level of growth of emerging economies was based on the exponential increase in domestic demand, implying at the same time an important reduction of the share of net exports on their GDP. In addition, the markets of emerging economies would have considerably consolidated the bases of domestic policy, by reducing as much as possible their external vulnerabilities, at the same time increasing the scope of countercyclical policies to cushion and optimally curb the impact of external shocks (Helbling et al., 2007).

It is also important to emphasize that the notion relating to the synchronization of economic cycles generally falls within the field of empirical study. It should be said first of all that the globalization of trade is at the origin of more synchronized economic cycles. It is in this context that Imbs (2004, 2006) analyzed, for a sample of 18 economies, the dependence between trade (of goods and assets), financial effects and the synchronization of economic cycles. These studies show that trade has a positive effect on the correlation of business cycles.

From another point of view, the studies carried out by Kose et al. (2003, 2008), on the subject of the decoupling of emerging economies from fluctuations in the business cycles of developed countries, showed that the correlation between the increase in international trade, the integration of financial markets and the degree synchronization of economic cycles is not always positive. Furthermore, studies carried out by Doyle and Faust (2005) highlight the fact that changes in cross-correlations between the economies of the Group of Seven (G7¹) are not statistically significant. Even more, the work of Monfort et al. (2003) revealed a drop in the level of economic synchronization, due to a reduction in the impact of common shocks, and despite the increase in the transmission of shocks originating in the American economy towards European economies.

Other empirical studies relating to economic cyclical synchronization have revealed that economic cycles are impacted by regional factors to the detriment of certain global factors. In this context, from the 1980s, focusing on the « industrialized European economies », we observed the existence of a "European economic cycle" (Artis and Zhang, 1997, 1999, and Artis, 2004). The aforementioned works, particularly those carried out by Artis and Zhang (1997), have largely returned to the relationship and cyclical synchronization between countries based on the European exchange rate mechanism (ERM) of the European Monetary System (EMS). Those works allow to demonstrate that there is a significant cyclical correlation between European economies.

In the same vein, Rose and Engel (2002) noted, relying on the correlation of business cycles between countries in the same monetary union, that these cycles are more synchronized compared to economies that do not belong to the same monetary union. Moreover, the studies carried out by Hirata et al. (2013) highlighted the accentuation of the correlation of regional economic cycles from the 1980s, with regard to their commercial and financial links. As part of a study on the synchronization of regional cycles in the Euro zone, Longlet (2011) showed that there is a strong heterogeneity in the levels of synchronization of the regions studied, despite the increase in the overall level of synchronization observed since the 1990s, leading at the same time to an attenuation of border effects.

¹ Discussion group and informal economic partnership made up of seven advanced countries, including the United

States, Canada, Germany, France, Italy, Japan, the United Kingdom and the bloc formed by the Union European.



III. EXPLANATORY FACTORS OF THE SYNCHRONIZATION OF ECONOMIC CYCLES

Many works on the co-movements of cyclics have allow to highlight several determinants, without however creating a consensus as to their nature. Indeed, the main determinants of the synchronization of economic cycles generally refer to trade, financial integration, the similarity of economic policies, common shocks and much more. Without claiming to be exhaustive, we will focus our study on the most relevant explanatory factors.

III.1. *Commercial exchanges*

From a theoretical point of view, it must be said that the impact of trade opening on the cyclical synchronization of economies is not always obvious. In this framework, Ramzi (2012) demonstrates that trade can be seen as the main channels of transmission of fluctuations between economies. It appears specifically that an increase in aggregate demand in an economy results in an increase in the demand for goods and services as well as the demand for labor in other economies leading to an increase in production. Therefore, a positive shock in demand in an economy contributes to real growth in the level of activity in the other economy. That means, an increase in production induces an increase in demand in other economies through price or tax policies. This transmission of fluctuations between economies occurs through trade. Specifically, it appears in substance that trade contributes strongly to the transmission of business cycles between countries, through the removal of trade barriers, which leads to a rapid propagation of demand shocks from an economy to another, reinforced by the positive effects of technological innovations, especially in a context marked by an increase in international trade (Frankel and Rose, 1998).

From another point of view, the studies carried out by Calderon, Chong and Stein (2007), Shin and Wang (2004) have shown that the upward trend in the level of trade does not necessarily lead to more economic cycles synchronous. For this purpose, economies would be subject to asymmetric sectoral shocks, face to the disparity in the trade structures of the different economies. Moreover, the consolidation of the commercial integration of economies would, where appropriate, induce idiosyncratic cycles. Moreover, the economists like Elachhab Fathi (2010) show that the influence of trade openness actually results from the intra- or inter-industrial nature of trade between economies. When trade is intra-

industrial, commercial integration contributes favorably to the cyclical synchronization of economies. If they were inter-industrial, we would rather speak of a cyclical decoupling.

III.2. *Financial integration of economies*

Concerning financial integration, it appears from a theoretical point of view that it has a negative effect on the synchronization of economic cycles (Obstfeld, 1994). As part of his work, the latter demonstrates that financial integration allows the movement of investments towards projects with a high risk propensity, which induces a specialization of economies based on their comparative advantage, implying at the same time a correlation negative of the increase in the level of production between financially integrated countries. The contrary causality could also explain the negative relationship between financial integration and cyclical synchronization of economies. Therefore, international financial integration can contribute to consolidate of the level of specialization of production of economies, mitigating by the same mechanism the transmission of shocks. From this point of view, Kalemli-Ozcan, Sorensen and Yosha (2001) confirm that financial integration promotes optimal distribution of risk, ultimately leading to specialization of economies in sectors of activity where countries have certainly comparative advantages, which reduce the possibilities of co-movements between economic cycles.

Conversely, on an empirical level, several studies have shown a positive correlation between financial integration and cyclical co-movement. Indeed, an important part of the economic literature makes it possible to show that the increase in financial investments abroad induces an improved receptivity of household consumption and business investment to exogenous financial shocks, consolidating by same occasion the level of synchronization of economic cycles (Fathi, 2010). In this context, Kose et al. (2003) demonstrate, over the period of 1960-1999, that financially open economies are characterized by greater cycle synchronization. In the same domain, Imbs (2006) relies on bilateral IMF data relating to the financial assets of several countries to show that there is a significant positive correlation between bilateral financial links and co-movement. Furthermore, Kose et al. (2004) demonstrate, over the period from 1960 to 1999, that financially open countries are more synchronized.



III.3. *Shocks and common factors*

The appearance of new notions, such as the globalization of trade, commercial openness or the financial integration of economies, have contributed to making common shocks essential mechanisms for transmitting economic fluctuations (Ramzi, 2012). These common shocks generally arise from the action of common factors that can be understood as exogenous sources that can significantly act on economies in the same way. For illustration, we can return to the fact that economies which fundamentally rely on open capital markets are also subject to changes in the global interest rate. This indicator is considered a basic element at the origin of the transmission of economic fluctuations (Pigott (1994), Gagnon and Unferth (1993) and Bernanke and Blinder (1992)).

According to the work carried out by Artis et al. (2009), common shocks are random events that simultaneously influence several economies. These may include, among other things, variations in commodity prices or reference interest rates in advanced economies, potentially sources of crises in emerging and developing countries (Elgahry, 2015). As a result, it happens that the occurrence of common shocks can contribute favorably to cyclical synchronization between countries. It is in this context that we emphasize that the variation in the key rates of the American central bank caused, in the 1990s, a movement of capital flows towards Latin America (Calvo and Reinhart 1996). From another point of view, we can mention the fall in oil prices between 2014 and 2016 (drop in oil prices of 51% in 83 days) which led to a serious crisis in the main oil producing countries, particularly those of sub-saharan economies (Baffes et al. 2015).

III.4. *The similarity of economic policies*

In the case of common economic policies (monetary and budgetary), these may influence the cyclical fluctuations of economies, through a significant direct impact on overall supply and demand as well as on the expectations of households and businesses. On the basis of data on the relationships between macroeconomic fluctuations and economic policies on an international scale, it essentially emerges that common economic policies can contribute to the consolidation of the synchronicity of cyclical movements between countries. In view of common shocks or exogenous shocks, we generally observe that identical variations in economic policies generate similar reactions at the level of prices, production and demand components, from one economy to another (Otto et al., 2003).

It is important to emphasize that the studies carried out by Artis and Zhang (1997) made it possible to highlight the interrelation between a common monetary policy and similar developments in terms of GDP growth. Conversely, a common monetary policy can increase divergences between economies when they are less synchronized. Furthermore, the partial compensation of asymmetric shocks by budgetary readjustments could lead to an increase in co-movements between countries. In addition, budget cuts are found to reduce the volatility of fiscal policy and fluctuations in economic activity (Fatás and Mihov, 2006). In the same framework, the studies carried out by Agnello et al. (2013) show that synchronized budgetary consolidation programs in different economies induce deeply linked economic cycles, particularly when it comes to budgetary adjustments lasting 2 or 3 years.

III.5. *Industrial structures*

The indications and data on the nature of the events at the origin of business cycles lead us to believe that these fluctuations are particularly caused by inter-industrial shocks (Clark and Shin, 2000; Funk, Hall and Ruhwedel 1999 and Kwark 1999). Indeed, the economies which have almost similar industrial structures tend to experience and transmit these common shocks in a similar way, thereby conveying economic cycles that are irremediably synchronized (Fathi, 2010). In the sense of the work carried out by Imbs (1999) based on systems of simultaneous equations, it appears among other things that this resemblance in industrial structures highlights the preponderance or the influence of specific sectoral shocks compared to shocks of a exogenous.

By focusing particularly on the synchronization between Tunisia and the economies of the Zone, Fathi (2010) sets out to measure, within the framework of his work, the similarity/dissimilarity of industrial specialization between Tunisia and its European partners. In this case, he relied on the dissimilarity index of industrial specialization constructed by Krugman (1991), the formulation of which is as follows:

$$IS_{ij,t} = \sum_{k=1}^M |S_{ik,t} - S_{jk,t}|$$

Where $S_{ik,t}$ corresponds to the share of the added value of a sector k in relation to the overall added value of a country i . The values taken by this index are included in the interval $[0;2]$. When these



values are close to 2, we can speak in this specific case of a presumption of strong dissimilarity.

III.6. Financial factors and credit markets

Theoretical considerations relating to economic fluctuations have largely highlighted the existence of financial cycles linked not only to the evolution of credit, but also to variations in the prices of financial assets. In this context, Borio et al. (2001) emphasize that financial cycles are strongly procyclical with the cycles of global activity and consolidate the amplitude of the latter. Then, the evolution of credit during the expansive phases of the cycle and its sudden reversal, during the recessive phases, feed and increase the level of real fluctuations (Balke, 2000; Hofmann, 2004; Calza et al. 2006; Calza et al. Sousa, 2006).

Consequently, the study of the determinants of the synchronization of real activity cycles cannot ignore the different mutations of financial variables. Therefore, the homogeneity of financial systems partially explains the co-movements of real cycles of global economic activity. To measure the degree of homogeneity of financial systems as well as their impact on the synchronization of economic cycles, Elachhab (2010) adopted the difference in the evolution of bank credits between Tunisia and its main economic partners. He considers in his analysis that in Tunisia, banks are in reality the main vectors of financial intermediation and contribute to providing the credit necessary for the economy. The degree of homogeneity of financial systems is established as follows:

$$\left| \frac{C_{i,t}}{GDP_{i,t}} - \frac{C_{j,t}}{GDP_{j,t}} \right|$$

where C_i and C_j correspond, respectively, to the credits granted to the private sector in economies i and j .

IV. METHODOLOGICAL APPROACH TO ESTIMATION OF CYCLIC SYNCHRONIZATION BETWEEN ADVANCED AND SUBSAHARIAN ECONOMIES

We set out to measure and to analyze the synchronization of business cycles in advanced and

sub-Saharan countries. In this framework, we have previously realized the « quarterly of time series » of real Gross Domestic Product extracted from the World Bank database (World Development Indicators) with the method established by Brahim Mansouri (2019). We studied the behavior of business cycles of a sample of some advanced and sub-Saharan economies who have the particularity to have a significant commercial and economic scale on the international and regional level, over the period from 1981.Q1 to 2021.Q1. In addition to the advanced economies of the Group of 10 (G10²), we will also focus on 39 sub-Saharan countries, in order to better understand the reality of co-movements between these two main blocs.

IV.1. Overview of the results of the characterization and dating of business cycles in sub-Saharan and advanced economies

The studies relating to the experimental analysis of business cycles reveals that there are two main methods of dating turning points. These include non-parametric approaches based on pattern recognition algorithms as well as parametric approaches based on the approximation of econometric³ models. As part of our work we will apply the first method.

This strategy for developing the dating of cycles, established by the NBER, is based on the detection and identification, using shape recognition algorithms of turning points or local extrema (peaks and troughs) of an economic cycle. In this context, it is from an initial detection of extrema (turning points) that we can determine and validate or not the main phases and characteristics of the cycles. In the present case, one of the most used methods was proposed by Bry and Boschan (BB) in 1971. Basically, the BB approach (1971) makes it possible to detect respectively for a series Y_t , a peak or a trough, such as:

- for a peak: $Y_t > Y_{t-k}; Y_t > Y_{t+k}; k = 1 \dots K$;
- for a trough: $Y_t < Y_{t-k}; Y_t < Y_{t+k}; k = 1 \dots K$..

where $K = 2$ for quarterly series and $K = 5$ for monthly series. Subsequently, we proceed to detect

of detecting the change or even the transition of an economy from an expansion regime to a recession regime, and vice versa). time series, which study the behavior of data. These are particularly (i) models with Markovian regime changes and (ii) threshold models.

² United States of America, China, France, United Kingdom, Germany, Canada, Italy, India, Republic of Korea, Japan.

³ The parametric methods used for dating cycles are generally based on non-linear econometric models (capable



the criteria defined above, in particular the “severity” S, the “duration” D and the “depth”. This criterion corresponds, in the sense of the NBER, to the recession highlights “a significant decline in economic activity. It is calculated, according to Aviat et al (2021), as follows:

$$Depth_R = (Y_P - Y_C)/Y_P$$

where Y_P and Y_C correspond respectively to the values taken by the series Y_t at the level of the peak and trough of an economic cycle. In the same register, we can estimate that the amplitude in the expansion phase corresponds :

$$Depth_E = (Y_P - Y_C)/Y_C$$

Furthermore, the non-parametric methods are known to be simple and efficient. However, they present certain shortcomings, in particular that linked to the difficulty of aggregating the extrema corresponding to the bypass points associated with the series which highlight the aggregated economic activity and the adaptation of the study of the business cycle to a multi-varied context.

Afterward, we will present below an illustration of the characterization and dating of business cycles for the Cameroonian and French economies.

(i) Analysis of the cyclical behavior of sub-Saharan economies

Overall, it emerges from the analysis of business cycles of the sub-Saharan economies in our sample that they experienced, over the period from 1981.Q₁ to 2021.Q₁, an average 07 complete cycles, composed by an average of 07 phases of expansion and 07 phases of recession. It remains that the average duration of the expansion phases of the economies of sub-Saharan Africa corresponds at more than 15 quarters, while the contraction phases had an average duration of 07 quarters, with an average amplitude estimated at 0.113(0.673)⁴, reflecting an average overall decrease in GDP. Recessive phases are generally explained by the drop in export revenues resulting from several terms of trade shocks. It was particularly marked during the periods ranging from: (i) 1981.Q₄ to 1985.Q₃ with the appearance of the oil shock of 1985 (fall of 66%

in 82 days in oil prices); (ii) 1991.Q₃ to 1994.Q₂ following the oil shock caused by the invasion of Kuwait as well as the persistence of the debt crisis and (iii) from 2014.Q₂ to 2016.Q₂ with a drop of around 65 % of barrel of crude oil price which began in June 2014. This spectacular decrease in the price of barrel, add with the prices decrease of other main raw materials, contributed to ringing the death knell of a glorious era that began at the beginning of the 21st century, marked by the occurrence of a “*super cycle*” (Baffes et al. 2015).

In another point of view, it clearly appears that the phases of expansion are more numerous, more marked and longer than those of recession. To this end, we note, beyond the average duration of the upward phases mentioned above, that their average of depth stands at 0.548 (6.58), justified by an improvement in the exploitation of cash-generating industries.

⁴ The severities of the different phases are in brackets.



Table 1 : Illustration of the characterization and dating of Cameronn’s business cycle (1981.Q1-2021.Q1)

Period		Duration	Depth	severity	excess	Period		Duration	Depth	severity	excess
hollow	peak					peak	hollow				
1981.Q1	1987.Q3	27	0,9717	13,118	0,4786	1987.Q3	1989.Q2	7	0,158	0,5529	0,1121
1989.Q2	1990.Q3	5	0,1234	0,3085	0,0524	1990.Q3	1992.Q1	6	0,0498	0,1494	0,0351
1992.Q1	1993.Q2	5	0,3961	0,9903	0,1737	1993.Q2	1994.Q3	5	0,4754	1,1886	0,3878
1994.Q3	1996.Q2	7	0,2895	1,0134	0,1354	1996.Q2	1997.Q2	4	0,029	0,0579	0,0246
1997.Q2	1999.Q2	8	0,0775	0,31	0,0355	1999.Q2	2000.Q3	5	0,0933	0,2332	0,0719
2000.Q3	2008.Q4	33	1,6615	27,4154	0,8261	2008.Q4	2010.Q2	6	0,0243	0,073	0,0155
2010.Q2	2011.Q3	5	0,1265	0,3161	0,0549	2011.Q3	2012.Q2	3	0,0271	0,0406	0,0216
2012.Q2	2014.Q2	8	0,2176	0,8705	0,0997	2014.Q2	2015.Q3	5	0,1215	0,3037	0,0948
2015.Q3	2018.Q3	12	0,2841	1,5249	0,1198	2018.Q3	2019.Q2	3	0,0144	0,0216	0,0129
2019.Q2	2021.Q1	7	0,1857	0,65	0,0775						

Source: The Authors.

(ii) Analysis of the cyclical behavior of advanced economies

The analysis of the business cycles of the advanced countries in our sample, over the period from 1981.Q1 to 2021.Q1, highlights that overall the economies of these countries have experienced on average 06 complete cycles, composed on average 07 phases of expansion and 06 phases of recession. It should be noted that the average duration of expansion phases in advanced economies was more than 19 quarters, while recession phases were marked by average duration of around 04 quarters, with an average depth estimated at 0.01 (0.03), reflecting an average overall decrease in GDP. These phases of contraction overall by the occurrence of several shocks in particular: (i) the debt crisis of developing countries of 1982 which generated cyclical fluctuations in certain advanced European economies (France, United Kingdom, Germany and Italy); (ii) subprimes financial crisis of 2008 ; (iii) the crisis in basic raw materials and oil shock (2014-2015) and more recently (iv) the economic crisis caused by the Covid-19 pandemic has shaken several economies in the world, the vast majority of which have experienced phases of recession until the end of the second quarter of 2020, with the benefit of lifting the containment measures applied in the different countries.

From another point of view, it should be noted that the expansion phases of advanced economies seem longer; as illustration we can cite those experienced respectively by the United States (on average 51 quarters) and China (on average 50 quarters).



Table 2 : Illustration of the characterization and dating of France's business cycle (1981.T1-2021.T1)

Period		Duration	Depth	severity	excess	Period		Duration	Depth	severity	excess
hollow	peak					peak	hollow				
1984.Q3	1990.Q4	25	1,423	17,7847	0,7045	1981.Q3	1984.Q3	15	0,1767	1,3255	0,1064
1991.Q2	1992.Q3	5	0,114	0,2851	0,0519	1990.Q4	1991.Q2	2	0,0184	0,0184	0,0073
1993.Q3	1995.Q4	9	0,2218	0,9979	0,1022	1992.Q3	1993.Q3	4	0,0587	0,1175	0,0448
1997.Q3	1998.Q3	4	0,0408	0,0816	0,018	1995.Q4	1997.Q3	7	0,1046	0,3662	0,074
2000.Q3	2008.Q4	32	1,1553	18,4855	0,572	1998.Q3	2000.Q3	8	0,1	0,3999	0,0687
2010.Q2	2011.Q4	5	0,0882	0,2204	0,0405	2008.Q4	2010.Q2	7	0,0988	0,3459	0,0672
2012.Q3	2014.Q2	7	0,0728	0,2547	0,0355	2011.Q4	2012.Q3	4	0,064	0,128	0,0495
2015.Q3	2018.Q3	12	0,155	0,9297	0,0723	2014.Q2	2015.Q3	5	0,1603	0,4008	0,1265
2020.Q2	2021.Q1	3	0,1649	0,2474	0,0509	2018.Q3	2020.Q2	7	0,062	0,217	0,0422

Source: The Authors.

IV.2. Methodological approach to measure the synchronization of cycles in advanced countries and sub-Saharan Africa

(i) Measurement of common movements by the correlation coefficient

The usual method for measuring the level of synchronization of two variables x and y is established and calculated by the linear correlation coefficient, the objective of which is to have an approximation of the degree of the linear relationship between these two variables. This coefficient is presented as follows:

$$\rho_{xy} = cov(x, y) / \sigma_x \sigma_y \quad (3.1)$$

In the present case, ρ_{xy} corresponds to the correlation coefficient between the variables x and y , $Cov(x, y)$ designates the covariance between said variables, and finally σ_x and σ_y represent respectively the standard deviations of x and y . Indeed, the correlation coefficient corresponds to the ratio between the covariance which measures the common movements of the aforementioned variables as well as the product of their standard deviations corresponding to their total variation.

Furthermore, it is important to note the value of the correlation coefficient is included in the interval $[-1; 1]$. Therefore, when the coefficient equal to 1 this refers to perfect synchronization of the variables, in the opposite case it corresponds to total desynchronization. A correlation is zero, for its part, corresponds to the non-existence of a possible relationship between the two variables.

(ii) Harding and Pagan (2006) concordance index

The concordance index of Harding and Pagan (2006) is one of the most used instruments to study the synchronization of macroeconomic variables in economy or to examine the concordances of cyclical fluctuations of a panel of countries belonging or not to a set regional (Maurin, 2018). This index is also based on the measurement of turning points, allowing to determine whether the indicators analyzed are pro-cyclical or counter-cyclical and whose formula is as follows:

$$I_{X,Y} = \frac{1}{n} (\sum_{i=1}^n S_{X,i} S_{Y,i} + \sum_{i=1}^n (1 - S_{X,i})(1 - S_{Y,i}))$$

With the variables X and Y which represent two economies of the same sample size " n ", S_i a binary variable highlighting the different phases in an economy. For this purpose, when $S_i = 1$ the economy is said to be in expansion phase and when $S_i = 0$ it is in recession phase.

The analysis overall reveals, with regard to the concordance of the economic cycles of two economies, that if the index $I_{X,Y}$ takes a value equal to 1 we speak of perfect concordance, highlighting the fact that the two economies are perfectly synchronous. Otherwise, that is to say when the index $I_{X,Y}$ takes a value equal to 0, we speak in this case of a perfect phase opposition (anti-concordance).

(iii) Quasi-instantaneous correlation measure from Abiad et al. (2013)

The cyclical synchronization measurement method developed by Abiad et al. (2013) makes it possible to calculate co-movements or the synchronization at any time point of growth rates



between economies. The almost instantaneous measure of correlation under review is presented as follows:

$$Qcorr_{ij,t} = \frac{(A_{i,t} - A_i^*) * (A_{j,t} - A_j^*)}{\sigma_i^A * \sigma_j^A}$$

where $Qcorr_{ij,t}$ corresponds to the quasi-correlation between the real GDP growth rates of economies i and j for year t , $A_{i,t}$ denotes the growth rate of production of economy i during period t . A_i^* and σ_i^A represent respectively the mean and the standard deviation of the growth rate of country i in period t .

IV.3. Measuring of global cyclical synchronization between advanced and sub-Saharan economies

After a brief presentation of the methods for calculating the synchronization of the economic cycles of economies, it appears from the analysis that the method based on the correlation coefficient is more appropriate for evaluating the degree of correlation of the growth rate between the different economies, while the concordance index of Harding and Pagan (2006) makes it possible to return to the degree of cyclical transmission, by at the same time measuring the overall synchronization of the different economic phases between economies over a specific time series.

The quasi-instantaneous correlation measurement method of Abiad et al. (2013), for its part, focuses on the quarterly or annual correlation of GDP and instantaneously calculates the comovements of growth rates at any point in time, independently of the determination of the cyclical phases.

As part of our work, we apply, after identifying the positions of economies in the different cycles, the concordance index of Harding and Pagan (2006) to evaluate the overall cyclical synchronization between advanced economies (10 countries) and sub-Saharan economies (39 countries) over the period between (1981.Q1-2021.Q1).

As illustration, we will calculate the degree of synchronization, within the framework of the business cycle, between the Cameroonian economies and the French economy, the chronologies of which are presented in the appendices. After searching for the different turning points (trough and peak), we

proceed to detect the binary variables S_i respectively for the periods of expansion and the periods of recession, in accordance with the method described above. It should also be noted, in the present case, that the recession and expansion phases are respectively in light gray and white color. The table for calculating the concordance index of Harding and Pagan (2006), resulting from our work, is presented as follows:



Table 3.1 : Illustration of the calculation of the degree of synchronisation between the cameronian and french economies ; case of the business cycle

Trimesters	Cameroun	France	Cameroun Sx	France Sy	(1-Sx)	(1-Sy)	SxSy	(1-Sx)(1-Sy)
1981. Q ₁	6 630 791 257,26	644 112 264 867,08	1	0	0	1	0	0
1981. Q ₂	6 614 893 327,70	622 797 046 060,29	1	0	0	1	0	0
1981. Q ₃	6 606 984 032,07	608 326 386 157,88	1	0	0	1	0	0
1981. Q ₄	6 607 063 370,38	600 700 285 159,85	1	0	0	1	0	0
1982. Q ₁	6 595 031 013,86	596 019 901 906,62	1	0	0	1	0	0
.....
.....
2008. Q ₄	28 023 291 554,75	2 862 984 129 060,30	1	0	0	1	0	0
2009. Q ₁	27 891 461 898,36	2 764 212 131 976,82	0	0	1	1	0	1
2009. Q ₂	27 945 997 227,85	2 707 409 742 326,85	0	0	1	1	0	1
2009. Q ₃	27 920 004 178,08	2 673 081 763 826,06	0	0	1	1	0	1
2009. Q ₄	27813482749,05	2 661 228 196 474,46	0	0	1	1	0	1
2010. Q ₁	27446622457,22	2 643 857 902 663,99	0	0	1	1	0	1
2010. Q ₂	27 341 101 919,90	2 632 029 017 698,91	0	0	1	1	0	1
.....
.....
2019. Q ₄	40 005 603 572,74	2 694 248 368 048,39	1	0	0	1	0	0
2020. Q ₁	40 147 353 643,88	2 647 204 497 738,60	1	0	0	1	0	0
2020. Q ₂	40 421 468 537,97	2 624 953 470 433,87	1	0	0	1	0	0
2020. Q ₃	41 126 151 221,78	2 653 306 515 742,05	1	1	0	0	1	0
2020. Q ₄	42 261 401 695,28	2 732 263 633 663,14	1	1	0	0	1	0
2021. Q ₁	46 977 664 216,11	3 057 911 801 450,28	1	1	0	0	1	0
Sum of products (SxSy) and (1-Sx) (1-Sy) over the ((1981.T1-2021.T1)							84	29
Degree of synchronisation (France/Cameroun)							0,7151	

Source :The authors.

It appears from the above calculations that the degree of synchronization between the Cameroonian and French economies is estimated at 71.51%. Which assumes a strong correlation between these two countries. We will then proceed, for each type of cycle (business, growth and acceleration), to the calculation of the concordance index of Harding and Pagan (2006) for the other economies in our study sample.



V. ANALYSIS OF THE RESULTS

The study of the cyclical fluctuations generated by the economic shocks mentioned above over the period going from (1981.Q₁-2021.Q₁), it follows that the American economy and the emerging economies, in particular that of China, have been for two decades the starting points of the main global crises. As a result, we could provide a positive answer to the rhetorical question posed by Kose et al. (2008), namely “.....when the United States economy sneezes, the rest of the planet catches a cold? ”. It remains that this contagion of cyclical fluctuations is not direct between the American and sub-Saharan economies, the latter having mainly European economies as trading partners.

Therefore, it seems appropriate, before focusing on the degree of cyclical synchronization between sub-Saharan and advanced countries, to return to the correlation between advanced economies, based on their business cycles⁵.

The results of the calculation of the cyclical correlation between sub-Saharan countries and advanced countries are presented and analyzed according to the main regional economic communities of sub-Saharan Africa, as follows:

V.1. Global cyclical synchronization between ECCAS and advanced economies

The conclusions of the calculations of cyclical synchronization between the ECCAS economies and advanced economies (Table 4.1) highlight a fairly strong concordance between these two groups of countries which is established on average around of 0.6477. It specifically appears that the pair constituted by the economy of Rwanda and the economies of the G10 represents the most significant proportion of cyclical transmission weight of the sample of ECCAS economies (the degree of overall synchronization being estimated at 68.48%),

with degrees of synchronization reaching more than 80% with the American⁶, Indian and Chinese economies, thereby reflecting ever-increasing trade, generally made up of industrial products (construction equipment, machinery, pharmaceutical products) and agricultural products for Rwandan imports as well as agricultural products for exports. Furthermore, it appears from our estimates that the highest overall level of cyclical transmission was observed between the bloc of ECCAS economies and the North American economies, notably 0.6741 with the United States and 0.6994 with Canada.

From another point of view, it is important to note that the economies of the Central African Monetary Union (UMAC), with the exception of Equatorial Guinea, have displayed particularly high cyclical synchronization with advanced economies of Euro zone, highlighting a sufficiently pronounced commercial and financial integration (pegging of the CFA Franc to the euro) between these two blocks, as shown in table 4.1. For example, we note that the concordance index of Harding and Pagan (2006) between the Cameroonian economy and the French, German and Italian economies correspond respectively to (0.715), (0.684) and (0.728).

It should also be noted that the lowest levels of cyclical dependence were recorded in the respective couples formed by the ECCAS economies with the Japanese economy. The lowest degree of synchronization was observed for the circumstance in the couple (Japan-Burundi), as shown in the table below :

⁵Our analysis of the correlation of business cycles will be based primarily on classic type cycles, which have the particularity of being less erratic and reflecting major changes in the economic activity of a country, particularly through the Gross domestic product. Moreover, it clearly appears that the degrees of cyclical synchronization and

even the cyclical dependence between economies are eroding depending on the type of cycle studied.

⁶ In this context, it should be noted that Rwanda benefits from limited preferential trade benefits under the AGOA (African Growth and Opportunity Act) initiative.



Table 4.1 : Summary of cyclical synchronization coefficients between advanced and ECCAS countries

Pays	USA	France	United Kingdom	China	Germany	Canada	Italy	India	Rep. Korea	Japon	Average
Cameroon	0,703	0,715	0,576	0,671	0,684	0,652	0,728	0,677	0,677	0,525	0,6608
Angola	0,652	0,652	0,690	0,620	0,595	0,791	0,690	0,627	0,703	0,487	0,6506
Gabon	0,620	0,722	0,722	0,589	0,703	0,722	0,696	0,582	0,696	0,494	0,6544
Rwanda	0,816	0,589	0,639	0,810	0,519	0,728	0,614	0,804	0,715	0,614	0,6848
Burundi	0,589	0,487	0,500	0,633	0,468	0,614	0,500	0,589	0,538	0,437	0,5354
Tchad	0,690	0,728	0,766	0,646	0,734	0,690	0,741	0,639	0,639	0,551	0,6823
DRC	0,690	0,601	0,677	0,684	0,595	0,665	0,576	0,614	0,601	0,449	0,6152
CAR	0,608	0,785	0,696	0,601	0,766	0,582	0,722	0,684	0,595	0,595	0,6633
Congo	0,671	0,620	0,671	0,639	0,576	0,772	0,620	0,633	0,747	0,532	0,6481
Guinée E	0,753	0,627	0,677	0,684	0,595	0,778	0,652	0,715	0,741	0,601	0,6823
Average	0,679	0,652	0,661	0,657	0,623	0,699	0,653	0,656	0,665	0,528	0,6477

[0 ; 0,1]
[0,1 ; 0,2]
[0,2 ; 0,3]
[0,3 ; 0,4]
[0,4 ; 0,5]
[0,5 ; 0,6]
[0,6 ; 0,7]
[0,7 ; 0,8]
[0,8 ; 0,9]
[0,9 ; 1]

Source : The authors.

V.2. Global cyclical synchronization between ECOWAS and advanced economies

The results of the calculations of the synchronization of the economic cycles of the ECOWAS and G10 economies (see Table 4.2), obtained from classic cycles, show that the weight of the cyclical transmission between the two blocks, approximately 0.623, is sufficiently significant to confirm the hypothesis of cyclical dependence or coupling between the two aforementioned groupings of economies. From a specific point of view, it appears that the ECOWAS economies which have the highest level of synchronization with the G10 economies are Burkina Faso (0.7215), Cape Verde (0.7215) and Mali (0.7114). These degrees of synchronization which can reach more than 80%, such as the couples (Cape Verde/France), (Cape

Verde/Germany) as well as (Cape Verde/Italy), sufficiently reflecting the high level trade between the Cape Verdean economy and the European G10 countries.

It should also be noted that the advanced economy most synchronized with the ECOWAS economies is french economy, with a level of transmission of business cycles equivalent to (0.7039). This high degree of cyclical synchronization is justified not only by the traditional commercial relations between France and the ECOWAS economies, but also by the financial integration with the economies of West Africa, notably the countries⁷ of the West African Economic and Monetary Union (UEMOA), as shown in Table 4.2.

⁷ The least significant degree of overall cyclical synchronization recorded in the West African Economic and Monetary Union countries which use the franc of the

financial community in Africa is that of the couple (France/Cote d'Ivoire), i.e. approximately (0.525).



From another point of view, the least significant cyclical dependence was observed in the Ivorian economy, particularly with regard to the level of transmission of economic cycles estimated at (0.4608). Which reflects a certain trend towards diversification of the Ivorian economy. It also is important to note that the respective couplings formed between the ECOWAS economies and the

Japanese economy have highlighted less significant levels of cyclical dependence, with a weight of transmission of cyclical fluctuations equal to 0.4816.

Table 4.2 : Summary of cyclical synchronization coefficients between advanced and ECOWAS countries

Pays	USA	France	United Kingdom	China	Germany	Canada	Italy	India	Rep Korea	Japon	Average
Togo	0,677	0,766	0,766	0,671	0,734	0,665	0,728	0,741	0,614	0,551	0,6911
Sierra Leone	0,627	0,627	0,601	0,608	0,671	0,639	0,614	0,563	0,677	0,475	0,6101
Senegal	0,627	0,829	0,677	0,582	0,797	0,576	0,778	0,652	0,576	0,487	0,6582
Niger	0,627	0,778	0,690	0,620	0,772	0,601	0,728	0,703	0,563	0,513	0,6595
Benin	0,677	0,753	0,703	0,633	0,772	0,639	0,728	0,639	0,614	0,513	0,6671
Burkina Faso	0,734	0,797	0,785	0,690	0,791	0,684	0,772	0,722	0,671	0,570	0,7215
Cap Vert	0,734	0,861	0,759	0,665	0,829	0,646	0,835	0,658	0,684	0,544	0,7215
Gambia	0,608	0,633	0,595	0,614	0,601	0,532	0,633	0,519	0,557	0,557	0,5848
Guinea B	0,709	0,684	0,633	0,690	0,665	0,696	0,684	0,646	0,734	0,481	0,6620
Mali	0,734	0,797	0,734	0,728	0,753	0,658	0,772	0,696	0,671	0,570	0,7114
Mauritanie	0,532	0,601	0,563	0,506	0,582	0,570	0,595	0,538	0,519	0,430	0,5437
Ivory Coast	0,481	0,525	0,456	0,449	0,532	0,443	0,500	0,430	0,475	0,316	0,4608
Ghana	0,557	0,665	0,582	0,532	0,627	0,544	0,639	0,525	0,500	0,405	0,5576
Nigeria	0,481	0,538	0,544	0,500	0,519	0,481	0,494	0,538	0,399	0,335	0,4829
Average	0,6288	0,704	0,649	0,606	0,689	0,598	0,678	0,612	0,589	0,482	0,6237

Source : The authors.



V.3. Global cyclical synchronization between Southern African Development Community (SADC) and advanced economies

Calculations relating cyclical synchronization between the SADC economies and advanced economies (Table 4.3), obtained on the basis of business cycles, show that the weight of cyclical transmission between these two groups of countries equals to approximately 0.622, thereby confirming the cyclical dependence (coupling) of the SADC economies, mainly exporters of certain basic raw materials (ore).

Specifically, it happens that the SADC economies most synchronized with the advanced economies are the small open economies such as the Seychelles (0.733), Mauritius (0.744) as well as the least developed economies like Botswana (0.715). In the present case, peaks in the degree of cyclical

correlation were recorded at the level of the Comoros/France (0.823), Seychelles/USA (0.842), Botswana/Republic of Korea (0.823) as well as Mauritius/Republic of Korea (0.823).

From another point of view, it should be noted that the cyclical correlation between the emerging South African economy and the advanced economies is the least significant among the SADC economies (0.3506). These results confirm the hypothesis according to which the business cycles of emerging economies have become, over the years, more independent of the business cycles of advanced economies (Elgahry, 2015).

Table 4.3 : Summary of cyclical synchronization coefficients between advanced and SADC countries

Pays	USA	France	United Kingdom	China	Germany	Canada	Italy	India	Rep. Korea	Japon	Average
Zimbabwe	0,563	0,487	0,576	0,544	0,468	0,525	0,462	0,652	0,563	0,563	0,5405
Zambie	0,646	0,608	0,608	0,627	0,627	0,709	0,582	0,595	0,658	0,494	0,6152
Seychelles	0,842	0,715	0,766	0,759	0,709	0,690	0,703	0,753	0,791	0,601	0,7329
Namibie	0,614	0,665	0,741	0,582	0,671	0,665	0,677	0,652	0,703	0,614	0,6582
Maurice	0,797	0,734	0,747	0,728	0,703	0,747	0,747	0,709	0,823	0,709	0,7443
Botswana	0,759	0,696	0,734	0,677	0,703	0,722	0,734	0,658	0,823	0,646	0,7152
Comores	0,684	0,823	0,658	0,639	0,804	0,608	0,797	0,684	0,633	0,582	0,6911
Lesotho	0,570	0,709	0,671	0,500	0,728	0,582	0,684	0,494	0,633	0,633	0,6203
Madagascar	0,608	0,684	0,595	0,589	0,665	0,544	0,633	0,608	0,570	0,468	0,5962
Malawi	0,595	0,557	0,608	0,627	0,551	0,633	0,608	0,557	0,557	0,481	0,5772
South Africa	0,354	0,316	0,361	0,323	0,323	0,361	0,304	0,392	0,399	0,373	0,3506
Average	0,639	0,636	0,6421	0,5995	0,632	0,617	0,630	0,614	0,650	0,560	0,6220

Source : The authors.



V.4. Global cyclical synchronization between East African Community and advanced economies

The results of calculations of the synchronization of business cycles of the East African Community (EAC) and G10 economies (Table 4.4), obtained from classic cycles, show that the weight of cyclical transmission between the two blocks is estimated at approximately at 0.624, which helps to support the hypothesis of coupling between the aforementioned economies.

In this case, the most significant cyclical correlation of the EAC economies in our sample was recorded in Kenya (0.6772), followed by Ethiopia (0.6582), Uganda (0.6772), 6253) and finally Sudan (0.5354). This situation is justified, as for other sub-Saharan economies, by their exacerbated dependence on their exports, which are also subject to the ups and downs and fluctuations of the international market for basic raw materials.

In addition, the most significant transmission weights of business cycle fluctuations were respectively established in the India/EAC (0.6978), USA/EAC (0.6883) and China/EAC (0.663) pairs. This demonstrates the depth of trade relations between the CAE economies and those of the United States of America, China and India.

Table 4.4 : Summary of cyclical synchronization coefficients between advanced and EAC countries

Pays	USA	France	United Kingdom	China	Germany	Canada	Italy	India	Rep. Korea	Japan	Average
Uganda	0.703	0.538	0.576	0.696	0.557	0.703	0.576	0.715	0.652	0.538	0.6253
Soudan	0.582	0.544	0.544	0.500	0.563	0.557	0.519	0.557	0.544	0.448	0.5354
Ethiopia	0.734	0.582	0.582	0.728	0.551	0.759	0.646	0.734	0.696	0.570	0.6582
Kenya	0.734	0.709	0.684	0.728	0.715	0.620	0.684	0.785	0.688	0.506	0.6772
Average	0.6883	0.5934	0.5965	0.6630	0.5965	0.6598	0.6060	0.6978	0.6250	0.5142	0.6241

Source : The authors.

VI. CONCLUSION

At the end of our analysis, it appears overall that the level of cyclical synchronization between the sub-Saharan economies and the advanced economies members of the G10 is strong enough to justify the cyclical dependence between these two groups of countries. From this point of view, the weight of cyclic transmission is overall significant, i.e. around 0.6. Specifically, the largest and most pronounced cyclical correlations among the countries of sub-Saharan Africa, generally made up of extractive and exporting economies, were observed in the least developed sub-Saharan economies (Burkina Faso, Mali and Botswana) as well as than small open economies (Seychelles, Mauritius and Cape Verde).

Thus, sub-Saharan countries dependent on the volatility of prices of basic raw materials on the international market, were specifically marked by most of the terms of trade shocks (economic crises) over the period 1981.Q1-2021.Q1. It should also be mentioned that the least significant cyclical transmission weights in our study sample are those established in the context of the couplings between the Japanese economy (specialized in the manufacturing and marketing of high technology products particularly requested by developed countries) and sub-Saharan economies.

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