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**On the Determinants of output Co-movements in the CEMAC Zone:  
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**Abstract**

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This paper aim to examine the forces driving co-movements in the CEMAC. For that purpose, a two-step methodology is employed. First, a DCC-GARCH is used to assess correlations between member states. Second, panel models are employed to examine whether and the extent to which trade, policies, economic structure and common factors determine output growth correlations. Results from the DCC-GARCH model suggest that spikes of co-movements appear during high volatility oil prices episodes namely the 1998 oil crisis, the 2008 financial crisis and the recent 2014 collapse. Panel regressions suggest that trade has negative effects on output co-movements. The differential fiscal policy displays strong and significant positive effects on output correlations while the role of the single monetary policy is not robust across models. The degree of specialization has negative effects while the financial development increase co-movements. The landlocked situation of Chad and Central Africa reduces their co-movements with other member states. Results also reveal non-linearities in the effects of trade linkages which are non-significant when the country is landlocked. As a policy implication, national governments may limit the cyclical behaviour of their fiscal policy in order to in increase co-movements in the region.

JEL Classifications: E32, E42, F41, F42

Key Words: output co-movements, trade integration, common shocks, fiscal and monetary policy, GMM dynamic panel, specialization, Monsoon effects, random effects.

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**On the determinants of output co-movements in the CEMAC zone:  
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**1. Introduction**

It is well recognized that the world has become smaller, as information technologies tend to delete geographic frontiers. The economic and political environments have also become increasingly globalized. This evolution has in-depth implications for economics and finance, because the borders between national, regional, and global issues are becoming less clearly defined. The increase of financial and trade linkages, liberalization of markets, and banking globalization led to high interconnection among economies, so that sudden changes in one country generally have economic repercussions in others. The 2008 financial turmoil has underlined again the globalized world in which countries and markets evolves. This globalization makes impossible for economies to collapse in isolation. Their macro interdependencies due to closer linkages could lead to a succession of decreases by domino chain.

The CEMAC region is a currency union formed by small open economies highly dependent to raw material exports. The participation of member states to a common economic and monetary union is assumed to stimulate spillover effects from one economy to another through closer economic links and geographic proximity. One of the main criteria of an Optimal Currency Area (OCA) is based on the synchronization of business cycles. Which can be the fact of macro interdependences or spillover effects between the states in the region.

The novelty of the study consists to examine the effects of common monetary policy, similar fiscal policies, economic structure and global factors (including oil prices and euro exchange rate against dollar) on co-movements in the CEMAC zone measured by real output growth correlations. It is worth examining the role of oil prices since CEMAC countries production is predominantly made up of commodities and especially oil. Exception of the Central African Republic (CAR), CEMAC economies are low diversified and remain mainly driven by the oil sector which represents a large part of export revenues. It is also interesting to examine the role of the exchange rate of the euro area against the US dollar on the output co-movements dynamics in CEMAC. This evaluation provides light on the benefits of pegging the CFA franc on the euro.

The present paper focuses on output co-movements over time. It extends the existing literature in two directions. On the one hand, regardless of the plethora of papers on business cycle synchronization, there is only a restricted number of studies focusing to co-movements of real output in CEMAC. Understand output co-movements in the sub-

region business cycles indicates the symmetric response to shocks affecting the member states within a given cluster. This is a critical condition for CEMAC countries to better coordinate their macroeconomic policies and secure the benefits of adopting of a common monetary policy and a common currency (e.g. Mundell 1961, and Frankel and Rose 1998). On the second hand, the study adopt conditional correlations of output growth from a DCC-GARCH compared to other studies based on rolling window growth correlations.

The remainder of the paper is organized as follows. In the next section we review the relevant prior theoretical and empirical literature. Section 3 briefly discusses the methodological issues in a technical manner. Section 4 presents sources where data were extracted, stylized facts and summary statistics. Section 5 displays and discusses the empirical estimates and Section 5 concludes.

## **2. Related literature**

The point of departure of business cycle co-movements and cross-country spillovers is the endogeneity theory of optimal currency area (OCA) developed by Mundell (1961) and Frankel and Rose (1997, 1998). They have suggested that stronger trade relations are likely to increase business cycle synchronization (BCS) through the aggregate demand channel. An expansion period in one country leads to an increase of demand for imported goods from its trading partners, therefore transmitting the expansion to these partners. Therefore, a large empirical literature has been developed to analyze the influence of trade relations on business cycle synchronization. Over all, the results tend to confirm a positive impact of trade integration on economic synchronization, especially for advanced economies (see e.g., Canova and Dellas, 1993; Clark and Van Wincoop, 2001; Bordo and Helbling, 2003; Kose et al., 2008, 2003a,b; Crucini et al., 2011; Antonakakis, 2012; Kose et al., 2012; Cerqueira, 2013). A similar outcome emerges when trade integration promotes more intra-industry trade than inter-industry trade (Frankel and Rose, 1998; Imbs, 2004; Baxter and Kouparitsas, 2005; Calderón et al, 2007; and Inklaar et al. 2008). An increase of trade integration induces similar industrial shocks which could lead to greater business cycle correlation and enhance spillovers magnitude. He and Liao (2012) has refined the analysis, showing that increased vertical trade intensity have contributed more to regional business cycle synchronization within the Asian region.

Another range of the literature defends that the most determinant factor of the propagation of disturbances is the degree of economic specialization rather than the volume (see e.g. Krugman, 1993; Kalemli-Oczan et al., 2001, 2003; Imbs, 2004; Kose and Yi, 2002, Inklaar et al., 2008). The economic specialization drives industry-specific supply shocks and increases the magnitude of asymmetric shocks. If that is the case, trade is likely to increase business cycle decoupling. On the contrary, two economies that

feature similar production structures are likely to be subject to analogous shocks, therefore displaying similar business cycle patterns (Crosby, 2003; Imbs, 2004; Kumakura, 2006). In sum, the more countries' production bases differ, the more their business cycles move away from one another. Moreover, considering the contrast in trade structures, asynchronous effects may be more pronounced in developing countries and for industrial-developing country pairs than just for industrial countries (Calderón et al., 2007). In a different way, Stockmann (1988) has underlined the role of sectorial shocks showing that two economies are similarly hit by sector-specific shocks if they have similar nature and size economic sectors.

The hypothesis of OCA has been examined from another approach suggesting that a common monetary policy or a harmonized fiscal policy lead to common business cycles (see e.g Dai, 2014, Castro, 2011; Crespo et al., 2011; Kocenda et al., 2008 ; Clark and van Wincoop, 2001, Darvas et al., 2005; Artis and Zhang, 1997). Artis and Zhang (1997) have showed that the common policies induced by adherence to the Exchange Rate Mechanism (ERM) have generated a convergence of real cycles in the European context. Crespo et al. (2011), Darvas et al. (2005) and to a lesser extent Fatas and Mihov (2003) have underlined the negative impact of fiscal indiscipline and divergence on business cycle synchronization since countries running high budget deficits create idiosyncratic shock. A similar monetary and fiscal policies have at least as strong effect on the business cycle synchronization as trade intensity (Inklaar et al., 2005). Furceri (2009) has found that countries with similar government budget stance tend to have smoother business cycles, implying that fiscal policy convergence might lead to smoother cycles. By contrast, estimates from Dai (2014) has revealed that similar monetary policy leads to closer cycle correlation but greater fiscal balance differential leads to more correlated business cycles. On the opposite, Clark and van Wincoop (2001) has revealed that correspondence in policies has no consequence on business cycle synchronization.

Concerning external common factors, Moneta and Ruffer (2009) argue that oil prices movements and changes in the USD/JPY exchange rate have a significant role in explaining the synchronization of Asian activity. Kang et al. (2002) and Kwan (2001) have found that the severe appreciation of the yen vis-à-vis the dollar from the mid-1980s to the mid-1990s, and its subsequent depreciation was a crucial determinant of the economic fluctuations in East Asia. Kang et al. (2002) has underlined that while the dynamic response of Korean industrial production to changes in the yen/dollar exchange rate was not significant during the pre-crisis period, it has become significant during the post-crisis period. Assume that the economy suffers from a collapse in global demand away from the goods it produces, a monetary policy expansion leading to a depreciation of the currency could be adopted to stimulate demand for domestic products. Therefore, the output could rise more speedily than under a fixed exchange rate regime (Frankel et al., 2002).

### 3. Methodological issues

#### 3.1. Measuring output co-movements using a DCC-GARCH

The Dynamic Conditional Correlation (DCC) model proposed by Engle (2002) is used to estimate dynamic conditional correlations (DCC) in this study. Defining  $r_t = (r_{1t}, r_{2t}, \dots, r_{nt})'$  as an  $n$ -variable vector, the DCC model is given by:

$$r_t = H_t^{-\frac{1}{2}} \varepsilon_t, \text{ with } \varepsilon_t \sim N(0, I_N) \quad (1)$$

where  $|\phi| < 1$  and  $\varepsilon_t$  are independently and identically distributed random variables and  $h_t$  is positive with probability one.

Next, the multivariate conditional covariance matrix in the DCC is expressed as follows:

$$H_t = D_t R_t D_t \quad (2)$$

where  $D_t$  is the  $n \times n$  diagonal matrix of time-varying standard deviations from univariate GARCH models with  $\sqrt{h_{iit}}$  on the  $i$ -th diagonal  $i = 1, \dots, n$ ;  $R_t$  is the  $n \times n$  time-varying correlation matrix. The DCC model proposed by Engle (2002) involves a two-stage estimation of the conditional covariance matrix  $H_t$ . In the first stage, univariate volatility models are fitted for each of the metal returns and estimates of  $\sqrt{h_{iit}}$  are obtained. In the second stage, stock return residuals are transformed by their estimated standard deviations from the first stage. That is  $u_{it} = \varepsilon_{it} / \sqrt{h_{iit}}$  where  $u_{it}$  is then used to estimate the parameters of conditional correlation. The evolution of the correlation in the DCC model is given by:

$$Q_t = (1 - a - b) \bar{Q} + a u_{t-1} u_{t-1}' + b Q_{t-1} \quad (3)$$

where  $Q_t = [q_{ijt}]$  is the  $n \times n$  time-varying covariance matrix of  $u_t$ ,  $\bar{Q} = E[u_t u_t']$  is the  $n \times n$  unconditional variance matrix of  $u_t$ .  $a$  and  $b$  are non-negative scalar parameters satisfying  $a + b < 1$ . Since  $Q_t$  does not generally have ones on the diagonal, we scale it to obtain a proper correlation matrix  $R_t$ . Thus,

$$R_t = \left( \text{diag } Q_t^{-\frac{1}{2}} Q_t \text{diag } Q_t^{-\frac{1}{2}} \right) \quad (4)$$

Now  $R_t$  in (4) is a correlation matrix with ones on the diagonal and an off-diagonal element less than one in absolute value, as long as  $Q_t$  is positively definite. A typical element of  $R_t$  is of the form:

$$\rho_{ijt} = \frac{q_{ijt}}{\sqrt{q_{iit}q_{jtt}}}, \quad i = j = 1, \dots, n \text{ and } i \neq j \quad (5)$$

### 3.2. Dynamic panel for measuring determinants of dynamic co-movements

For an empirical assessment of channels of output co-movements discussed above, the paper proposes a model which features real output growth correlations as a function of these channels. The estimation is applied to panel data including all the CEMAC countries. The model that we have estimated is specified as follows:

$$\psi_{ij}^g(\mathbf{H})_t = \varphi_0 + \varphi_1 A_{i,t} + \varphi_2 B_t + \varphi_3 \varphi_{1,t}^- + \varphi_4 \varphi_{2,t}^- + \eta_i + \xi_{i,t} \quad (6)$$

with,  $A_{i,t} = \left[ \overline{XM}_{ij,t} \quad \overline{S}_{i\bullet,t} \quad \overline{\Delta B}_{i\bullet,t} \quad \psi_{i,t} \right]$  a vector of country-specific explanatory variables including the trade intensity between country  $i$  and other CEMAC countries  $j$   $\overline{XM}_{ij,t}$ , similarity in economic specialization  $\overline{S}_{i\bullet,t}$ , fiscal balance differential  $\overline{\Delta B}_{i\bullet,t}$  and financial development  $\psi_{i,t}$ .  $B_t = \left[ r_t \quad \theta_t \quad e_t \right]$  is a vector of common variables comprising monetary policy rate  $r_t$  oil prices ( $\theta_t$ ) and the euro area exchange rate against the US dollar ( $e_t$ ).  $\varphi_{1,t}^-$  is a dummy variable for the 2008 financial crisis (1 for 2008, 2009, and 2010) while  $\varphi_{2,t}^-$  is a dummy variable for the landlocked situation of Chad and Central Africa.  $\mu_{i,t} = \eta_i + \xi_{i,t}$  is the fixed effects decomposition of the error term.

Trade intensity is computed as a mean of bilateral trade intensity between country  $i$  and other CEMAC countries  $j$  in a standard way introduced by Frankel and Rose (1998):

$$\overline{XM}_{i\bullet,t} = 100 \times \left\{ \frac{1}{N-1} \sum_{j=1}^{N-1} \left[ \frac{X_{ij,t} + M_{ij,t}}{GDP_{i,t} + GDP_{j,t}} \right] \right\}, \quad (7)$$

where  $X_{ij,t}$  denotes nominal bilateral exports FOB (Free On Board) expressed in US dollar of country  $i$  to economy  $j$ ,  $M_{ij,t}$  is trade imports CIF (Cost-Insurance-Freight) of country  $i$  from country  $j$  in US dollar.  $GDP_{i,t}$  and  $GDP_{j,t}$  are the gross domestic product of economy  $i$  and economy  $j$ , respectively, at time  $t$ . Bilateral trade data come from the IMF database Direction of Trade (DOTS).  $\overline{XM}_{i\bullet,t}$  can also be considered as the trade integration.

The fiscal balance differential variable is calculated by taking the average differences in absolute value in the budget balance (as a percentage of GDP) between the two economies as measures of fiscal policy differences:

$$\overline{\Delta B}_{i\bullet,t} = \frac{1}{N-1} \sum_{j=1}^{N-1} |\Delta B_{i,t} - \Delta B_{j,t}| \quad (8)$$

where  $\Delta B_{i,t}$  and  $\Delta B_{j,t}$  is the budget balance in country  $i$  and  $j$  respectively.

Similarity in economic specialization is computed using average differential sectorial real value added:

$$\overline{S}_{i\bullet,t} = \frac{1}{N-1} \sum_{h=1}^H \sum_{j=1}^{N-1} |S_{ih,t} - S_{jh,t}| \quad (9)$$

where  $S_{ih,t}$  denotes the GDP share of sector  $h$  in country  $i$  representing the average of the discrepancies in the economic structures of countries  $i$  and  $j$ . Thus,  $S$  reaches its maximal value of two for two countries with no sector in common (Imbs, 2004).

## 4. Data sources, stylized facts and preliminary analysis

### 4.1. Data and stylized facts

The empirical analysis of this paper is based on a panel data set that we construct from different sources mainly composed by the IMF International Financial Statistics and the World Development Indicators of the World Bank. It covers the six member States of the sub-region. We construct output co-movements as follows. First we extract gross domestic product (GDP) from 1995 to 2016 that comes from the World Bank World Development Indicators (WDI). The data are disaggregated to a quarterly frequency by

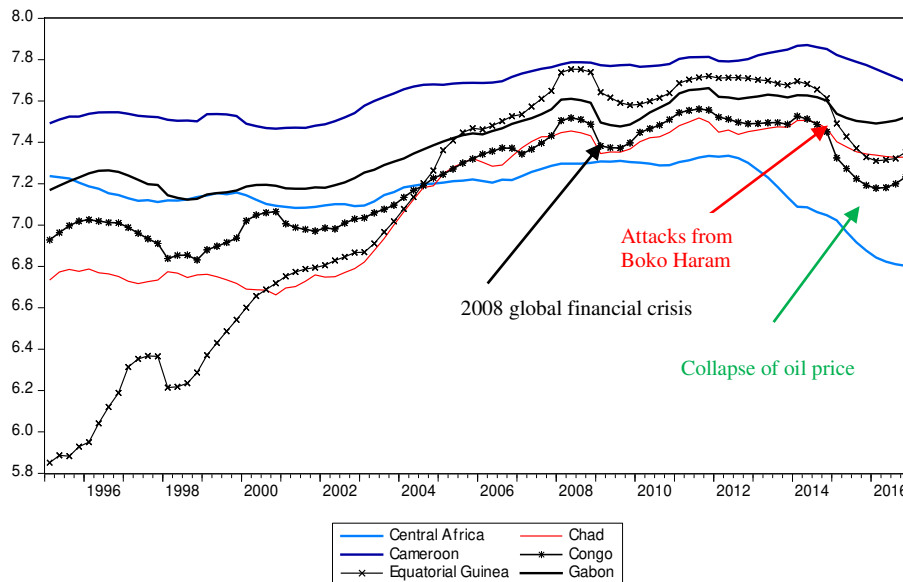


fitting a local quadratic polynomial for each observation of the annual series<sup>1</sup>. The natural logarithm of GDP corrected by the consumer price index is then considered as a measure of log real output. Second, a DCC-GARCH model for the real output growth is run to obtain time-varying correlations. Finally, we take the regional mean of these correlation coefficients for each country  $i$  as our measure of co-movements with other member states.

Figure 1 below depicts time-variations of real output in CEMAC during the period under investigation.

**Figure 1. Log-Real output dynamics in CEMAC**  
(Logarithm forms covering 1995Q1-2016Q4)

Figure 1 shows that the real output in Cameroon appears to be highest in Cameroon over time under the period consideration. During the 2008 financial and economic turmoil a recession was observed in the region. The double effects of oil prices collapse and insecurity crisis has also led to similarities of movements in CEMAC.



Source: Author's calculations

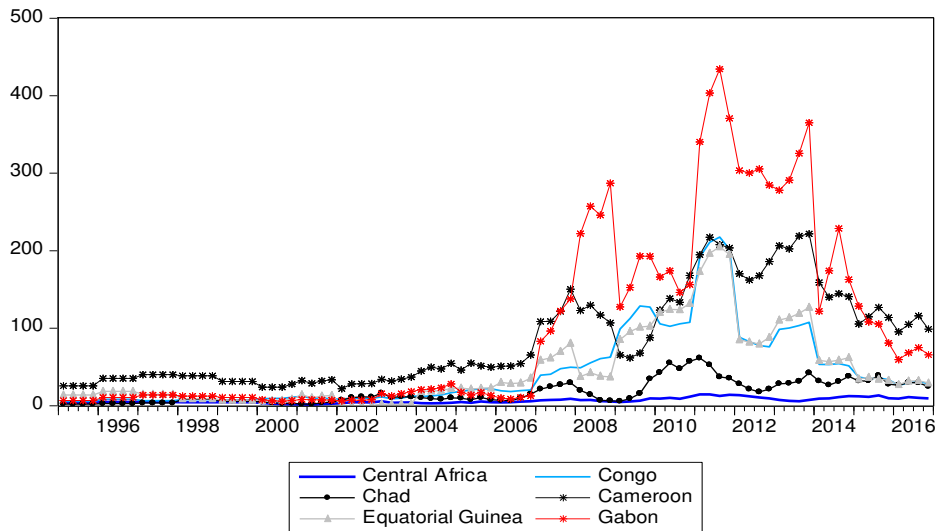
Note: The period under consideration covers 1996:Q1-2016Q4. The real output is computed as the current GDP expressed in US dollar, extracted from the WDI, divided by the consumer price index sourced from the IMF International Financial Statistics. We disaggregate annual data to a quarterly frequency due to data limitations.

<sup>1</sup> This polynomial is used to fill in all observations of the quarterly series associated with the period. The quadratic polynomial is formed by taking sets of three adjacent points from the source series and fitting a quadratic so that either the average or the sum of the high frequency points matches the low frequency data actually observed. For most points, one point before and one point after the period currently being interpolated are used to provide the three points. For end points, the two periods are both taken from the one side where data is available.

Figure 2 shows regional trade in the CEMAC zone. It noticeably appears that the amount of trade between the economies of the Central African Monetary and Economic Union is low compared to their economic activity. The trade linkages between a country and other member states don't exceed 500 US dollars. It is clear that Gabon's trade with other member states grew significantly since 2006. Cameroon is the second most important imports partner after France. Their imports from Cameroon consist on agricultural products. Figure 2 also shows that regional trade has registered a downtrend in 2008. The decline may be declined to the transitory insecurity food crisis which has threatened Cameroon in 2008. This has caused a deceleration of trade flows with Gabon and Equatorial since the country has to manage domestic pressures on foods supply.

**Figure 2. Regional Trade across CEMAC countries**  
(US dollars, from 1995Q1 to 2016Q2)

Figure 2 shows that trade flows in the CEMAC zone have significantly increased in 2007. The rise of linkages was particularly noteworthy for Gabon which appears therefore like the most important trade partner for other member states at the regional level since. The value of flows tends to collapse since the beginning of 2014. This decline is associated to the double effects of oil prices collapse and insecurity crisis in the region.



Source: Author's calculations

Note: Figure shows depicts regional trade by countries in the CEMAC zone. The data used to compute trade are aggregated bilateral imports and exports, at a regional level, extracted from the IMF Direction of Trade Statistics (DOTS).

Figure 3 depicts the movements of real output growth in the CEMAC zone. We can notice that volatility clustering can be easily observed. Large changes follow large changes of either sign and small changes follow small changes. The volatile growth rate reflects oil price volatility. Except, Central Africa these economies are driven by the oil output; this explains the high growth volatility. Many spikes of output growth correspond to episodes of high volatility oil prices.

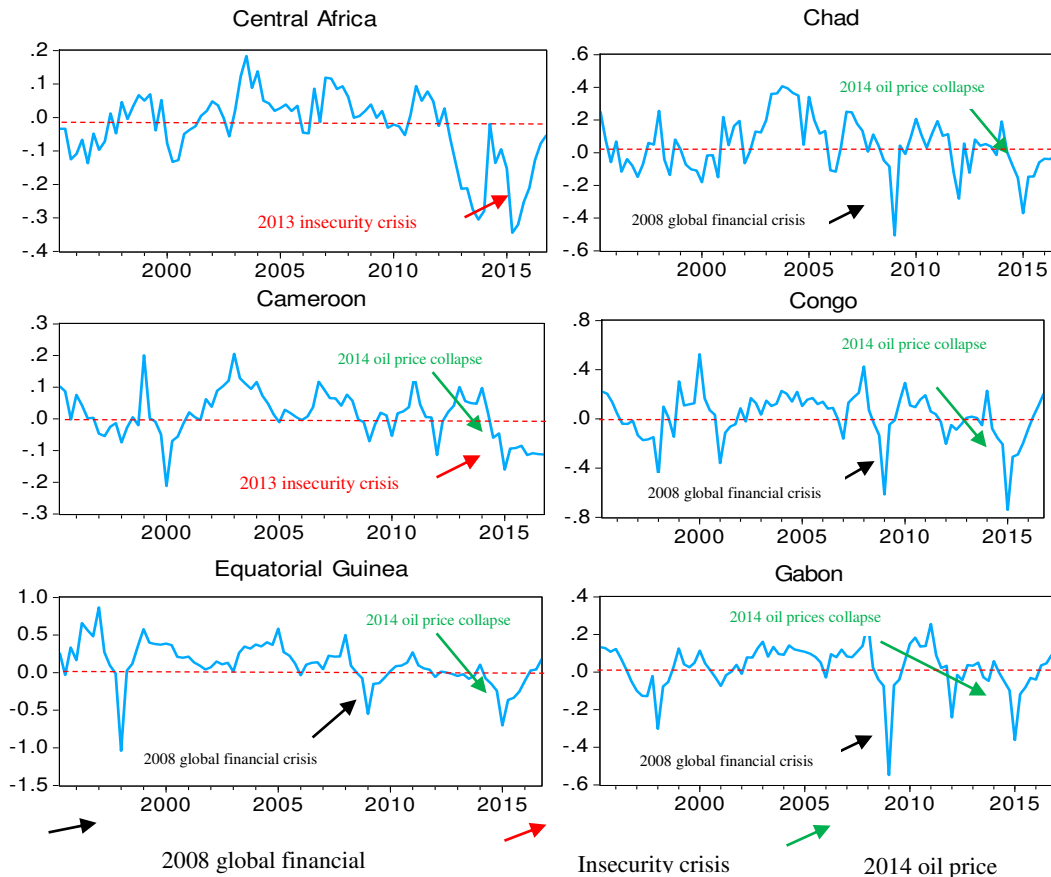
First, considering, the 1998 shock which corresponds to the period dominated by Cameroon, Congo and Gabon in the oil production, figure 3 shows that Congo and Gabon

experienced the most important drop. The deceleration was minor in Cameroon which displays the more diversified economic structure of the three. Second, significant negative peaks of the real GDP growth appears during the 2008 global financial crisis. Taken individually, member states have not registered uniform negative growth rates. Specifically, the real output has highly decelerated in Chad, Gabon, Congo and Equatorial Guinea during this turmoil given their mono specialization and their oil-dependency. Third, figure 3 suggests that the downfall of oil prices in 2014 jointly with public deficits caused by increased military expenses was associated to a persistent decrease of the real output in Cameroon.

Concerning moments of insecurity, real GDP growth has registered important downtrend since the 2012-13 civil war. Attacks from Boko Haram which started in 2014 has undermined the economic activity in Cameroon and Chad.

**Figure 3. Real output growth in CEMAC**

Figure 3 shows that important peaks appear during episodes of high volatility oil prices (1998 oil price shock, 2008 global financial crisis and 2014 oil price collapse) and the moments of insecurity



Source: IMF International Financial Statistics, World Development Indicators, Author's calculations

## 4.2. Summary statistics

Table 1 reports common summary statistics for selected variables. Table 2 reports the corresponding unconditional correlations. Several points are worth noting. First, output growth correlations in the CEMAC is relatively high (0.47) although compared to other findings (Imbs, 2004 for instance) although trade intensities are insignificant. Second, table 1 reports a large extreme values for the selected variables used in this study, namely output growth correlations, trade, specialization, differential development and discount rate.

Table 1  
Summary Statistics across Countries

	Output growth correlations	Trade intensity	Specialization	Differential fiscal balance	Financial development	Discount rate
Mean	0.47	1.93E-06	1.86	7.58	0.08	4.84
Median	0.47	1.44E-06	1.86	6.71	0.08	5
Maximum	0.87	8.51E-06	2.07	21.46	0.12	7.3
Minimum	0.07	9.37E-09	1.63	1.88	0.03	2.45
Std, Dev,	0.18	1.52E-06	0.09	3.91	0.02	1.48
Skewness	-0.02	2.07	-0.16	1.17	-0.3	-0.08
Kurtosis	2.62	7.63	2.91	4.36	2.48	1.89
Jarque-Bera	0.65	173.44	0.5	33.21	2.87	5.62
Probability	0.72	0	0.78	0	0.24	0.06

## 5. Empirical results and discussion

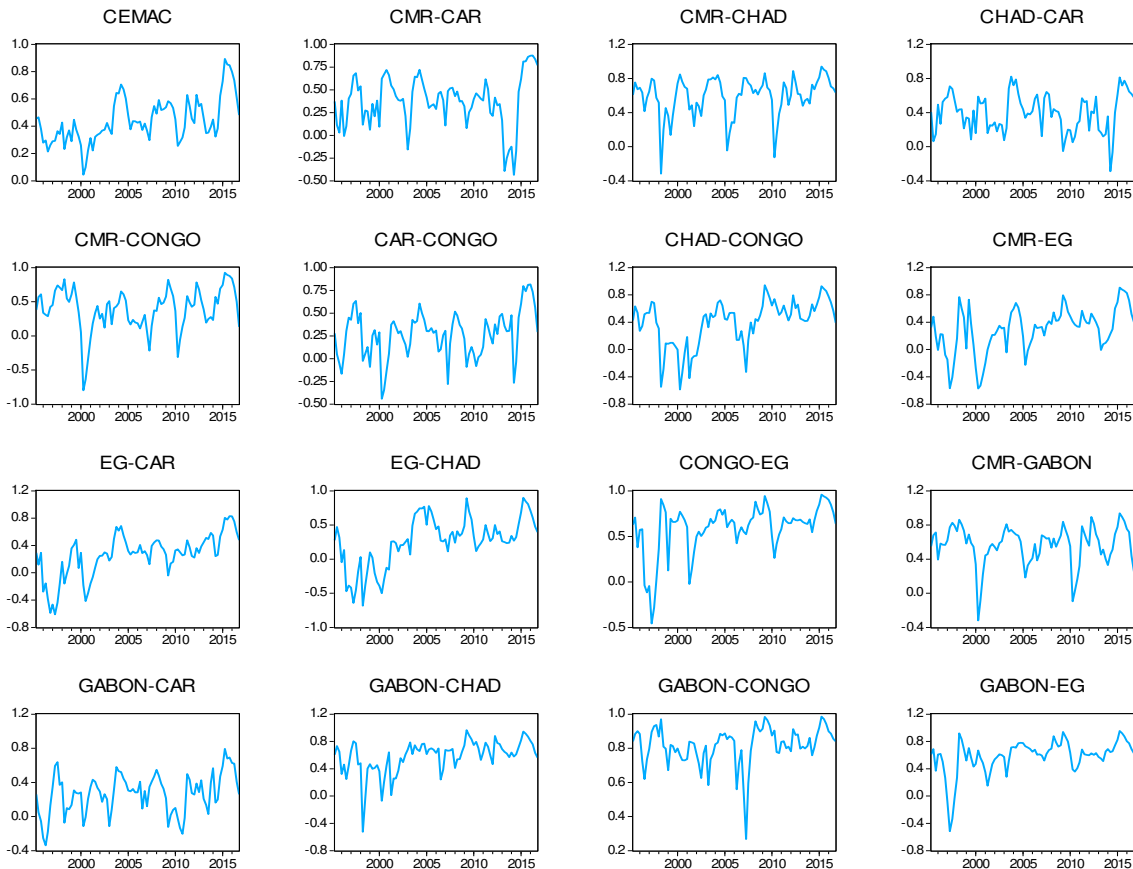
In the following, we present the results from our empirical analysis. We start with the estimates of the real output growth correlations and then consider the estimates of determinants of co-movements.

### 5.1. Dynamics of output co-movements in CEMAC

Figure 4 depicts pair-wise conditional-correlation coefficients between CEMAC countries, from the DCC GARCH model. The sample covers the period 1995Q2-2016Q4.

## Figure 4 Output Co-movements: 1995-2016

Figure 4 Output growth correlations remained relatively low in the CEMAC zone. The use time-varying correlations indicates that spikes in output co-movements correspond to well-documented global, regional or country-specific events such as economic recessions, 2008 global financial and political instability or armed conflicts.



Sources: IMF International Financial Statistics and author calculations.

Note: Figure shows dynamic conditional correlations from the DCC-GARCH model of quarterly real GDP growth rates

Notice that real output co-movements are relatively low in the CEMAC zone. The simple average output growth correlation in the entire region is 0.44 around. An important rise of output co-movements in the region has appeared in 2003-2004, reflecting the entrance in force effects of a new regional convergence framework. Figure 4 shows that the 2008 global financial crisis was associated to a relative increase of output growth correlations in CEMAC. The high co-movements can be explained by the fact that the demand of raw materials from CEMAC has declined during this generalized turmoil. A period of significant co-movements also appears at the end of 2014 corresponding with the collapse of oil prices.

At the country level, Gabon output growth appears to be the most correlated in the region. This is in line with the trade intensity found above. The average growth correlations equal to 0.57 with Cameroon, 0.58 with Chad, 0.59 with Equatorial Guinea

and 0.81 with Congo. The high output growth correlation between Gabon and Congo can be attributed to the frontier effects. Another reason can be the common exports revenue sources which are composed by oil output and forest products especially timber. However, during the 1999 economic crisis which has threatened the country, output co-movements with Cameroon, Equatorial and Chad were negative as these countries have registered good economic performances. The significant output co-movements between Gabon and Equatorial Guinea is in line with the small size of both economies and the similar economic structure turned to oil sector.

Central Africa appears to be the most disconnected country in the region, except with Cameroon. The persistent political instability and armed conflicts can be the reason of this disconnectedness. However, the landlocked situation of this country makes enhances its exposure to Cameroon which is the target for merchandise imports and exports.

## 6.2. What drives output co-movements in the CEMAC zone?

To assess the role of trade, policy Channel, economic structure and Monsoon effects in amplifying co-movements across CEMAC countries, we regress the average conditional correlation of output growth between a country  $i$  and other member states  $j$  on the trade intensities between them  $\overline{XM}_{ij,t}$ , budget balance as percentage of GDP ( $\Delta B_{i,t}$ ), discount rate ( $r_t$ ), specialization index ( $S_{i,t}$ ), financial development index ( $\varpi_{i,t}$ ), oil prices ( $\nu_t$ ) and exchange rate against the US dollar ( $e_t$ ). The regression covers the period 1999-201. Two dummy variables are included in the model: the first in 2008-09 matching to the global financial crisis and the second for Chad and Central Africa corresponding to their landlocked situation.

To ensure robustness of estimates, regressions were run using system dynamic panel technique introduced by Blundel and Bond (1998) and specifications using linear random fixed effects and Hausman-Taylor estimation. The results are reported in Table 1.

**Table 1**  
**Determinants of output growth co-movements in CEMAC**

		System-GMM	Random Effects	Hausman-Taylor
Discount rate	$r_t$	<b>-0.0414**</b> (0.0169)	-0.0384 (0.0247)	-0.0381 (0.0239)
Fiscal policy differential	$\Delta B_{i,t}$	<b>0.00338*</b> (0.00183)	<b>0.00602**</b> (0.00300)	<b>0.00616**</b> (0.00244)

Trade linkages	$\overline{XM}_{i,t}$	<b>-0.0410**</b> (0.0156)	<b>-0.0302</b> (0.0288)	<b>-0.0315*</b> (0.0178)
Specialization	$S_{i,t}$	<b>-0.677***</b> (0.0576)	<b>-0.678***</b> (0.144)	<b>-0.689***</b> (0.110)
Financial development	$\overline{w}_{i,t}$	<b>0.241***</b> (0.0320)	<b>0.255***</b> (0.0760)	<b>0.256***</b> (0.0888)
Oil prices	$v_t$	<b>-0.396**</b> (0.150)	<b>-0.454**</b> (0.178)	<b>-0.452**</b> (0.193)
Crisis	$\varphi_{1,t}^-$	<b>0.160*</b> (0.0858)	0.0192 (0.0817)	0.0191 (0.0419)
Euro/US dollar exchange rate	$e_t$	<b>-1.717***</b> (0.579)	<b>-2.108***</b> (0.740)	<b>-2.108***</b> (0.601)
Land-locking	$\varphi_{2,t}^-$	<b>-0.0164**</b> (0.00706)	-0.0258 (0.0218)	-0.0250 (0.0230)
Constant	$\varphi_0$	<b>2.462***</b> (0.309)	<b>2.579***</b> (0.425)	<b>2.588***</b> (0.429)
Observations		108	108	108
Number of year		18	18	18

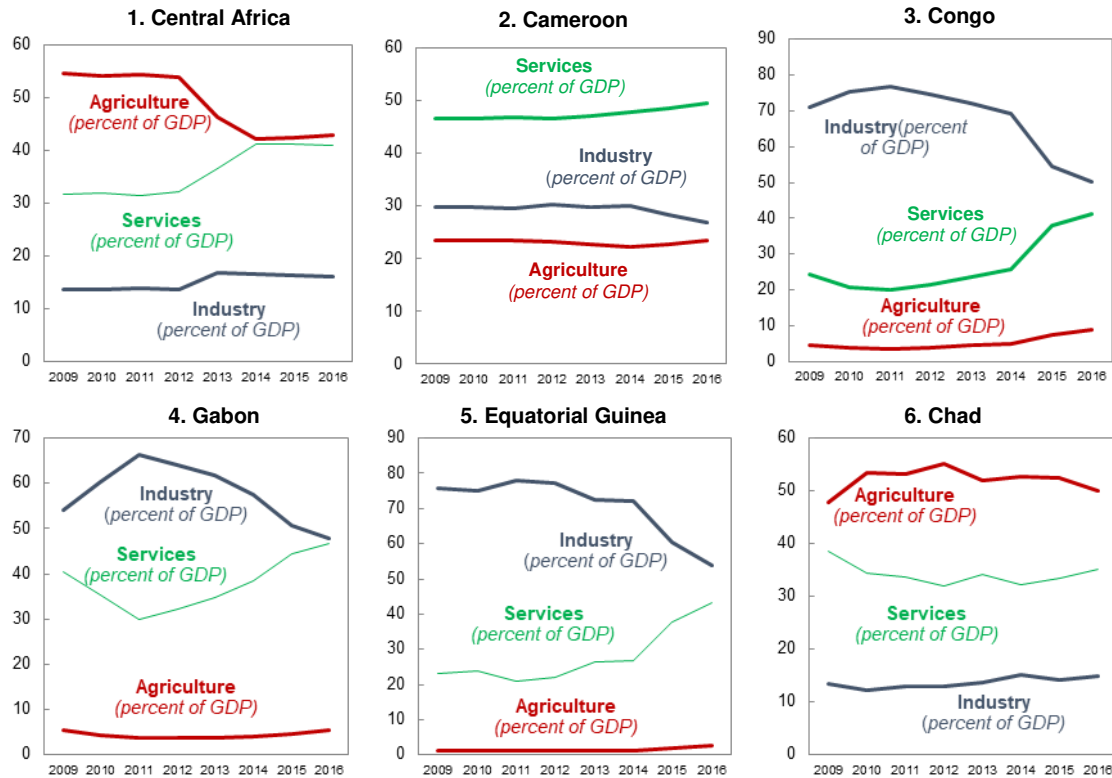
Standard errors in parentheses  
\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The econometric estimation suggests that an increase of trade intensity on output growth correlation among CEMAC countries is positive and significant. The coefficient associated to  $\overline{XM}_{i,t}$  is negative and significant, indicating that increased trade linkages are associated with less-synchronized growth of output in the CEMAC. The magnitude of the estimated coefficient suggests that if a country increase its trade intensity with other CEMAC member states by 1 point, the correlation of their growth rates would decline by around 0.28%. This supports the fact that the low level of intra-regional trade between member states of the sub-region allows them to enhance partnership with advanced and emerging economies. Additionally there intra-regional trade between member states occur mainly in different sectors since comparative advantages are not similar. Economic activity is more oriented toward oil production in Gabon and Equatorial Guinea, and primary sector in Central Africa and Chad. The output is more diversified in Cameroon. Although being an oil-exporting country, Cameroon exports to its CEMAC neighbours agricultural and horticultural commodities<sup>2</sup>, plastics, and chemicals, especially cosmetics while its imports are mainly organised around mineral fuels, oils and distillation products. Econometric regressions also suggest that an increase by 1% of dissimilarities ( $S_{i,t}$ ) in economic structure result in a decrease of output growth correlation by around 0.68% across models. CEMAC countries display high difference of economic structures (figure 4) which limits synchronicity in the sub-region.

<sup>2</sup> The main important are avocado, plantain, carrots, flour cassava, cocoa, mango, onion, tomato, potato, pepper, parsley and cola

## Figure 4 Output composition in the CEMAC countries

Figure 2 depicts the contribution of different sectors to the GDP. Economic activity in Gabon and Equatorial is highly led by industry. Chad and Central Africa are focused on agriculture. Cameroon is relatively diversified with around 25% of agriculture 30% of industry and 48% of services.



Source: World Development Indicators

Central Africa and Chad are landlocked country, their economic structure is dominated by agriculture which represents around 50% of the GDP since 2004. The industrial sector represents the quasi totality of output in Gabon and Equatorial Guinea regarding their small size and their dependence to minerals and fossils resources. Since the collapse of oil prices 2014 this predominance of the industry decreases. Cameroon is the most diversified economy in the region. Services sector tends to be the main sector of its economy. Indeed, a lot of landlocked countries in the zone are constrained to use the logistics of Cameroon for their external operations.

A slight significant negative coefficient is found for the dummy variable landlocked situation which decrease output co-movements by 0.02, a minor impact given the average output growth correlations given by 0.34 in Central Africa and 0.47 in Chad. The inaccessibility to sea imposes additional transaction costs for these countries. Chad and Central Africa which are surrounded by land depend mostly on logistics in Cameroon for their external trade.

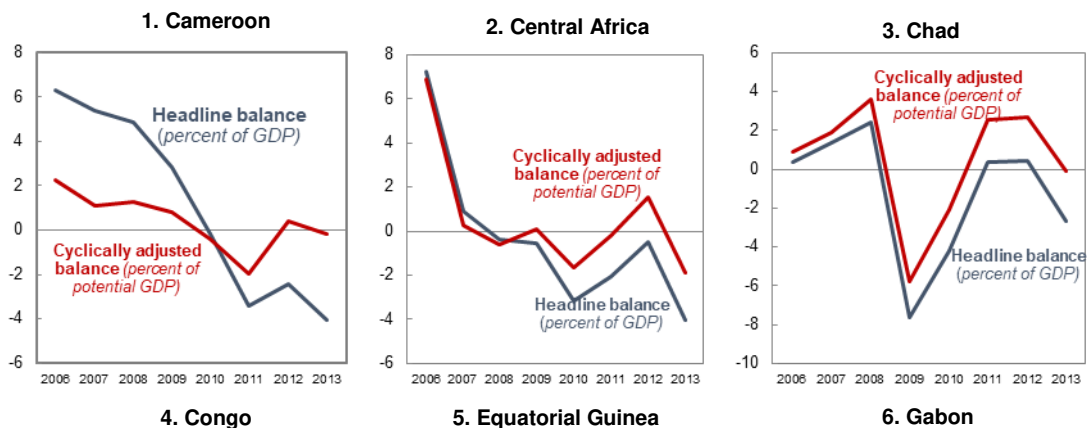


Examining the effects of policy channel, results shows that monetary and fiscal shocks have different effects on output co-movements in the CEMAC zone. For the fiscal channel, econometric results find positive evidence on the relevance of the fiscal balance differential explanatory variable. Specifically, the more different their fiscal stance is, the greater their fiscal balance differential would be and the more correlated their business cycles would be. GMM estimates show that a 1 point increase of the fiscal balance differential increases output growth correlations by around 0.05. This finding in line with that of Dai (2014) but counterintuitive regarding a large part of the previous empirical (Agnello et al. 2013; Rozmahel et al. 2014; Agnello, 2017 as e.g.) suggesting that fiscal consolidation/stimuli measures and adjustments can lead to an increase synchronicity among countries. The pro-cyclicality of the fiscal policy in the CEMAC<sup>3</sup> countries which increase output volatility in the zone can explain this result. This confirm evidences from Gavin and Perotti (1997), Lane (2003), Kaminsky et al. (2004) and Aguiar et al. (2005) suggesting that pro-cyclical behaviour of fiscal policy and changes in the institutional or the political background make sizeable fiscal adjustments unavoidable. Therefore consolidation/stimulus programmes can be associated with a fall in business cycle synchronization.

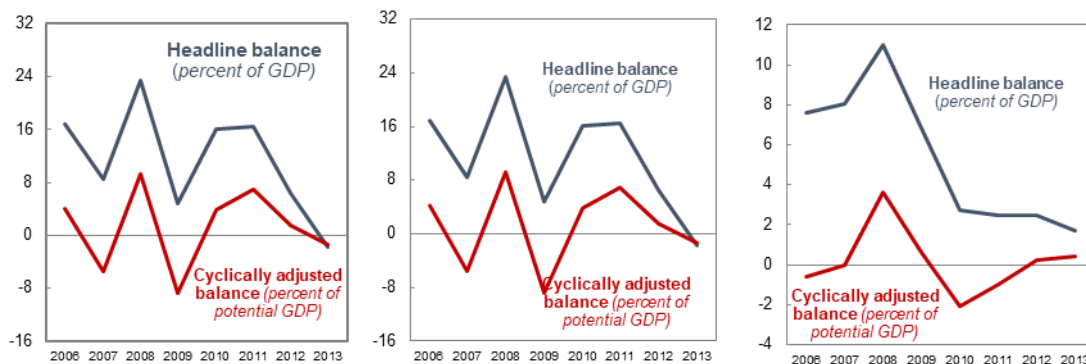
Figure 5 below shows that important discretionary budgetary pulses are adopted by governments in Cameroon, Congo, Equatorial Guinea and Gabon.

### Figure 5 Headline and Cyclically Adjusted Balance

Figure 5 depicts headline fiscal balance and cyclically component of fiscal balance. Significant cyclical behaviours of fiscal policy appear. The gap between the headline and the cyclical component reveal that the necessary fiscal adjustment is pronounced in Cameroon, Congo, Equatorial Guinea and Gabon



<sup>3</sup> Many empirical evidences of the cyclical behaviour of fiscal policy in the CEMAC has been provided (see for instance, Mpatswe et al. 2011; Bikai, 2015; Konuki and Villafuerte, 2016)



Source: World Development Indicators, Author calculations

Note: Cyclically components are computed using the filter developed by Baxter and King (1999)

GMM estimates show that a 1 point increase of the discount rate tends to lower output correlations in the CEMAC by around 0.39%. This result could be explain by the asymmetric responses of CEMAC countries to monetary policy shocks. This impact is lower and not statistically significant when using other panel regression methods (including linear random effects and Hausman-Taylor estimations). The explanation of this result could be the non-significant effects of the monetary policy on the economies of member states through the interest rate channel (Bikai and Kenkuou, 2015).

Not surprisingly, results shows that a rise of financial development leads to a significant increase of output growth correlations in the CEMAC zone by 0.25%. Strong financial institutions and more liquid and deep financial markets tends to facilitate access to funds for public and private investments which benefits to the entire region.

Regarding common factors, we can notice that oil prices tends to lower real output growth correlations. An increase of oil prices by 1% is associated to a decrease of output growth correlations by 0.40-0.45%. The negative impact of oil prices on output co-movements in the region could be explained by heterogeneous country-specific business climate, degree of dependency and governance of revenues generated by oil production. A depreciation of the euro against the US dollar decrease output co-movements in the region by 1.72-2.11 percent. This result imply that pegging the CFA franc to the euro is not beneficial for all member states since movements against the US dollar limit synchronisation of real growth.

The effect of the 2008 global financial crisis is significant according the GMM estimates, increasing the output co-movements by 0.16. This impact is lower not statistically significant when using random effects regression methods. This is in line with the asymmetric responses of CEMAC economies observed during this turmoil.

We run another regression by introducing interaction terms between landlocked situation and trade with in order to investigate the role of non-linearities similarly to Georgiadis (2015). Table 2 reports the results.

		<b>Table 2</b>		
		<b>Non-linearities of trade effects considering landlocked situation</b>		
		System-GMM	Random Effects	Hausman-Taylor
Discount rate	$r_t$	<b>-0.0630***</b> (0.0205)	<b>-0.0426*</b> (0.0238)	<b>-0.0424*</b> (0.0240)
Fiscal policy differential	$\Delta B_{i,t}$	<b>0.00594**</b> (0.00234)	<b>0.00549**</b> (0.00248)	<b>0.00570**</b> (0.00243)
Trade linkages	$\overline{XM}_{i,t}$	0.0252 (0.0269)	-0.00159 (0.0215)	-0.00334 (0.0212)
Specialization	$S_{i,t}$	<b>-0.662***</b> (0.0858)	<b>-0.657***</b> (0.109)	<b>-0.669***</b> (0.106)
Financial development	$\overline{\omega}_{i,t}$	<b>0.189***</b> (0.0464)	<b>0.209**</b> (0.0816)	<b>0.211***</b> (0.0811)
Oil prices	$\nu_t$	<b>-0.489**</b> (0.180)	<b>-0.485**</b> (0.193)	<b>-0.483**</b> (0.193)
Crisis	$\overline{\varphi}_{1,t}$	0.161 (0.106)	0.00397 (0.0440)	0.00389 (0.0437)
Euro/US dollar exchange rate	$e_t$	<b>-1.575*</b> (0.790)	<b>-2.134***</b> (0.597)	<b>-2.135***</b> (0.594)
Land-locking	$\overline{\varphi}_{2,t}$	<b>-2.812***</b> (0.704)	<b>-1.408***</b> (0.478)	<b>-1.401***</b> (0.477)
Trade linkages $\times$ land-locking		<b>-0.473***</b> (0.120)	<b>-0.234***</b> (0.0790)	<b>-0.233***</b> (0.0788)
Constant	$\varphi_0$	<b>3.014***</b> (0.348)	<b>2.733***</b> (0.416)	<b>2.741***</b> (0.414)
Observations		108	108	108
Number of year		18	18	18

Note: Standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The landlocked position of Chad and Central Africa amplifies the negative role played by their trade linkages on output growth correlations. High volume traded generates supplementary transactions costs which are revenues for their neighbours with access to sea. Trade only is unable to explain co-movements regardless the technical specification. Additionally, the negative effects of the monetary policy is less unambiguous for all econometric specifications.

## **6. Some concluding Remarks and policy implications**

The main objective of this paper was to analyse the determinants of co-movements between CEMAC countries. The co-movements was assessed using a DCC-GARCH model introduced by Engel (2002). The dynamic conditional correlations has revealed that spikes of output growth correlation appears during episodes of high oil volatility prices namely the 1998 oil price shock, the 2008 financial crisis and the recent 2014 oil price collapses. The insecurity crisis observed sin the end of 2014 was also a period of high co-movements.

Results from the set of panel models used to examine the determinants of the output growth correlations has suggested that trade intensities has negative effects on the output co-movements of CEMAC countries. The differential fiscal stance has appeared to rise output correlations whereas the common monetary policy is not robust in driving co-movements across estimation techniques. Variables related to economic structure as sectorial specialization and financial development displays different roles. The degree of specialization has negative effects while the degree of financial development increase co-movements. The landlocked situation of Chad and Central Africa reduces their co-movements with other member states. Finally, results reveals that there are non-linearities in the effects of trade intensities which has limited effects when the country is landlocked.

The finding that output co-movements exist in the CEMAC zone could be an important topic to enforce the role played by the monetary policy and the convergence of fiscal policy. Even if results suggest that differential fiscal stance increases output growth correlations, the convergence criteria may not be rejected. This should drive interest of government to limit the cyclical behavior of their fiscal policy. Concerning the limited role of the policy in driving output co-movements, country-specific economic structure may take into account.

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