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Dynamic risk sharing in the Central African Economic and monetary community

By Laetitia P. SOKENG DONGFACK [a]
& Hongbing OUYANG [b†]

Abstract. In contrast to the first Optimum Currency Area (OCA) theory which was mostly about preventing currency areas' exposure to asymmetric shocks, the second model introduced by Robert A. Mundell (1973) focuses on risk sharing across member states when facing adverse macroeconomic shocks. This paper explores how risk is shared across the six member states of the Central African Economic and Monetary Community (CEMAC). Using dynamic panel VAR, we measure disposable income and consumption smoothing of negative output shocks. We find that more than 72 percent of GDP idiosyncratic shocks remain unsmoothed in the case of the Central African currency area from 1986 to 2018.
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1. Introduction

The possible devaluation of the CFA Franc was discussed during several summits held in Yaoundé (2016 and 2019) and N'djamena (2018) involving the international Monetary Fund (IMF) and CEMAC countries thus raising questions about the optimality of the CFA franc zone as a currency area. The debate intensifies in the face of local authorities' determination to defend the CFA franc's peg to the euro, thus refusing devaluation and choosing to comply with the IMF'S structural adjustment program (SAP) instead.

The CFA Franc zone consists of two currency unions: the Central African Economic and Monetary Community (CEMAC) comprised of six member states (Cameroon, the Central African Republic, Chad, Republic of Congo, Equatorial Guinea and Gabon) on one hand, and the West African Economic and Monetary Union (WAEMU) formed by eight member states (Benin, Burkina-Faso, Cote d'Ivoire, Guinea Bissau, Mali, Niger, Senegal and Togo) on the other hand. Two central banks, namely the Bank of the Central African States (BEAC) and the Central Bank of the West African

[a] Huazhong University of Science and Technology, School of Economics, China.
☎. +86 182 7927 8243 ✉. laetitia.sokeng@gmail.com
[b†] Huazhong University of Science and Technology, School of Economics, China.
☎. +2782 906 0090 ✉. ouyanghb@126.com

States (BCEAO), issue two separate currencies both named CFA Franc and pegged to the euro since the existing monetary cooperation agreements between the member states and France[1]. The CFA franc rate has evolved through time[2].

This loss of the CFA franc purchasing power throughout the years has led economists such as M'Bet and Niamkey to express their skepticism on the common currency's ability to shelter member states from adverse macroeconomic shocks. This echoes Baldwin & Wyplosz (2004) who stress that the loss of economic monetary policy sovereignty becomes most significant for members of a currency union if poorly integrated member states face asymmetric macroeconomic shocks. Indeed, forming a currency union carries benefits and costs. However, in order for it to be considered optimal, the economic gain obtained by the increase of interregional trade must outweigh the cost of losing control over national monetary policy. The OCA theory holds that an entire area should adopt a fixed exchange rate administration between currencies or a single currency within its geographic boundaries in order to benefit from the reduction of exchange rate uncertainty. For this reason, a country that considers membership in a currency union has to balance the economic stability loss against the monetary efficiency of a single currency.

In this paper, we explore Mundell's (1973) hypothesis that a common currency area offers insurance for its members against country-specific shocks in the context of OCA with international risk sharing. By analyzing and quantifying risk-sharing across CEMAC countries, we can assess the optimality of the CEMAC as a currency union, regarding this theory. In so doing, we use the Asdrubali et al. output variance decomposition both in a static and dynamic context, using a panel VAR. We also discuss about the evolution of risk sharing overtime as well as the substitutability of smoothing channels. Then we compare our results with the existing literature, in particular Yehoue's (2005) results concerning risk sharing within the CEMAC, as well as Asdrubali and Kim's results on risk sharing in Europe and in the US.

Following the present introduction in Section 1, Section 2 includes an overview of international risk sharing in currency unions, including the CFA Franc zone, in the economic literature and reviews different approaches used by scholars in order to quantify the amount of shock smoothed through identified channels. Section 3 describes the methodology and estimation techniques we apply in this study. Then we proceed on presenting dataset sources, empirical results, as well as policy implications in Section 4. Finally, in Section 5 we provide concluding remarks and offer some suggestions for future research concerning the CEMAC as a currency union.

2. International risk-sharing and currency unions in the economic literature

Research related to international risk sharing mostly concern industrialized advanced economies such as the United States and European countries. Inspired by Mundell's (1973) OCA theory on international risk-sharing suggesting that asymmetric shocks cannot threaten a currency area if risk-sharing mechanisms are efficient in facilitating adjustments, a fairly substantial literature focus on measuring the amount of international risk sharing happening across a set of economies.

Testing for full risk-sharing was one of the first approaches taken by scholars while measuring the efficiency of a currency area. A significant number of studies such as Cochrane (1991), Canova & Ravn (1996), Lewis (1996) and Mace (1991), reject the hypothesis of full risk-sharing. The same conclusion is made by Obstfeld (1994) who also reject the hypothesis of full risk-sharing among G7 countries. Breaking with the traditional approach of testing for full risk-sharing, another popular approach consisting of measuring the amount of shock smoothed started to emerge over time. For instance, Sachs & Sala-i-Martin (1992) estimate risk-sharing through federal government fiscal policy in a pioneering work by taking the amount of income insurance provided to the US states by the US federal government as a proxy for the income insurance role. von Hagen (1992) also finds that a high amount of risk-sharing is provided by the federal government, although in a significantly smaller quantity than the one in the previous study, but close to the one found by Asdrubali, Sorensen & Yosha (1996). They further explain in a seminal paper the dynamic of risk-sharing in selected states of the U.S., even introducing a method based on cross-sectional variance decomposition for quantifying the amount of interstate risk-sharing happening across the country. They identify three channels, namely capital markets, credit markets and international transfers and conclude following this framework that markets are more efficient than the Federal government when it comes to income and consumption smoothing. Since then, academic debates have been concerned with the specific issue of risk-sharing increasing overtime. Some researchers such as Sorensen *et al.*, (2007) find an increase of risk-sharing through income-smoothing and consumption-smoothing following the introduction of the euro as a common currency. For this purpose, they follow the approach formerly introduced by Melitz & Zumer (1999), allowing for country-specific and time-varying beta coefficients. Likewise, the hypothesis of risk-sharing increasing is supported by La Porta *et al.*, (1998), Kim (1995) and Kalemli-Ozcan, Sorensen & Yosha (1999) as they proceed to back it up with empirical evidence that an increase in specialization may be the cause for an increase in risk sharing. Nevertheless, conflicting results have been found by Moser, Pointner & Scharler (2004) as well as Bai & Zhang (2012). Moreover, recent findings by Kalemli-Ozcan, Luttini & Sorensen (2014), point out the collapse in risk sharing in the European Union following the last debt crisis. Therefore, they further decompose channels of smoothing in order to highlight the role of government and private savings.

On the other hand, one can argue that these implemented methodologies are not complete as they exclude major smoothing channels previously identified by Mundell (1961) in the OCA theory. Asdrubali, Sorensen & Yosha (1996) gave the reason for ignoring interstate labor mobility in the United States while identifying the different channels through which most of the smoothing will be achieved. Along the lines of Barro & Sala-i-Martin (1991) as well as Blanchard & Katz (1992), they considered interstate labor mobility in the US to play a minor role in shock smoothing as it involve long lags. They argue that if workers did migrate whenever a shock happened, differences in per capita gross state product would not hold. In this regard, Gurtner (1999) finds it difficult to evaluate the degree of labor mobility within the CFA Franc zone, and concludes that neither WAEMU nor CEMAC fit the classical criterion of OCA as defined in the literature. Boccara & Devarajan (1993) came to the same conclusion, and show that factor mobility is low within the CFA franc zone.

In contrast to Europe and the U.S., very few academic studies have been conducted on international risk sharing across the CFA Franc zone. Yehoue (2005) notices the poor performance of standard shock absorbers such as transfer payments, labor mobility and capital mobility in the efficient smoothing of negative external shocks in the CFA Franc zone. By analyzing the pattern of risk sharing through these channels and comparing them to studies related to the euro zone, Yehoue (2005) finds that only about 15 percent of shock to output are smoothed through these standard channels in the CEMAC, and only 13 percent in the WAEMU. This result is very low when put into perspective with findings displaying that about 44 percent of shocks are smoothed in the euro zone. This suggests that mechanisms of risk sharing in Europe were already more elaborate even prior to the creation of the euro zone in 2000, in comparison with shock absorption mechanisms present in the CFA Franc zone, despite the latter having over half a century of existence more than the former. He also demonstrates that the CEMAC and the WAEMU are more likely to achieve risk sharing through financial support from France than through standards channels of shock dampening. This assumption does not contradict Boughton (1991), who sees France's role as the reason why member states benefit from their participation to currency unions. Studying risk sharing in the ECOWAS, Zouri (2019) provides more information on the accounting decomposition of national aggregates and therefore concludes that countries within that zone must prioritize the expansion of regional credit markets and increasing the effectiveness of official development assistance as well as net primary income.

3. Methodology and estimation techniques

3.1. Static smoothing channel approach

As part of our process in assessing the CEMAC's economic efficiency, this paper will mainly focus on measuring the degree of international risk sharing across member states. Asdrubali, Sorensen & Yosha (1996) first developed a framework based on cross-sectional variance decomposition allowing quantification of the amount of risk sharing happening across the US states, as well as the repartition through various identified channels, namely capital markets, fiscal system channel and credit markets. This technique also allows determining whether or not full risk sharing does take place in the currency union by gauging the amount of risk unsmoothed through those three main channels in a distinct component.

The underlying intuition for channels of international risk sharing identification follows the System of National Accounts' structure. Here, the capital market channel is represented by the Net Factor Income obtained by subtracting the Gross Domestic Product (GDP) to the Gross National Income (GNI), the fiscal channel is reflected by Net International Transfers which can be found by subtracting GNI to the Gross Disposable Income (GDI), and finally the credit market channel is represented by savings which are the result of subtracting GDI to consumption (C). Accordingly, Asdrubali, Sorensen & Yosha (1996) design a measure of smoothing by establishing the following identity:

$$GDP^i = \frac{GDP^i}{GNI^i}\frac{GNI^i}{GDI^i}\frac{GDI^i}{C^i}C^i \tag{1}$$

Where i denotes an index for country. Hence, the decomposition of cross-sectional variance in GDP into identified components can be found first by taking logs and first differences, then multiplying both sides of identity equation (1) by $\Delta \log GDP^i$. Next step consists in taking expectations written as follows:

$$\begin{aligned}\mathrm{Var}\{\Delta \log GDP^i\} &= \mathrm{Cov}\{\Delta \log GDP^i, \quad \Delta \log GDP^i - \Delta \log GNI^i\}\\ &+ \mathrm{Cov}\{\Delta \log GDP^i, \quad \Delta \log GNI^i - \Delta \log GDI^i\}\\ &+ \mathrm{Cov}\{\Delta \log GDP^i, \ \Delta \log GDI^i - \Delta \log C^i\}\\ &+ \mathrm{Cov}\{\Delta \log GDP^i, \ \Delta \log \mathrm{C}\}\end{aligned} \tag{2}$$

Last, identity equation (3) is obtained by dividing both sides of equation (2) by the variance of $\Delta \log GDP^i$:

$$1 = \beta_K + \beta_F + \beta_C + \beta_U \tag{3}$$

Where β_K , β_F and β_C are interpreted as the amount of smoothing (in percentage) of a GDP shock achieved respectively through net factor income payments (capital market channel), international transfers (fiscal stabilization channel) and savings (credit market channel); β_U denotes the quantity of shock that remains unsmoothed. Accordingly, the basic empirical method used to estimate the β coefficients thus quantifying the amount of risk sharing fulfilled through each known channel consists in a series of Generalized Least Squares (GLS) regressions. The GLS regression of $\Delta\log GDP^i - \Delta\log GNI^i$ on $\Delta\log GDP^i$ in order to obtain β_K, the regression of $\Delta\log GNI^i - \Delta\log GDI^i$ on $\Delta\log GDP^i$ in order to obtain β_F, the regression of $\Delta\log GSP^i - \Delta\log C^i$ on $\Delta\log GDP^i$ in order to obtain β_C and finally the regression of $\Delta\log C^i$ on $\Delta\log GDP^i$ in order to obtain β_U. The set of equations for the said GLS panel regressions are stated as follows:

$$\Delta\log GDP^i - \Delta\log GNP^i = \alpha_{K,t} + \beta_K \Delta\log GDP^i + \mu^i_{K,t} \tag{4}$$
$$\Delta\log GNP^i - \Delta\log GDI^i = \alpha_{F,t} + \beta_F \Delta\log GDP^i + \mu^i_{F,t} \tag{5}$$
$$\Delta\log GDI^i - \Delta\log C^i = \alpha_{C,t} + \beta_C \Delta\log GDP^i + \mu^i_{C,t} \tag{6}$$
$$\Delta\log C^i = \alpha_{U,t} + \beta_U \Delta\log GDP^i + \mu^i_{U,t} \tag{7}$$

Where α is the time fixed effect coefficient in each equation. It reflects the impact of GDP growth rate during each specific year. In the case where $\beta_K + \beta_F + \beta_C = 1$, we conclude that there is full risk sharing and $\beta_U = 0$. A negative value of β will be interpreted as a sign that there is great smoothing happening through the channel. However, a β> 1 denotes that rather than being smoothed, the effects of shocks are boosted instead of being reduced by the channel.

3.2. Dynamic panel VAR

Though using a static smoothing channel approach allow us to fulfill our goal in this study, still we ought to consider the evolution in the empirical methodology for measuring risk sharing in the literature. Motivated by Baxter & Crucini (1995) work on the behavior of consumption smoothing channels using dynamic equilibrium open economy model, as well as Canova & Ravn (1996) focus on exogenous consumption shifters that they identified as shocks, Asdrubali & Kim (2004) introduced a VAR framework as a technique to not only for testing the implications of the evolution of risk-sharing literature, but also addressing the limits of the static smoothing channel approach. Therefore, Asdrubali & Kim (2004) were able to not only analyze risk-sharing and consumption smoothing channels, but they were also able to measure how long it takes for a shock to be dampened. The panel vector auto regression (VAR) they used takes into account the dynamic properties of different smoothing channels, making it possible to efficiently answer policies issues regarding the degree of complementarity and substitutability among channels[3]. Here, we will use the dynamic panel VAR in order to analyze risk-sharing in CEMAC, then we will compare those results with previous work on the topic. In so doing, we first consider the following reduced form panel VAR:

$$Z^i_t = \gamma + \theta(L) Z^i_{t-1} + \varepsilon^i_t \tag{8}$$

Where γ is an $n-1$ constant matrix; Z_t^i is an n − 1 data vector $\theta(L) = \theta_0 + \theta_1 L + \theta_2 L^2 + \cdots = \sum_{j=0}^{\infty} \theta_j L^j$ is a matrix polynomial in the lag operator L; n is the number of variables in the model; ε_t^i is the residual and $\text{var}(\varepsilon_t^i) = \Sigma$. Therefore to describe the economy, we recover the structural form equation written as follows:

$$B_0 Z_t^i = \varphi + B(L) Z_{t-1}^i + \omega_t^i \tag{9}$$

Where A_0 is the nxn contemporaneous structural parameter matrix with 1's in the diagonal; $B(L)$ is a matrix polynomial in the lag operator L;φ is an $n-1$constant matrix and ω_t^i is an $n-1$ structural disturbance vector. The error term ω_t^i is serially uncorrelated and $\text{var}(\omega_t^i) = \Omega$. Ω is a diagonal matrix whose diagonal elements are the variances of structural disturbances. The following moving average representation of the structural form equation:

$$Z_t^i = \varphi^* + B(L)\omega_t^i \tag{10}$$

With the assumption that $B_0 - LB(L)$ is invertible, $\varphi^* = \phi.(B_0 - LB(L))^{-1}$, $B(L)^* = \left(B_0 - LB(L)\right)^{-1} B(L)$, and $B(0)^* = B_0^{-1}$. We impose short run restrictions on the contemporaneous structural parameters B_0 along the lines of Sims (1980) so that we are able to recover the parameters in the structural form equation[4]:

$$\begin{bmatrix} 1 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & 0 \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 \end{bmatrix} \begin{bmatrix} \Delta logGDP_t^i \\ \Delta logGDP_t^i - \Delta logGNP_t^i \\ \Delta logGNP_t^i - \Delta logGDI_t^i \\ \Delta logGDI_t^i - \Delta logC_t^i \end{bmatrix} = \varphi + B(L) \begin{bmatrix} \Delta logGDP_{t-1}^i \\ \Delta logGDP_{t-1}^i - \Delta logGNP_{t-1}^i \\ \Delta logGNP_{t-1}^i - \Delta logGDI_{t-1}^i \\ \Delta logGDI_{t-1}^i - \Delta logC_{t-1}^i \end{bmatrix} + \begin{bmatrix} \omega_{GDP,t}^i \\ \omega_{K,t}^i \\ \omega_{F,t}^i \\ \omega_{C,t}^i \end{bmatrix} \tag{11}$$

The difference between the analysis using the static system and the dynamic panel VAR is that the first examine the smoothing of an exogenous variable $\Delta \log GDP^i$ by identified channels when the latter focus on examining the smoothing of $\omega_{GDP,t}^i$, the actual exogenous shocks to output. However, Athanasoulis & van Wincoop (2001) stressed the importance to isolate unpredictable shocks in order to obtain a more accurate measure. The way to do that is by setting a restriction to $\omega_{GDP,t}^i$ so that it is orthogonal to the information about the history of all the variables in the system[5]. As for the short-run identifying assumptions, we keep the same ordering[6] than Asdrubali & Kim (2004). First, capital markets smoothing channel depends only on lagged values of the other variables. Then, international transfers channel depends on contemporaneous capital markets but not the credit market channel. Finally, the credit market channel depends on both contemporaneous inflation and international transfers[7].

4. Data sources and empirical results

4.1. Data description and estimation strategy

The dataset analyzed for international risk sharing and consumption smoothing within CEMAC is a heterogeneous dynamic panel data, made of National Accounts data for six countries, covering the timespan 1986-2018[8] sourced from the World Bank's *World Development Indicators* database (WDI). The variables used in this analysis are in real per capita terms (in 2010 U.S. dollars) defined as follows: GDP (Gross Domestic Product), GNP (Gross National Product), GDI (Gross Disposable Income) and Total Consumption (C). By using panel data we are able reduce the noise coming from the individual time series and therefore avoid the issue of heteroscedasticity. Moreover, panel data analysis is best suited for developing countries where data availability is an issue, often insufficient for fitting time series regressions. Also, panel estimation techniques takes into account dynamic changes due to repeated cross-sectional observations by including lagged dependent variable as a regressor. Particularly in this study we included two lags[9] as well as a constant term. All the variables are I(1), since the null hypothesis that the data series exhibits a unit root cannot be rejected, and thus specified in logged differences. Similarly, we cannot reject the null hypothesis that the variables are not cointegrated[10].

In the lines of Kose *et al.* (2009) we analyze the evolution of international risk sharing overtime by estimating the models for the whole sample, as well as three subsamples namely 1986-1993, 1994-1999 and 2000-2018. This partition[11] allows us to check the effect of the CFA Franc's depreciation against the French currency following the devaluation in 1994 and the introduction of the euro in 2000.

4.2. International risk sharing in the CEMAC

4.2.1. Empirical Results and Analysis

4.2.1.1. Evolution of Risk Sharing Overtime

Table 1 displays the estimates β-coefficients for the amount of smoothed output shocks at impact (impact GDP change = 100), using both the static smoothing channel approach (SSCA) and the dynamic panel VAR (DPVAR) from 1986 to 2018 within CEMAC. Estimation is made for the whole sample 1986-2018 as well as for three subsamples 1986-1993, 1994-1999 and 2000-2018. The capital market channel is represented by $\Delta\log GDP - \Delta\log GNP$ and referred to as "CAP" in the present study. The same goes for the fiscal channel ("FIS") and credit market channel ("CRE") respectively represented by $\Delta\log GNP - \Delta\log GDI$ and $\Delta\log GDI - \Delta\log C$. The amount of unsmoothed shocks ("UNS") is reported in the last row and satisfies equation (3). The β_K coefficients reported for the smoothing channel CAP reveals that international risk sharing through capital markets rose after 1994, but especially after the CFA franc devaluation in 1994 and drastically goes down after the introduction of the euro in 2000. On the contrary, the β_F coefficients reported for the smoothing channel "FIS" show that international risk sharing through international transfers appears to be very minimal. There is a slight improvement after the CFA franc devaluation in 1994, but after euro has been introduced in 2000, risk-sharing did not happen through FIS, even there is di-smoothing. Regarding the β_C coefficients reported for the smoothing channel CRE show that credit markets channel is the strongest out of all the identified smoothing channels, except for the second subsample 1994-1999.

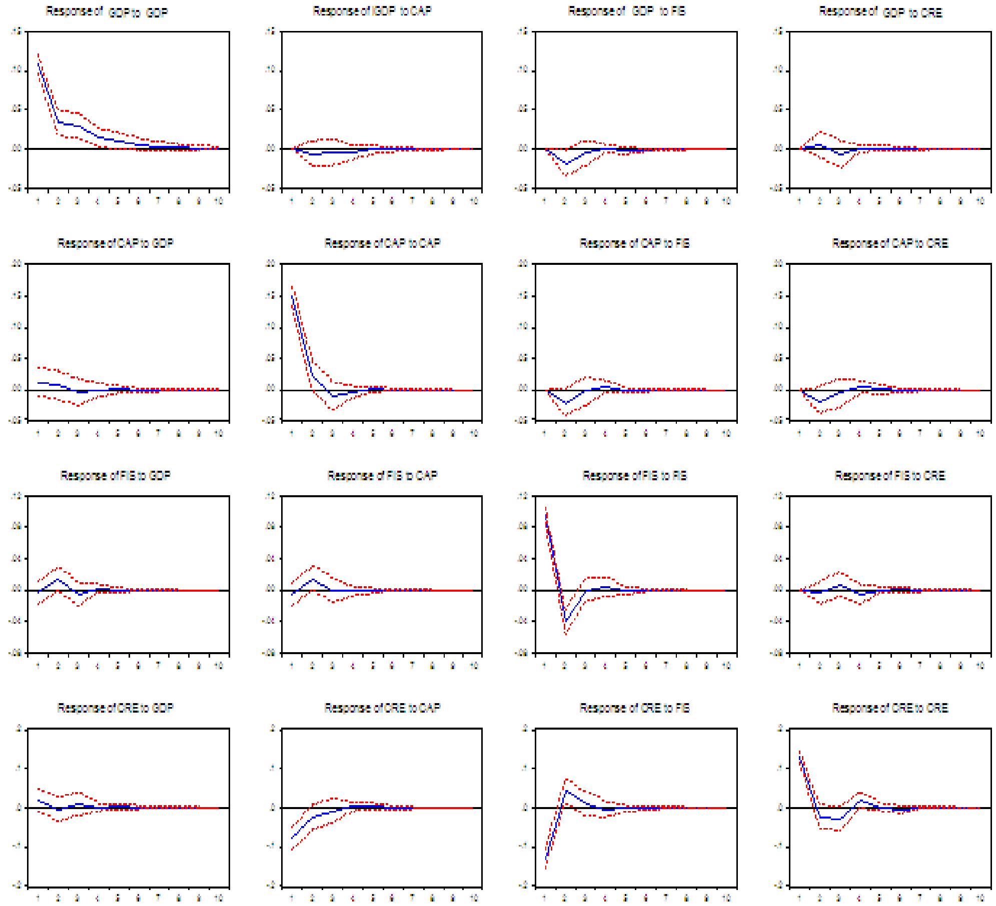
Roughly 72.09 percent of shocks to output stay unsmoothed from 1986 to 2018, using dynamic panel VAR. Besides, we notice that not taking into account dynamics as well as the endogeneity of output, results in the underestimation of the fraction of unsmoothed shocks. There is a 5 point-difference when considering the whole sample (1986-2018) which is relatively low compared to the 35 point-difference displayed in the second subsample (1994-1999), which goes up to 56 point- difference when considering the last subsample (2000-2018). The first subsample (1986-1993) displays the lowest difference (4 points) between the results using the static smoothing channel approach and the dynamic panel VAR.

Table 1. *International Risk Sharing Estimates through Various Smoothing Channels*

Channel	1986-2018		1986-1993		1994-1999		2000-2018	
	SSCA	DPVAR	SSCA	DPVAR	SSCA	DPVAR	SSCA	DPVAR
CAP	0.1461	0.1148	0.1406	-0.1197	0.165	-0.3707	0.0477	-0.3057
	(0.0979)	(0.1032)	(0.2101)	(0.2587)	(0.2339)	(0.0579)	(0.1728)	(0.1739)
FIS	0.0291	-0.0316	0.079	-0.0918	-0.0495	0.0538	0.0525	-0.1094
	(0.0674)	(0.0658)	(0.1030)	(0.0854)	(0.1817)	(0.1722)	(0.1501)	(0.1652)
CRE	0.1522	0.1959	0.1277	0.4488	-0.0709	0.0868	0.4585	0.3955
	(0.1482)	(0.0906)	(0.2517)	(0.2161)	(0.1962)	(0.0247)	(0.3136)	(0.1801)
UNS	0.6761	0.7209	0.7236	0.7627	0.8845	1.2301	0.455	1.0196

Source: Author's elaboration.
Notes: a. Static Smoothing Channel Approach (SSCA) refers the estimation of the system of equations (4) using Generalized Least Squares and fixed effects modeling and auto-correlated AR (1) errors; Dynamic Panel VAR (DPVAR) refers to the estimation of equation (8), impact responses to GDP shock (impact GDP change =100). b. "CAP", "FIS", "CRE" and "UNS" denotes respectively amounts smoothed through the capital market channel, fiscal channel, credit market channel and the amount of unsmoothed shocks. c. Standard errors are reported in parentheses

On the other hand, the evolution of international risk-sharing overtime is uneven with a peak during the second subsample period 1994-1999 attesting that the CFA franc devaluation of 1994 had a negative impact, using both methods. The introduction of the euro in 2000 appears to have a positive impact on international risk-sharing for CEMAC countries when using the static regression as the amount of shock smoothed during this period is greater. However, we observe that results using dynamic panel VAR show there is no international risk-sharing happening after the CFA franc depreciation against its reference currency, after 1994 and again after 2000.



Graph 1. *Impulse ResponsesFunctions of Output and Smoothing Channels within CEMAC, 1986-2018*

Notes: a. Graph 1 reports impulse responses with two standard errors bands (at 95% probability) over 10 years in the system with SR restrictions. The scale of all the graphs in each column is the same. b. Standard errors are reported in parentheses.

To further breakdown the behavior of the smoothing channels following an exogenous output shock, we observe the impulse response functions (IRFs). Shock to output (in the first column in graph 1) causes GDP to rise sharply on impact (impact GDP change = 100), displaying a positive response (10.82 percent of total GDP increase a year). There is a plateau on the third year, then followed by a steady decline during the fourth year and finally converging to zero on the tenth period following the shock. Regarding the dynamics of the smoothing channels' impulse responses to the exogenous shock (see table 2), we note that capital market (CAP) smoothing is mostly positive until the third year following the shock when we even note a dis-smoothing, before converging to zero the fourth year. Shock smoothing through fiscal channel (FIS) displays a different, as there is dis-smoothing happening at impact and persisting until a year after the shock. The essential of smoothing through net transfers happen only the second year following the shock, again followed by dis-smoothing during the third period and finally converging to zero after the fourth year following the exogenous shock.

Table 2. *Impulse Responses to Output Shock, CEMAC, 1986- 2018*

Year	GDP	CAP	FIS	CRE
0	**1.0000**	**0.1148**	**-0.0316**	**0.1959**
	(0.005)	(0.103)	(0.065)	(0.090)
1	**0.1082**	**0.0124**	**-0.0038**	**0.0194**
	(0.005)	(0.011)	(0.007)	(0.015)
2	**0.0331**	**0.0074**	**0.0138**	**-0.0052**
	(0.008)	(0.011)	(0.007)	(0.015)
3	**0.0287**	**-0.0038**	**-0.0055**	**0.0102**
	(0.008)	(0.010)	(0.007)	(0.014)
4	**0.0143**	**-0.0004**	**0.0025**	**0.0006**
	(0.006)	(0.005)	(0.002)	(0.005)

Source: Author's elaboration

Notes: a. Standard errors are reported in parentheses. b. "CAP", "FIS", "CRE" denote respectively the amount of shocks smoothed by capital markets, fiscal transfers and credit markets channels, "Cum" denotes cumulative responses to GDP shock.

As for GDP shock smoothing through savings (CRE), we note that the impulse response function visibly goes to the opposite direction compared to the previous fiscal channel. In fact, we observe a positive response until a year after the exogenous shock happened. However, during the second year, there is dis-smoothing happening through savings, following an increase during the third year and finally converging to zero during year four.

4.2.1.2. Substitutability of smoothing channels

The IRFs of shock to each smoothing channel (from the second to the fourth column in graph 1) are useful to check if the channels act as substitutes or complements. A positive shock to capital market channel, fiscal channel and credit market channel leave GDP almost unchanged at impact. After the first year however, we spot very small though persisting dis-smoothing through capital market channel, rather significant dis-smoothing through fiscal channel as well as slight smoothing happening through credit market channel both converging to zero by the fourth year following the shock. As stated by Asdrubali & Kim (2004), if a change in a smoothing channel is destabilizing output, the said channel may be reconsidered in its utility in the smoothing process. In the case of CEMAC, capital market channel and fiscal channel may be at fault. This can be explained by the fact that capital markets in the region are not well integrated, and despite the decision made by authorities to create a regional stock exchange to serve the CEMAC, the lack of local big companies to enlist makes its implementation quite laborious. In the case of fiscal channel, considering it as a possible hindrance to output shock smoothing process ties in with Chambas (1994) conclusion that francophone Africa fiscal instruments are too unwieldy to be considered as reliable stabilization tools.

The response of capital market channel to a positive shock to fiscal channel and credit market channel is quite similar as the variable remains unchanged at impact, yet shows a negative reaction after two years. The same goes for fiscal channel which displays a similar response to a positive shock to capital market channel and credit market channel. However, if the variable remains unchanged at impact, a slightly positive reaction takes place in both cases on the following years, finally converging to zero after four years. Most importantly, we find that an increase in net factor income and international transfers significantly decreases saving, ceteris paribus. More precisely, an increase in net factor income (14.95 percent) reduces saving almost by half (-7.80 percent). This shows that there is partial substitutability linking capital market channel to credit market channel. Though, the relationship between fiscal channel and credit market channel appears to be deeper than the previous one as an increase in the fiscal channel (9.51 percent) totally supplants credit market channel (-13.09 percent), we can therefore note the total substitutability linking fiscal market channel to credit market channel.

4.2.2. Comparison with existing literature and discussion

For comparison purposes, we take estimates from Yehoue (2005) analysis of international risk sharing within CEMAC from 1980 to 2000. The sample period obviously differs from ours, as it includes a time period when Equatorial Guinea was not a part of the currency union yet (before 1986) and stops at the introduction of the euro (2000) against which the CFA was greatly depreciated compared to the new French currency.

When comparing Yehoue's (2005) empirical results to our estimates using the static regression, we observe from table 3 below that there less than a unit difference between β- coefficients for capital market channel and fiscal channel. However, we also find almost twice the amount of output shock is smoothed through credit market channel, compared to Yehoue's (2005) estimation. Again, the explanation of these differences may be the difference of the sample period. The gap grows deeper when we consider the results obtained using dynamic panel VAR, not only for credit market, but capital market and fiscal channels as well. But surprisingly, our dynamic panel VAR estimate for unsmoothed shocks is closer from Yehoue's (2005) findings than the static regression estimate.

Table 3. *Comparison of Smoothing Channels Estimates for CEMAC (% of total shock to output)*

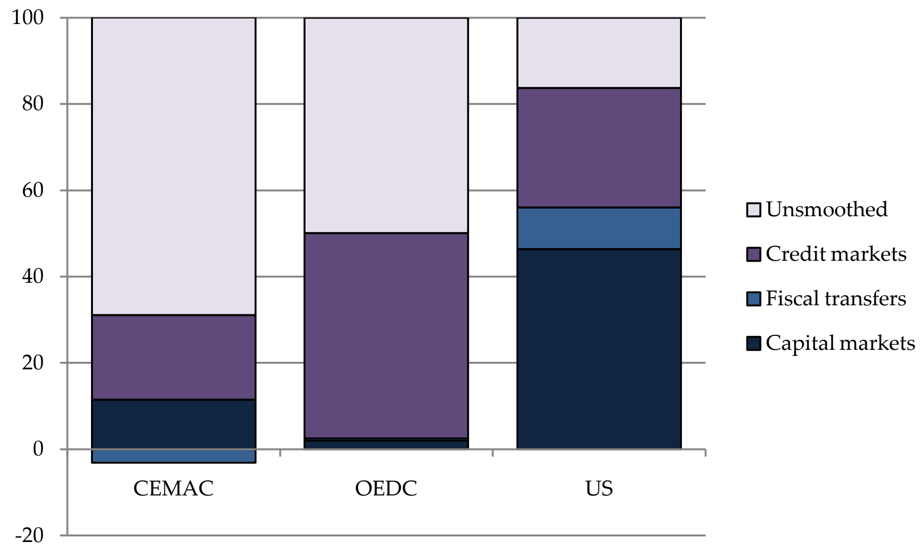
	YH[a]	SSCA[b]	DPVAR[c]
CAP	14.00	14.61	11.48
	(0.95)	(0.09)	(0.10)
FIS	2.00	2.91	-3.16
	(0.56)	(0.06)	(0.06)
CRE	8.00	15.22	19.59
	(0.54)	(0.14)	(0.09)
UNS	85	67.61	72.09

Source: Author's elaboration following the description in the notes

Notes: a. Yehoue (2005) analyzes international risk sharing for CEMAC from 1980 to 2000.T-statistics are in parentheses. b. Static smoothing channel approach for CEMAC from 1986 to 2018. Standard errors are in parentheses. c. Dynamic panel VAR for CEMAC from 1986 to 2018, impact responses to GDP shock (impact GDP change = 100). Standard errors are in parentheses.

Likewise, in order to evaluate CEMAC performance when it comes to smoothing shocks, we compare our findings to similar empirical studies applied to other unions, namely the United States and Europe[12]. Using the static smoothing channel for Europe, Sorensen & Yosha (1998) found 65.5 percent quantity of non-smoothed shocks to output, slightly lower than our estimate using the same technique. However, Melitz & Zumer (1999) estimation of 80 percent of unsmoothed output shocks appear to be more in line with Yehoue (2005) findings. Asdrubali & Kim (2004) find even less amount of unsmoothed shocks (49.9 percent) across Organization for Economic Co-operation and Development (OECD) countries. However, when considering cumulative responses, the quantity of unsmoothed shocks (78.8 percent) is higher. Thus, we can conclude that static regression approach fails to appropriately detect the lagged dis-smoothing effect. On the other hand, the use of dynamic panel VAR shows that international risk sharing is larger in Europe than it is in the CEMAC. Also, we note that credit market channel appears to have the strongest capacity to smooth shocks to GDP than fiscal and capital markets channels within Europe. This result can be justified by the fact that credit markets are much more elaborated and regionally integrated in developed countries than they are in developing countries. Nevertheless, regarding net factor income channel not being more effective at absorbing shocks in Europe than in CEMAC, is surprising when one would have expected that the presence of operational European financial markets to make a clear difference.

This is not the case for the US as results found by Asdrubali, Sorensen & Yosha (1996), Melitz & Zumer (1999) and Asdrubali & Kim (2004) point capital market channel as the strongest shock absorber out of the three standard smoothing channels. Net transfers from federal government although minor compared to other channels, also play a non-negligible role in the smoothing of structural shocks. Overall, the estimates for the quantity of unsmoothed shocks are lower in the case of the US than our estimates for CEMAC. In fact, out of all the studies Melitz & Zumer (1999) find the highest amount of non-smoothed shocks (39 percent) within the US[13], therefore concluding that interstate risk sharing within the US[14] is definitely larger than international risk sharing across European countries. Our findings do not contradict this observation as interstate risk sharing in the US is also larger than international risk sharing measured in the CEMAC.



Graph 2. *Dynamic Risk Sharing Through Different Smoothing Channels (% of total shock to output)*

Notes: a. Estimates reported for CEMAC are obtained using dynamic panel VAR (Impact GDP change=100). b. Estimates reported for OECD and the US are sourced from Asdrubali and Kim (2004), and obtained using dynamic panel VAR. (Impact GDP c hange = 100 and Impact GSP change = 100, respectively)

Graph 2 compares dynamic risk-sharing obtained in the CEMAC, the OECD and in the US. First, the direct impact of output shocks on consumption is more than four times bigger in the CEMAC than it is in the US and almost a time and a half than it is in Europe. One percent decline in GDP leads to a decline of about 0.72 percent in consumption in the CEMAC, against 0.49 percent in Europe and only 0.16 percent in the US. Secondly, although cross-border risk –sharing through fiscal transfers is not particularly strong in the US, it is almost non-existent in Europe and has an adverse effect in the CEMAC. Country-specific shocks can therefore lead to sub-optimal level of stabilization for the Central African Monetary union through fiscal channel. Also, cross-border borrowing appears to be more prominent across OECD countries (47.6 percent) than anywhere else, while the CEMAC displays the lowest amount of risk-sharing through credit markets channel (19.59 percent). This is certainly the result of better integrated credit markets in developed countries. Finally, shock absorption through capital markets channel reveal a striking difference between the US (46.4 percent) and the CEMAC (11.48 percent), and even more surprisingly between the CEMAC and OEDC countries (2 percent). While the capital markets channel is more than four times stronger in the US than in Central African countries as one could have expected, due to the presence of functioning financial markets, shock smoothing through this channel is even less efficient in Europe. As European countries are far more financially integrated than CEMAC member countries, one might speculate that the cause for this result relies elsewhere.

One possible explanation of the lack of international risk-sharing given by Asdrubali & Kim (2004) might be the presence of the consumption-output correlation puzzle[15] at the occurrence of output shocks. In this paper, we track consumption movements by observing fluctuations in savings as they are essentially attributable to changes in country-specific consumption ($\Delta \log C^i$). As we can see in graph 1, output shocks generate a higher cross-country consumption correlation than cross-country output correlation, hence generating the consumption-output correlation puzzle. As demonstrated by Baxter & Crucini[16] (1995), such puzzle happen due to market incompleteness, along the lines of our previous mention that member countries of CEMAC are not well financially integrated.

5. Policy implications

In this section, we comment the policies currently implemented with regards to our findings on international risk sharing within the CEMAC. Member states are under the IMF's structural adjustment program, meaning that the implementation fiscal consolidation and currency devaluation by member states is strongly recommended in order to reduce government deficits as well as debt accumulation. Fiscal consolidation often follows exchange rate crisis as a part of the measures taken to restore confidence. Indeed, one can expect improvement in the public deficit, simultaneously with improvement in the current account balance following fiscal spending cuts as the Mundell-Fleming approach implies[17]. Though, we observe that fiscal channel had little to no contribution on output shock smoothing in this particular case, even boosting shock instead of smoothing it. As a matter of fact, consolidation prevents transfer payments, yet identified by Mundell (1973) as a stabilizer which helps facilitating adjustment after an adverse macroeconomic shock. This is a possible explanation to why the fiscal channel has no contribution to risk-sharing. Moreover, in a context of unemployment and rigid prices/wages as it is the case in Central African countries, the decision to cut government expenditures causes demand shocks to have short-run output costs. Accordingly, the traditional Keynesian models anticipate a shift of the aggregate demand curve downwards and thereby contractionary real effects in terms of both consumption and output[18] in the context of rigid prices. Further explaining why not only the fiscal channel has no impact on output shock smoothing, but also government expenditure cuts amplify the negative short-run effects instead of offsetting them, thus boosting the shock. We can therefore come to the conclusion that fiscal consolidation prevent risk-sharing in the CEMAC through fiscal channel.

By raising the policy rate by 55 basis points to 3.5 percent[19], monetary authorities aim to stimulate the aggregate demand. However, the presence of excess liquidity in the banking system weakens the monetary transmission mechanism, thus the ability of monetary authorities to stimulate aggregate demand, as demonstrated by Saxegaard (2006) in his study of CEMAC countries. This obviously does not help to contribute to the risk-sharing ability of member states. Besides, due to the ongoing currency crisis, capital controls prevent capital movements, also identified by Mundell (1973) and Eichengreen (2003) as an alternative stabilization tool and a means of recovery for depressed countries. While the reduction of capital movement achieves to remove another key stabilization tool, Greenwood & Kimbrough (1985) explain the tendency for disturbances to have a more pronounced effect under capital controls, as there is less spillover to world markets. This causes risk-sharing within CEMAC to underperform under such policies.

6. Concluding remarks

In order to assess the optimality of CEMAC in the light of the second OCA model proposed by Mundell (1973), we measure in this paper the amount of risk-sharing happening across member states. Relying on the innovative technique of dynamic panel VAR introduced by Asdrubali & Kim (2004), we were able to break down international risk-sharing mechanism within CEMAC, taking into account dynamics between the identified smoothing channels.Therefore, we were able to compare the results obtained by using static smoothing channel approach to those obtained by using dynamic panel VAR.

First, the conclusion that emerges from this observation does not contradict Asdrubali & Kim (2004) statement that static estimation greatly undermines what they refer to as the lagged dis-smoothing effect as we observe significantly higher amount of unsmoothed output shocks using the dynamic panel VAR (72.09 percent) compared with static regression estimate (67.26 percent) for the CEMAC, from 1986 to 2018. Also, the observation of shocks to smoothing channels allows us to observe the dynamics between them and conclude that there is substitutability as a positive shock to capital market channel will oust credit market channel almost by half, while a positive shock to fiscal channel will completely offset credit market channel in CEMAC. Moreover, the detection of a consumption-output correlation puzzle while observing impulse responses functions for shocks to smoothing channels, further prove the emergency of better integrated capital markets. Previous studies on the CEMAC solely based on static regression were not able to spot these dynamics between smoothing channels, information that can be of use during the decision-making process.

Second, by parting our sample into three subsamples, we detect the negative effect of the CFA franc devaluation in 1994 on international risk sharing within the CEMAC. However, we note on the other hand that the introduction of the euro in replacement to the French franc in 2000 had a positive impact on international risk-sharing. When using SSCA, the amount of shock smoothed is the largest. But if we refer to DPVAR, even if there is a great improvement in smoothing through the credit channel, the di-smoothing through capital markets and transfer payments annihilates that.

Then, our analysis of fiscal and monetary policies currently implemented by the BEAC show that not only the adverse effects of fiscal consolidation on short-run aggregate demand will be amplified in a context of high unemployment and excess liquidity, hence undermining its benefits, but also capital controls, by restraining capital movements hinder the efficiency of the region as a currency area. We believe that in future work, it would be interesting to identify whether or not the degree of shock asymmetry plays a role in limiting international risk-sharing within the CEMAC.

Notes

[1] The cooperation agreements were signed in order for France to guarantee the convertibility of the CFA franc to the French currency.

[2] At the creation of the CFA franc in 1945, the rate was fixed at 1 CFA franc = 1.70 FF. It was revalued in 1948 to 1CFA franc = 2.00 FF. In 1960, the French franc was revalued, fixing the new rate at 1FF = 50 CFA franc. Then, the CFA franc was further devalued in 1994 to 1FF = 100 CFA franc. Finally in 2000, the replacement of the French franc by the euro fixed the current rate to 1 euro = 655 CFA franc.

[3] Asdrubali & Kim (2004) were able to examine whether each smoothing channel is a substitute or a complement for the others by tracing the impulse responses of all variables to shocks to smoothing channels.

[4] We can notice here that by setting the coefficients b_{32}, b_{42}, b_{43} and $B(L)$ all equal to zero, we obtain the static model stated in the system of equations (4) which considers neither contemporaneous nor lagged interactions.

[5] In the same way, $\omega^{i}_{K,t}$, $\omega^{i}_{F,t}$ and $\omega^{i}_{C,t}$ are interpreted respectively as shocks to capital markets, shocks to international transfers and shocks to credit markets.

[6] Choleski identification

[7] The ordering, as stated by Asdrubali & Kim (2004), is motivated by the idea that consumers would decide how much to save based on the risk-sharing achieved by other channels and income taxes are based on capital income.

[8] The start date 1986 represents the year when the sixth member Equatorial Guinea joined the CEMAC.

[9] Wooldridge (2001) mentions that the number of lags is typically small (1 or 2 lags), in order not to lose degrees of freedom. In this study we chose to use 2 lags with a constant like Asdrubali & Kim (2004).

[10] According to the Pedronicointegration test used to analyze panel data. The absence of cointegration denotes there is no long-run relationship between the variables, thus our decision to estimate only the dynamic panel VAR system with short-run restrictions.

[11] Regarding the dynamic panel VAR analysis, we would like to pinpoint that the use of this methodology exempt us from choosing between fixed effect or random effect model necessary in the Generalized Least Squares used in the static smoothing channel approach, even when we split our sample in several subgroups.

[12] All the estimates are sourced from Asdrubali & Kim (2004) and reported in appendix B.

[13] Asdrubali, Sorensen & Yosha (1996) find 25 percent of unsmoothed shocks, when Asdrubali & Kim (2004) find 16.3 percent (impact GSP change =100). Results are reported in Appendix B.

[14] The reason being that the US were supposedly hit by less severe idiosyncratic disturbances than OECD countries as stated by Melitz & Zumer (1999)Clark & Shin (2000).

[15] In a seminal paper, Backus, Kehoue & Kydland (1992) state that cross-country output correlations are higher than cross-country consumption correlations. When the opposite is observed, there is a puzzle.

[16] Using dynamic general equilibrium open economy model, Baxter & Crucini (1995) showed that cross-country output correlation is higher than cross-country consumption correlation in the bonds-only economy model, in the presence of permanent productivity shocks.

[17] The Mundell- Fleming approach implies that fiscal spending cuts will decrease aggregate demand and result in a real depreciation of the exchange rate together with an improvement in the current account.

[18] In the traditional Keynesian models, consumption is determined by current income.

[19] Real interest rate movements are known to be negatively correlated under capital controls. As explained by Greenwood & Kimbrough (1985), quantitative restrictions on international capital flows sever any direct link between domestic and foreign real interest rates. This may explain why in a global context of declining rates the BEAC follows an opposite direction.

Appendices

Appendix 1: The Dataset

Table A.1. *Definition of variables*[a]

Variable	Definition	Source
GDP	Gross Domestic Product	World Development Indicators
GNP	Gross National Product	World Development Indicators
GDI	Gross Disposable Income	GNP +ToT[b]
C	Total Consumption	GDI - GNS[c]

Source: Author's elaboration following the description in the notes
Notes: All the variables are calculated in real per capita terms (in 2010 U.S. dollars). a. ToT = Terms of Trade, sourced from the World Bank Development Indicators. b. GNS = Gross National Savings, sourced from the World Bank Development Indicators.

Appendix 2: Comparison of smoothing channels estimates

Table B.1. *Comparison of smoothing channels estimates, OECD (% of total shock to output)*

	SY[a]	MZ[b]	AK (impact)[c]	AK (cum.)[d]
GDP	100	100	100	100
	-	-	(2.9)	(7.2)
CAP	-1	5	2	-0.5
	(1.0)	(0.5)	(0.9)	(2.2)
FIS	1.5	-	0.5	-0.5
	(1.0)	-	(0.6)	(1.0)
CRE	34.5	13	47.6	22.3
	(4.0)	(0.7)	(2.7)	(4.2)
UNS	65.5	80	49.9	78.7
	(3.5)	-	(2.6)	(6.7)

Source: Asdrubali & Kim (2004)
Notes: a. Sorensen & Yosha (1998). Sample only includes 13 countries. Averages over two subsamples. b. Melitz & Zumer (1999). Pooled multiple regression estimates subject to UNS = 80% c. Asdrubali & Kim (2004). Impact responses to structural shock (Impact GDP=100). d. Asdrubali & Kim (2004).Cumulative responses to structural shock (cum. GDP change =100)

Table B.2. *Comparison of smoothing channels estimates, US (% of total shock to output)*

	ASY[a]	MZ[b]	AK impact[c]	AK cum.[d]
GDP	100	100	100	100
	-	-	(2.0)	(5.1)
CAP	39	24	46.4	35.8
	(3.0)	(3.2)	(1.7)	(5.1)
FIS	13	13	9.6	15
	(1.0)	(1.7)	(1.1)	(1.5)
CRE	23	24	27.7	13.5
	(6.0)	(3.5)	(3.4)	(4.6)
UNS	25	39	16.3	35.8
	(6.0)	-	(3.2)	(5.1)

Source: Asdrubali & Kim (2004).
Notes: a. Asdrubali, Sorensen & Yosha (1996). b. Melitz & Zumer (1999). Pooled multiple regression estimates subject to UNS = 39% c. Asdrubali & Kim (2004). Impact responses to GSP shock (Impact GSP change =100) d. Asdrubali & Kim (2004).Cumulative responses to GSP shock (cumulative GSP change =100).

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