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Effects of the Russian-Ukrainian Conflict on the Economic Activity of CEMAC States: Prioritization of Transmission Channels

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Abstract
The objective of this article is to analyze the effects of the Russo-Ukrainian Conflict on the economic activity of the CEMAC States by prioritizing the transmission channels. The two main channels of transmission of this war selected particularly for our study are, on the one hand, the dependence of the CEMAC States on the outside world for food and energy raw materials (wheat, fertilizer, gas, oil). …), which causes prices to soar in general and particularly for food products. On the other hand, the depreciation of the FCFA against the American dollar, which occurred via the depreciation of the euro, the currency to which the FCFA is linked at a fixed parity. It causes, apart from the repercussions on the financial market, the drop in export earnings and the increase in the cost of imports made in US dollars. From a simultaneous equation model on the real sector of the economy, the results show that the effect of the conflict via the inflation of basic products (food and energy) would reduce growth prospects in the CEMAC zone by 0 .3% to place it at 2.5% on average between 2023 and 2025, while the effect of the conflict via the depreciation of the FCFA against the US dollar would reduce growth prospects by 0.1% on average in the CEMAC zone for place it at 2.7% on average between 2023 and 2025. CEMAC States could put in place import/substitution procedures in order to reduce imported inflation and economic fragility caused by external dependence, a particular emphasis being focused on the creation of fertilizer factories and on the production of wheat and the development of its substitutes. They could accentuate the process of structural transformation in order to diversify their source of income, which would make the evolution of their GDP more resilient to external shocks while seeking the optimum in the agricultural sector. Monetary authorities should consider measures to mitigate the shocks caused by the depreciation of the euro against currencies, being linked to a fixed parity with the euro.

Keywords: Russo-Ukrainian Conflict, GDP, Depreciation, Inflation, Food Products

Introduction

Background and Justification for the Study

Russia's aggression against Ukraine and its illegal annexation of Crimea have brought to a screeching halt 25 years of efforts by the Allies to build a genuine strategic partnership with the great Eurasian power. President Vladimir Putin accused the West, and the United States in particular, of "double standards", of interfering in the internal affairs of other countries and, in particular, of trying to bring about "regime change" (BBC News). The NATO Secretary General at the time, Jaap de Hoop Scheffer, described the speech as "disappointing and unconstructive".

Russia invaded Ukraine on 24 February 2022. The Ukrainians showed fierce resistance and determination, with many combatants and civilians tragically losing their lives. Western reactions, mainly in the form of sanctions and defence and intelligence support for Ukraine, were swift and substantial. For experts and politicians, this conflict marks the turning point of an era and has global ramifications. Unfortunately, more than a year on, the economic repercussions are already being felt, particularly in Sub-Saharan Africa. In its recent report on the economic outlook for sub-Saharan

Africa, published on Friday 14 October 2022, the IMF forecast a slowdown in growth to 3.6% in 2022, down significantly from 4.7% in 2021, but still on track for 2023.

The slowdown in the economy, tighter financial conditions and a spectacular rise in global inflation are spreading to a region already reeling from an uninterrupted series of other shocks. Rising food and energy prices are penalising the region's most vulnerable populations, while public debt and inflation are at levels not seen for decades. The depreciation of the euro against the US dollar as a result of this conflict is also said to have had repercussions on these economies, and on the franc zone in particular.

Specifically for the CEMAC economies, there is an urgent need to measure the real impact of this conflict, which is already adding to the other problems facing the economies of the sub-region, notably climatic hazards, security crises and, more recently, the Covid-19 crisis, from which the countries are gradually recovering.

The aim of this study is therefore to assess the repercussions of this conflict on the economy of the CEMAC sub-region, starting with the identification of transmission channels in order to find appropriate prescriptions for the countries in this zone.

Transmission Channels of the Conflict on the Global Economy

Given the context of this war, two main transmission channels for the effects of the war in Ukraine on the global economy can be identified: the first is inflation in commodities and inputs, and the second is the depreciation of the euro against the US dollar.

Impact of the Russo-Ukrainian Conflict on Commodity and Input Prices

The conflict between the two countries and the economic sanctions imposed on Russia have led to an increase in world prices for energy and certain raw materials, particularly agricultural inputs and products. Russia and Ukraine play a major role in the global supply of oil and agricultural raw materials (see Table 1).

Products exported to the world	Russia World Ranking	Peas from Russia (%)	Ukraine World Ranking	Peas from Ukraine (%)
Fuels	**1**	**9,95**	**91**	**0,04**
- Oil and petroleum products	1	10,90	91	0,02
- Natural gas and manufactured gas	11	2,86	92	0,01
- Coal, coke and briquettes	3	13,10	38	0,05
- Electrical energy	13	2,31	28	0,87
Cereals and cereal preparations	**4**	**5,23**	**7**	**4,70**
- Wheat: Unground wheat and meslin	1	16,25	6	7,72
- Unhulled barley	3	11,06	4	10,37
- Unground corn	8	2,46	4	11,47
Non-ferrous metals	**4**	**4,99**	**71**	**0,07**
- Silver, platinum and mine metals	5	8,29	54	0,02
- Copper	7	3,90	56	0,08
- Nickel	2	11,21	42	0,03
- Aluminium	6	4,69	68	0,05
- Lead	9	3,17	36	0,46
Iron and steel	**5**	**5,16**	**15**	**2,23**
Crude fertilizers	**8**	**3,39**	**29**	**0,99**
Fertilizer (Unroasted sulphur and iron pyrite)	**3**	**7,55**	**67**	**0,01**
Oils, fats and waxes (animal or vegetable)	**10**	**2,80**	**5**	**4,73**

Table 1: Weight of Russia and Ukraine in Global Raw Materials Supply (2016-2020)

Source : CNUCED, 2022

The current crisis is causing supply difficulties for these products worldwide, and companies using these raw materials, particularly energy, are being directly or indirectly affected by this crisis in terms of their supply capacity due to the increase in production costs, and it should be noted that some companies, faced with these supply disruptions, are forced to interrupt their activities for a more or less long period.

CEMAC member countries are net importers from Russia and Ukraine, and are therefore directly affected by the repercussions of this conflict. Indeed, the rise in the price of commodities and certain inputs on the international markets on which CEMAC depends eventually seeps through to production costs, driving up the price of products that drive domestic inflation, mainly food and non-alcoholic beverages. This inflation further deepens the pockets of people, most of whom are already living in poverty, and risks further undermining the food security of the countries in this zone through rising prices for food products and basic necessities. This fall in household purchasing power does not benefit businesses in return, in that they lose potential demand and could therefore be subject to a fall in production, which would have a direct impact on economic activity as measured by the zone's GDP growth rate.

Figure 1 shows the joint evolution of growth and inflation in energy products in the CEMAC zone in the past. The analysis shows that these variables tend to move in the same direction. However, the empirical part of our study aims to provide concrete economic conclusions. Figure 2 shows that, with the exception of a few years, the rate of GDP growth in the CEMAC zone appears to be strongly linked to trends in food inflation. However, apparent correlation is not synonymous with causality, hence the need for empirical verification.

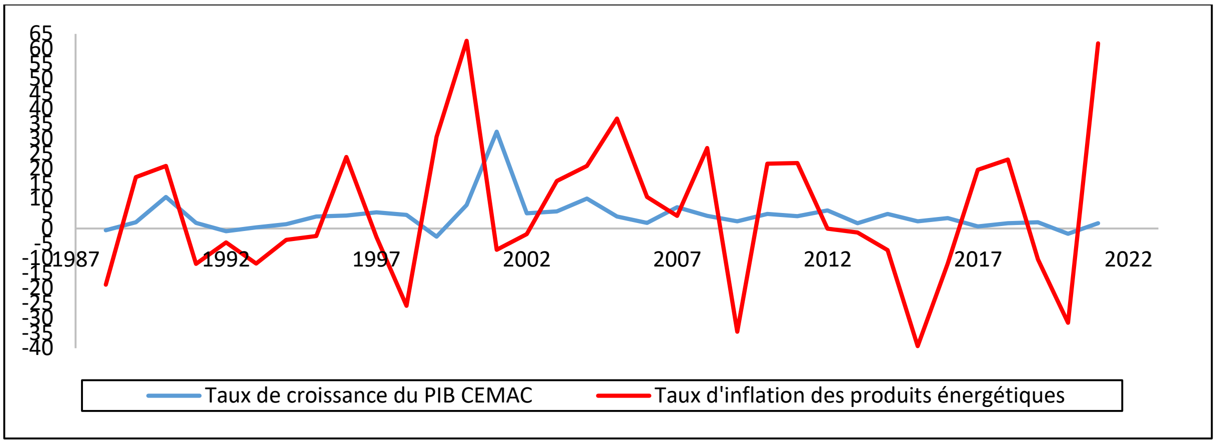


Figure 1: Joint Evolution of Growth and Inflation of Energy Products in the CEMAC Zone

Source : The authors, BEAC data

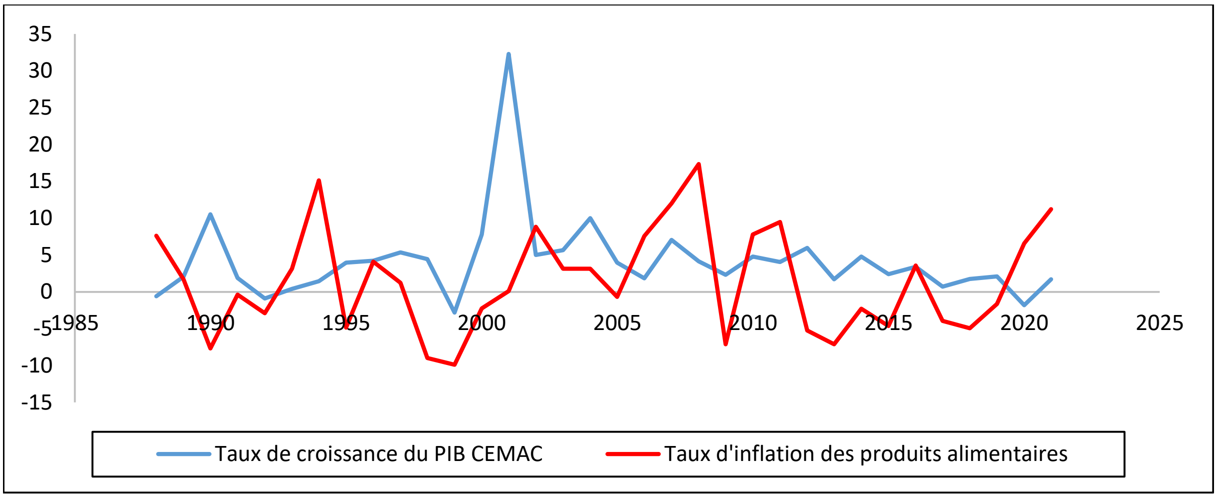


Figure 2: Joint Evolution of Growth and Inflation of Food Products in the CEMAC Zone

Source : The authors, BEAC data

Effect of the Russo-Ukrainian Conflict on Exchange Rates (Euro/Dollar...)

The second transmission channel is linked to the high volatility of asset prices, particularly those of Russians, in response to the tensions on the financial markets and the uncertainty generated. The United States and European countries decided to impose various sanctions on Russia, targeting the entire Russian banking system, including the Central Bank of the Russian Federation. These sanctions immediately led to a sharp fall in the value of the rouble and the prices of several Russian assets, with a knock-on effect of volatility in the prices of other assets due to the lack of visibility for investors on how the war was progressing. Against this backdrop of uncertainty, holders of securities prefer to get rid of them in order to avoid drastic losses in value. In fact, over the last few months, the prices of these assets have fallen by an average of 20%. As a result, interest rates on the financial markets are rising, hampering the financing of the economy in developing countries. This is all the more likely as central banks may be tempted to raise key interest rates in an attempt to contain inflationary pressures. In this respect, the FED did indeed raise its key rates in response to the inflation raging in the United States, which was not without consequences for the foreign exchange market, where we saw an appreciation in the dollar to the Euro, to which the CEMAC zone's CFAF is pegged at a fixed parity. However, a positive monetary shock (appreciation of the TCN) originating outside the anchor currency's economy can have a negative effect on the balance of trade via an increase in import volumes insofar as the country outside the anchor currency is an essential supplier and the inflation differential is significant. This is the case for the CEMAC countries, where a large proportion of imports come from the United States. Following the conflict, the REER for imports fell by 1.4% between the first and third quarters of 2022. A descriptive analysis of the evolution of the USD/FCFA exchange rate and growth in the CEMAC zone since 2005 reveals an apparently fairly similar evolution, which could confirm the hypothesis that the exchange rate is a transmission channel for the effect of the conflict on economic growth in the CEMAC zone.

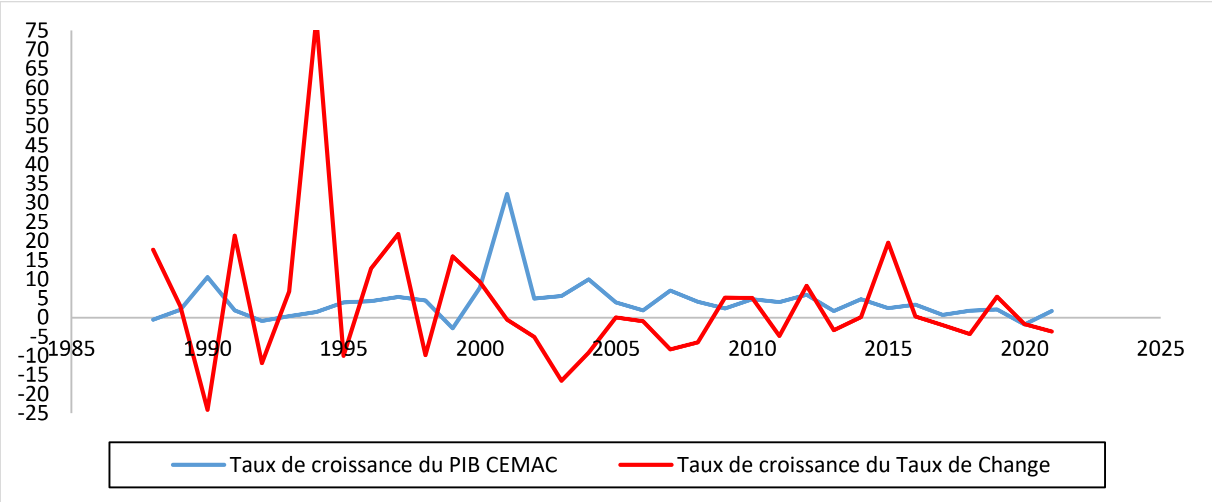


Figure 3: Joint Evolution of the Growth Rate and the USD Dollar/FCFA Exchange Rate

Source : The authors, BEAC data

Through these identified channels, we then note that it can have harmful consequences on the economies of the CEMAC, which transit via domestic inflation caused by costs and the depreciation of the CFAF against the US dollar, although beneficial effects could result, particularly with the rise in the price of oil.

Some Stylised Facts

Trends in Prices of Basic Products and Inputs

In the CEMAC zone, the Russo-Ukrainian conflict is occurring at a time when most countries have little room for manoeuvre to counter the effects of this shock. This situation is likely to exacerbate the socio-economic pressures, the vulnerability linked to public debt and the after-effects of the pandemic already faced by millions of households and businesses. Record wheat prices are particularly worrying (see chart1) for a region where imports account for around 85% of supply, a third of which comes from Russia or Ukraine.

Figure 4: Cereal Price Trends

Source: Bloomberg

In March 2022, the FAO Food Price Index, which tracks monthly changes in the international prices of the world's most commonly traded food products, reached its highest level since it was created in 1990, at 159.3 points, over 34% higher than its value a year earlier. This rise was mainly attributable to the explosion in the prices of cereals (+37%) and vegetable oils (+56%), particularly sunflower oil. In the days leading up to Russia's decision to invade Ukraine, the prices of many food products soared at international level: +54% for wheat, +31% for maize, +20% for soya, and the rise accelerated between February and March 2022 (+20% for wheat and +19% for maize in one month). The FAO food price index has continued to climb since the start of the conflict, reaching a new record level in March 2022, now standing at 159.3 points, an increase of almost 13% on its February level, and its highest level since it was created in

1990. This new spectacular rise can be explained by the record levels reached by the sub-indices for vegetable oils, cereals and meat, and by the increase in the sub-indices for sugar and dairy products. Inflation in the CEMAC zone is generally driven by food inflation, with energy inflation having a slightly smaller influence, as shown in Figure 5.

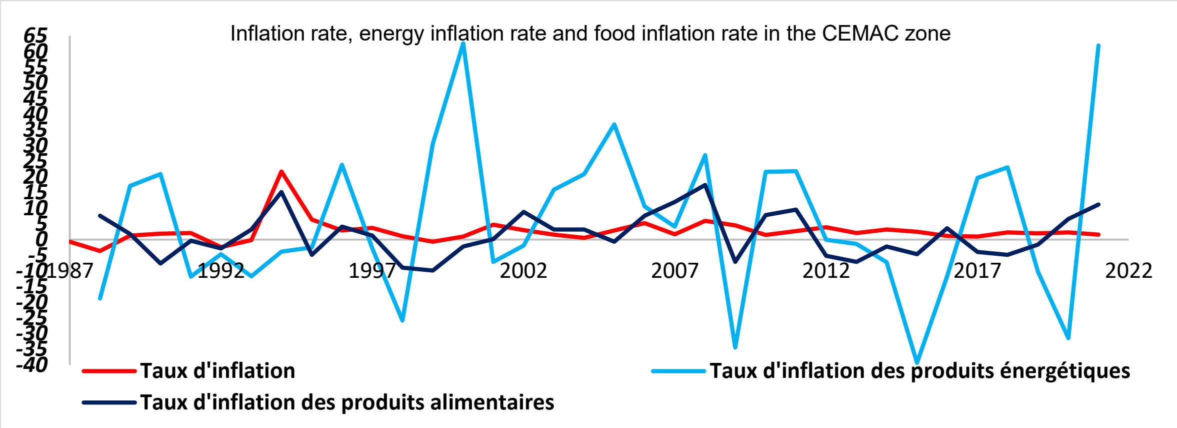


Figure 5: Inflation Trends in the CEMAC Zone

Source : The authors, BEAC data

Our two transmission channels therefore have a strong influence on general inflation in the sub-region. In the CEMAC zone, inflation begins a few weeks after the start of the conflict (February 2022), as shown in graph 2, and is more pronounced for food products and non-alcoholic beverages. The fallout from Russia's aggression in Ukraine will therefore further increase famine and poverty, as Kappel (2022) argues, since the inflation that has increased since the conflict is mainly caused by inflation in food and non-alcoholic beverages, as shown in Figure 6 [1].

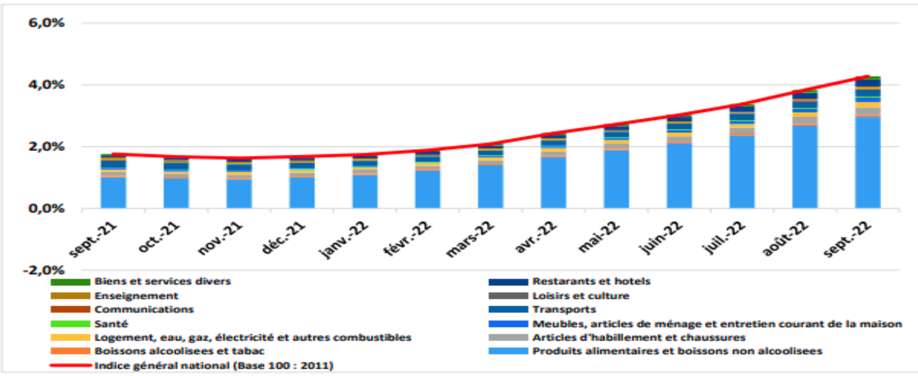


Figure 6: Inflation Trends in the CEMAC Zone by Consumption Function

On the other hand, conflict leads to higher energy prices, which in turn will increase vulnerability, particularly in African countries that have minimal policy space to counter the effects of external shocks [2]. Most countries in the CEMAC zone import refined oil and generally subsidise fuel prices, which places a heavy burden on their budgets. The sanctions against Russia have resulted in an increase in world oil prices, as shown in Figure 7 using Bloomberg data.

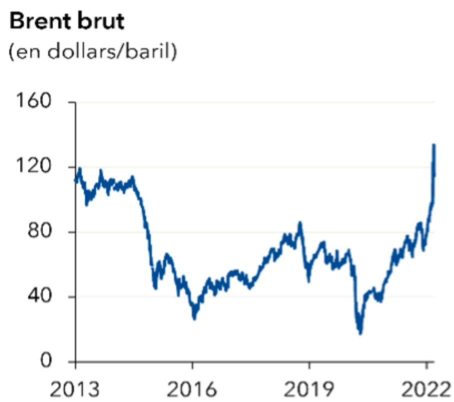


Figure 7: Oil Price Trends

Source: Bloomberg

Exchange Rate Trends (Depreciation of the CFAF/Euro Against the Us Dollar Caused by the Conflict on the CEMAC Economies)

The debt vulnerability of sub-Saharan African economies worsened at the start of the conflict, particularly for those with a high external imbalance and a risk of over-indebtedness. These economies will continue to see their currencies weaken and sovereign bond yield spreads widen. The only winners from this depreciation will be the exporters of the countries in the zone. "But the competitive effect of the fall in the CFA franc is limited by the fact that exports, most of which consist of raw materials, are mainly denominated in dollars," downplays Carl Grekou, an economist at the Centre d'études prospectives et d'informations internationales. The fall of the euro has reignited the debate on the usefulness of the CFA franc, whose acronym stood for "French colonies in Africa" until 1958, and which is accused of keeping African economies dependent on France. Its supporters insist on the stability it offers. The currency is not subject to speculative attacks, thanks to its fixed exchange rate, and guarantees moderate inflation. But this stability comes at a high price," observes Kwami Ossadzifo Wonyra, "because by giving priority to the fight against inflation, we don't have an expansionary monetary policy that opens the floodgates of credit and encourages investment. Finally, this stability benefits some people in particular. Europeans can import raw materials and other products without risking exchange rate fluctuations.

Figure 8: Euro/Dollar USD Exchange Rate Trend

Source : Bloomberg

In short, the depreciation of the FCFA/USD exchange rate can lead to imported inflation, in addition to that caused by food and energy products. Figure 9 above shows that since 2005, growth in the CEMAC zone has been strongly linked to inflation in the zone. However, we would point out that correlation is not synonymous with causality, hence the problem of this study, which is to rank the above-mentioned transmission channels and measure their effects on economic growth in the CEMAC zone.

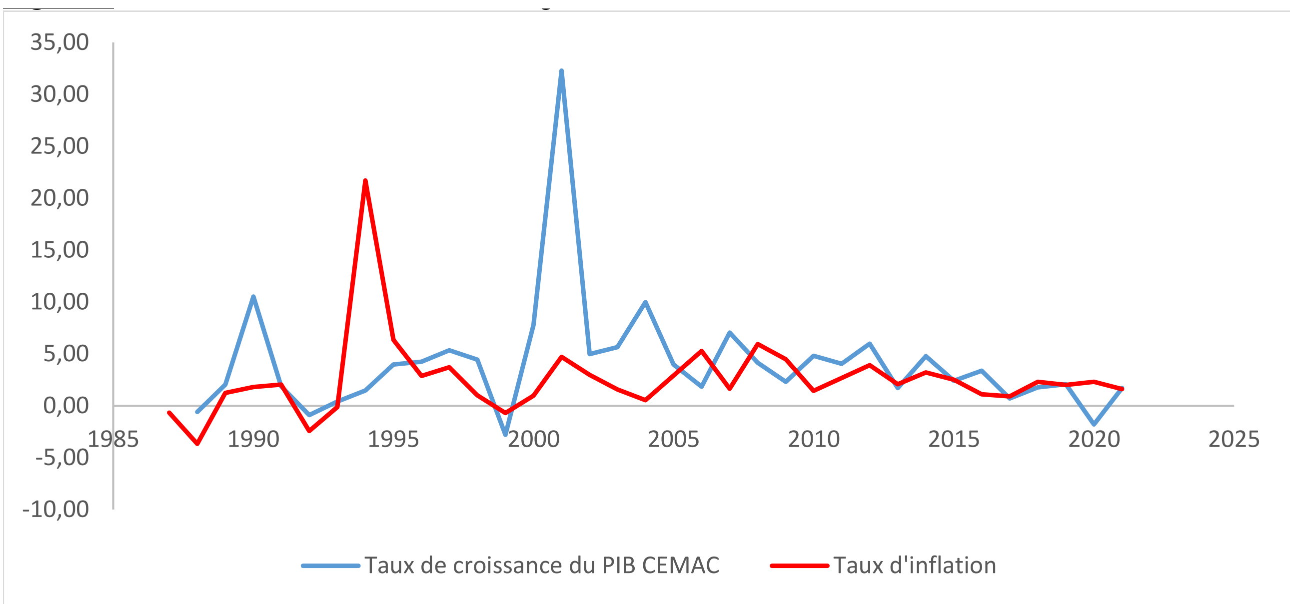


Figure 9: Joint Trend in Inflation and GDP Growth in the CAEMC Zone

Source : The authors, BEAC data

The Problem

So, given these few stylised facts on the conclusive consequences of the Russo-Ukrainian conflict on economic activity in the CEMAC zone through the 02 main channels of rising commodity prices and the depreciation of the CFAF against the US dollar, what is the order of priority of these effects?

This question can be subdivided into two sub-questions:

• What are the real effects of these 2 channels on the economic growth of CEMAC countries?

• Which of these effects is the priority from a strategic point of view for the BEAC's monetary authorities and the governments of the member states?

Aim of the Study

The aim of this study is to determine and prioritise the consequences of the increase in commodity prices and the depreciation of the CFAF against the US dollar on the economic growth of the CEMAC countries.

Study Hypothesis

The assumptions made in this study are as follows:

• The increase in commodity prices and the depreciation of the CFAF against the US dollar have a negative impact on economic growth in the CEMAC countries.

• The extent of the effects caused by the increase in commodity prices is more significant than that of the effects caused by the depreciation of the FCFA against the US dollar.

Study Plan

Following this introduction, the rest of the article is structured as follows. Section 2 presents the findings of the literature. Section 3 presents the data and methodology used. Section 4 presents the results and discussions, and Section 5 concludes.

Lessons From the Literature

The Russo-Ukrainian Conflict, Rising Commodity Prices and Economic Growth

According to Mba (2016), if we accept that economic power confers political power, then we must accept that monetary power confers political power [3]. Money is at the heart of modern economic policy. In liberal economies, it is one of the key variables in the conduct of economic policy, which is why it is essential to know how it works. Central banks play an important role in the quest for economic stability by issuing money. They remain an essential link in the production chain through monetary policy, the direction of which they define. Whether central banks are independent or not, they share common characteristics and objectives such as price stability and economic growth [4].

Price stability is one of the objectives of monetary policy [5]. It has to be recognised that in the current environment, which is marked by major upheavals (particularly in the economic and financial spheres), managing money and credit is an extremely delicate and complex exercise in practical terms. This management ensures that prices do not get out of control, while at the same time providing the economy with the financing it needs for balanced growth. It is therefore a difficult balance to strike between inflation, economic growth, employment and the current account [6].

The strategy followed by the Bank of Central African States (BEAC) prior to 16 October 1990 had as its ultimate objective the economic development of the member states of the Economic and Monetary Community of Central Africa (CEMAC). Since the introduction of the money market in July 1994, monetary stability has become the BEAC's main ultimate objective. The literature shows that the effects of monetary stability on economic activity are ambiguous and depend essentially on levels of development and economic activity.

Ndiaye Mamadou and Abdoulaye Konte (2013) propose an assessment of the relationship between uncertainty arising from inflation volatility and economic growth in WAEMU countries [7]. They also look at the repercussions of inflation shocks on the real economies of WAEMU countries.

Their study is based on a VAR-GARCH model capable of highlighting, on the one hand, the different characteristics of inflation shocks in the union and, on the other hand, the links between uncertain inflation and economic growth. The results suggest that the volatility of inflation and economic activity persists, but also that inflation uncertainty is very significant. The mechanisms by which uncertain inflation is transmitted to economic growth differ from country to country.

Macroeconomic convergence, stabilisation and development policies have failed to counteract the persistence of fluctuations in inflation and economic activity. Similarly, they have not succeeded in curbing the overall negative effects of the interaction of inflation shocks between countries and uncertain inflation on economic growth in the countries of the union.

The Russo-Ukrainian Conflict, the Depreciation of the FCFA Against the US Dollar and Economic Growth

Nersisyan and Wray (2011) argue that a sovereign government spends by issuing its own currency and therefore has no constraints on its ability to spend [8]. On the other hand, a non-sovereign country that pegs its currency to another currency can only issue currency up to the level where its foreign currency reserves allow it to maintain the peg. Adopting a peg forces a government to give up at least some of the autonomy of its monetary and fiscal policy. These constraints are obviously less restrictive if the country has a current account surplus and is accumulating foreign currency reserves.

They argue that a government that operates with a non-sovereign currency, issuing debt in either foreign currency or domestic currency pegged to a foreign currency (or precious metal) faces real operational risks and poses solvency risk. The depreciation of the euro against the US dollar caused by the Russian-Ukrainian war has therefore had repercussions on the CEMAC countries with a currency pegged at a fixed parity with the euro. The fall in the exchange rate of the euro, by about 16% against the dollar over one year, has consequences as far as Central and West Africa. This depreciation affects the CFA franc, which is pegged to the European currency and used in fifteen African countries. It is increasing the cost of their imports and fuelling soaring energy and food prices, which are already under pressure since the Russian war in Ukraine and the many export restrictions introduced in the aftermath. For countries with a high dollar debt, the devaluation of the CFA franc weighs heavily on public finances. "When the CFA franc loses 20% of its value against the dollar, it means that the repayment of dollar-denominated debt increases by 20%," explains Kwami Ossadzifo Wonyra, an economist at the Togolese University of Kara. However, many low-income countries have had to borrow in dollars to cope with the Covid-19 pandemic." In Senegal, they alone account for 40% of the external debt.

Mbuyi Kabamba and Deborah Matadi (2021) study the effects of the exchange rate on economic growth [9]. Their empirical analysis focuses on the Democratic Republic of Congo (DRC) from 1990 to 2019 and was based on the Ordinary Least Squares (OLS) method. The results show that exchange rate fluctuations have a negative effect on economic growth. In view of these results, they proposed some recommendations, including strengthening resilience by diversifying economic activity, building up fiscal reserves and raising the level of international reserves. And they suggested that the latter, which could only cover 3 weeks of imports of goods and services, should be gradually extended beyond that in a long¬term perspective.

Kevin Nansha (2021) studied the interaction between economic growth, inflation, and the exchange rate in the Kenyan context [10]. He used the SVAR and ARDL (bounds cointegration) models to empirically analyze the relationship between these three variables in the Kenyan context (from 1960 to 2020).

The main results of his study were that:
• In Granger's view, there are no statistically significant causal relationships between economic growth, inflation and the exchange rate in Kenya;
• With theoretical short-term restrictions on the SVAR model, a significant appreciation of the Kenyan local currency would cause a slight increase in the Kenyan inflation rate;
• Kenya's exchange rate and inflation rate would react positively to endogenous and exogenous shocks but negatively to innovations in the real sector;
• Kenya's economic growth impulse responses would be negative in the event of exogenous shocks and positive in the case of endogenous innovations;
• Under an ARDL model, in the short run, a 10% depreciation of the Kenyan local currency would lead to a 15.18% increase in the Kenyan inflation rate;
• The long-term relationship (co-integration at bounds) between inflation, economic growth and the exchange rate in Kenya is significant, such that a 10% depreciation of the Kenyan Shilling would lead to a 7.01% increase in the Kenyan inflation rate;
• In the long run, the Kenyan economy would have an inflationary memory (inflation would also depend on its past values).

In view of these opinions on the potential effects of the Russian-Ukrainian conflict via inflation and exchange rate depreciation on economic activity, an empirical analysis of the said question is important, particularly for the countries of the CEMAC zone.

Work on the Effect of the Russian-Ukrainian Conflict, Particularly in the Case of Cameroon

The Study of the General Directorate of Economy and Public Investment Programming of the Ministry of Economy, Planning and Regional Development of Cameroon

The above-mentioned management's working document No. 01/2022 stipulated that this conflict could have several effects, including the disruption of the overall supply of certain energy and agricultural products with notable consequences on international financial markets, global and domestic inflation. In Cameroon, this conflict is expected to have a negative impact on the development of agro-industrial sectors, particularly through the soaring prices of chemical fertilizers, of which Russia is one of the world's main importers.

The Study by the Consulting Firm KB SAP CONSULTING

The strategic positioning study on cereal-based products carried out by the consulting firm KB SAP CONSULTING, and made public on August 25, 2021 by the Cameroonian Business Upgrading Office (BMN), reveals that Russia and Ukraine respectively occupied the 3rd and 8th places in the world in terms of wheat production in 2020.

The conflict between Russia and the Western world has caused a shock to both stock markets and commodity prices, including West Texas Intermediate (WTI) and wheat. According to Euronext, the price of a barrel of oil has exceeded the 106 euro mark. The price of a tonne of wheat has reached a record level of 344 euros. The economic situation around wheat, whose consumption in Cameroon is increasing by an average of 60,000 tonnes per year and imports amounted to 860,000 tonnes in 2020, could therefore strongly influence the prices of wheat-based products, which are widely consumed in Cameroon [1].

Methodology and Data

Data

To achieve our objective, we use data at annual frequency, covering a period from 1980 to 2022 and covering 24 variables, namely GDP (Y), potential GDP (Yp), consumption (C), investment (I), exports (X), imports (M), private consumption (Cp), public consumption (Cg), private investment (Ip), public investment (Ig), domestic real interest rate (Ir), domestic nominal interest rate (In), long-term domestic real interest rate (In*), US real interest rate (Ir*), US nominal interest rate (In*), the inflation rate of the United States (π*), the nominal exchange rate between the US Dollar and the CFA franc (TCN), the real effective exchange rate index (ITCER), domestic inflation (π), the money supply (M2), the inflation target set by the Central Bank (πc), inflation in the prices of imported commodities ($\boldsymbol{\pi}$p) and GDP of key CEMAC partner countries (Y*).

First, we used data from the Bank of Central African States (BEAC), namely the interest rate on tenders (TIAO) used as a proxy for the domestic nominal interest rate. The inflation considered is core, measured by the change in the consumer price index (CPI), provided by the BEAC database. The real variables related to GDP, consumption (public and private), investment (public and private), imports and exports also come from the BEAC database. Also from this base, the money supply, the real effective exchange rate index and the nominal exchange rate between the US dollar and the CFA franc were extracted. The use of the Hodrick-Prescott filter made it possible to obtain the series of potential GDP and the long-term domestic nominal interest rate; the inflation target is 3% as conferred by the BEAC's monetary stability objective.

As for foreign variables, the nominal interest rate of the United States will be approximated by the Fed's key rate, the information of which can be found in the Fed's database, as well as that of American inflation. Regarding the GDP of CEMAC partner countries, in view of the foreign trade figures over the last 05 years, we consider the United States, the European Union, China, India, South Korea, the United Arab Emirates. The price of commodities is given by World Bank Commodities Price Data, where there are 2 categories: energy and food. The data are shown in the appendix.

Modeling

In this work, we will use a model with simultaneous equations on the real sector of the economy. The real sector reflects all the real economic transactions of an economy. It is characterized by the market for goods and services, labour and securities, where relative prices and equilibrium quantities are determined, noting that the variables used in this sector are real and not nominal.

This sector has sixteen (18) equations and each of them reflects an accounting relationship or a behavioural relationship that is then estimated using the autoregressive staggered delay model (ARDL). Second, a model with simultaneous equations and estimated to take into account the interaction between the different equations of the macroeconomic model.

The first equation is the one that defines the accounting equality of aggregate demand and supply, which is established from the country's national accounts:

$$\mathbf{Y = C + I + G + (X - M)} \qquad \mathbf{(1)}$$

Where Y: represents the income; C: represents consumption; I: represents the investment; G: represents public spending; X: represents exports and M: represents imports

Knowing that **C =Cp + Cg (2) et I =Ip + Ig (3),** equation (1) becomes :

$$\mathbf{Y = Cp + Cg + Ip + Ig + G + (X - M)}$$

Where Y: represents the income; Cp: represents private consumption; Cg: represents public consumption; Ip: represents private investment; Ig: represents public investment; G: represents public spending; X: represents exports and M: represents import. Equation (4) is that of private consumption in the economy. It is a function of income (in accordance with Keynesian theory).

$$\mathbf{Cp = f\,(Y)} \qquad \mathbf{(4)}$$

Where Cp: represents private consumption and Y: represents income.
Equation (5) describes the behaviour of private investment in the economy. It is a function of income (in accordance with the Keynesian accelerator principle) and the real interest rate (which negatively influences the level of private investment), it is the nominal interest rate without the price effect.

$$\mathbf{Ip = f\ (Y,\ Ir)} \tag{5}$$

Where Ip: represents private investment; Y: represents income and Ir: represents the real domestic interest rate. Equation (6) is that of imports. It is a function of income and the real effective exchange rate (which influences the level of imports).

$$\mathbf{M = f\ (Y,\ ITCER)} \tag{6}$$

Where M: represents the import; Y: represents income and ITCER: represents the real effective exchange rate index. Equation (7) concerns exports. It is a function of the income of the partner countries and the real effective exchange rate (which influences the level of exports).

$$\mathbf{X = f\ (Y^*,\ ITCER)} \tag{7}$$

Where X: represents the export; Y*: represents the income of the partner countries (exogenous) and ITCER: represents the real effective exchange rate index.

$$\text{With } ITCER = f\ (TCN) \tag{8}$$

$$TCN = f\ (Diff\_int) \tag{9}$$

$$Diff\_int = Ir^* - Ir \tag{10}$$

Where ITCER represents the index of the real effective exchange rate; TCN represents the nominal exchange rate between the US Dollar and the FCFA; Ir: represents the domestic real interest rate and Ir*: represents the real interest rate of the United States and Diff_int: represents the differential of these 02 real interest rates

Government consumption is illustrated through equation (11) where it is assumed that the change is equivalent to a share of potential income (fiscal stimulus).

$$\Delta Cg = f\ (Y^p) \tag{11}$$

Where Cg: represents public consumption and Y^p: represents potential (exogenous) income.
Public investment, on the other hand, is broken down into equation (12), where it is assumed that the growth rate of public investment is the same as that of private investment in real terms.

$$\Delta\%Ig = \Delta\%Ip \tag{12}$$

Where Ig: represents public investment and Ig: represents private investment. Subsequently, we consider that the Output Gap which is naturally given by:

$$\text{Output Gap} = \frac{Y}{Y^p} - 1 \tag{13}$$

On the inflation front, using the Phillips curve relationship on the one hand and assuming that inflation depends on the prices of imported commodities, we have:

$$\pi = f\ (\Delta\%M2,\ \text{Output Gap},\ \pi^p) \tag{14}$$

Where π: represents inflation, M2: represents the (exogenous) money supply, and πp : represents the inflation of the prices of imported commodities (energy and food) (exogenous). Moreover, the nominal domestic interest rate is given through Taylor's rule (standard) by the following relation :

$$In = f\ (\text{Output Gap, Ecart d'inflation},\ In^*) \tag{15}$$

Where In: represents the nominal interest rate and In*: the long-term (exogenous) domestic nominal interest rate.

$$\text{Noting that: } \textbf{Inflation gap} = \pi(-1) - \pi^{c} \quad \textbf{(16)}$$

Where п (-1): represents inflation in the previous period and π^{c}: represents the inflation target set by the Central Bank (exogenous).

We thus deduct the domestic real interest rate, which is just the differential between the domestic nominal interest rate and the inflation rate :

$$\mathbf{Ir = In - \pi} \quad \textbf{(17)}$$

We also consider the US real interest rate to be the differential between the nominal US interest rate and the US inflation rate :

$$\mathbf{Ir^{*} = In^{*} - \pi^{*}} \quad \textbf{(18)}$$

Where In*: represents the nominal interest rate of the United States (exogenous) and п*: represents the inflation rate in the United States (exogenous).

Note that we have 09 exogenous variables in all. Thus, with regard to the objectives, the main exogenous variables of interest are the Fed's key rate and commodity prices. Indeed, it is the rise in the United States' external real interest rate caused largely by the increase in the Fed's key rate (restrictive policy) that is the cause of the depreciation of the CFA franc against the US dollar, at the same time the rise in the prices of basic products, which are mainly imported, are the main vectors of inflation in the CEMAC (see transmission channels).

As a result, the rest of the exogenous variables remain unchanged while the Fed's key rate and commodity prices will each follow a distinct evolution according to scenarios, the simulation horizon is between 2022 and 2025 to capture short- and medium-term effects.

In this regard, we formulate 3 main scenarios, namely :
• A baseline scenario: all exogenous variables follow their predicted trajectories before the conflict.
• Scenario 1: All exogenous variables apart from commodity prices follow their expected trajectories before the conflict, commodity prices will increase by 5% relative to the baseline situation.
• Scenario 2: all exogenous variables outside the US Fed's key rate follow their planned trajectories before the conflict, we will assume an increase in the Fed's key rates of 50 points compared to the baseline situation.

Results and Discussions

Study of the Stationarity of Variables

In order to study the stationarity of the time series studied, we apply the augmented Dickey Fuller (ADF) and Phillips-Perron (PP) unit root tests. These tests test the null hypothesis of the presence of a unit root in the chronicle studied. To complete these first tests, we also perform the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) stationarity test, which has the particularity of having stationarity as a null hypothesis.

Overall, the variables are stationary either in level or in first difference. All the tests seem to support the stationarity of the following variables: the domestic real interest rate, the US real interest rate, the Fed's key rate, the inflation rate, the US inflation rate and the money supply growth rate (see Table 2).

The variables for which the tests unanimously compare a first-difference stationarity are: GDP, consumption, private consumption, investment, public investment, exports, imports, the real effective exchange rate index, the GDP of the partner countries and the prices of basic products (energy and food) (see Table 2).

Variables	**ADF Test**			**PP Tests**			**KPSS Test**
	Without constante	*With constante*	*With trend*	*Without constante*	*With constante*	*With trend*	
GDP		I(1)***			I(1)**		I(1)***
Potential GDP			I(0)***			I(1)**	I(0)***
TIAO	I(1)***					I(0)***	I(0)***
Consumption		I(1)***			I(1)***		I(1)***
Private consumption		I(1)***			I(1)***		I(1)***

Government consumption			I(0)***	I(1)*			I(0)***
Investment	I(1)***			I(1)***			I(1)***
Private investment	I(1)***			I(1)***			I(1)***
Public investment	I(1)***					I(0)***	I(0)*
Exports	I(1)***			I(1)***			I(1)***
Imports	I(1)***			I(1)***			I(1)***
Real Effective Exchange Rate Index	I(1)***			I(1)***			I(1)***
Nominal Exchange Rate		I(0)***		I(1)**			I(0)***
Domestic real interest rate			I(0)***			I(0)***	I(0)***
Long-term nominal interest rate		I(0)***				I(1)**	I(1)***
US real interest rate			I(0)***			I(0)***	I(0)***
Fed key rate			I(0)***			I(0)***	I(0)***
GDP of partner countries			I(1)***			I(1)***	I(1)***
Inflation rate		I(0)***			I(0)***		I(0)***
US inflation rate		I(0)***			I(0)***		I(0)***
Money supply growth rate	I(0)***				I(0)***		I(0)***
Commodity prices (energy)	I(1)***			I(1)***			I(1)***
Commodity prices (food)	I(1)***			I(1)***			I(1)***

Table 2: Stationarity Test Results

Source : Authors based on data from the BEAC, the FED and the World Bank Legend ; * =10%, ** =5% and *** =1%,

Thus, in view of Table 2, the ARDL cointegration approach appears to be the most appropriate option because the results of the various stationarity tests are not conclusive regarding the order of integration of the variables

Estimation of ARDL Models

In this section, we estimate the fourteen behavioural equations presented above using the stepped delay autoregressive models. The estimation procedure of these models takes place in three main steps, namely: the determination of the maximum delay of the model, the estimation of the models by information criterion and the choice of the optimal model.

Determining the Maximum Model Delay

To determine the optimal shift of the explanatory variables of our ARDL model to be estimated, we first estimate a VAR model on the study variables, then we deduce an optimal delay via the principle of minimization of the information criteria (AIC, SC, LR, FPE, HQ, FPE)

Estimates of Eligible Models

After determining the maximum delays, we estimate the corresponding ARDL model for each of the delays.

Choosing the Optimal Model

The choice of the optimal model is based on two principles: the validation of the estimated ARDL model and the principle of parsimony. Regarding the validation of the model, the optimal model is the one with the white noise residues. To verify this, ARCH, Breush-Godfrey, and Jacque-Bera tests are used to analyze the residues. In the case where several models satisfy this condition, the optimal model is the one with the smallest delay: this is the principle of parsimony We have 09 behavioral equations, these are the ones that are the subject of this ARDL modeling.

Equation 4: Private Consumption

Theoretically, according to Keynesian foundations, private consumption is largely explained by income, in this case real GDP. All the information criteria militate in favour of an optimal delay equal to one (see Annex 1). By setting this optimal delay, we arrive at an ARDL model (1,0), however with a long-term relationship confirmed by the boundary test of Pesarin et al (2001). In fact, there is indeed a long-term relationship between private consumption and income in the CEMAC zone (see Appendix 2). Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to Cusum's test, the equation would be stable (see Appendix 3), it is given through Appendix 4.

Equation 5: Private Investment

Also according to Keynesian analysis, private investment is explained by income and the domestic real interest rate. All the information criteria argue for an optimal delay equal to one (see Appendix 5). With this optimal delay, we arrive at an ARDL model (1,1,0), however with a long-term relationship confirmed by the bound test. This shows that there is a long-term relationship between private investment, income and the domestic real interest rate in the CEMAC zone (see Appendix 6), but income and the domestic interest rate have a more short-term than long-term effect on private investment. Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to the Cusum test, the equation would be stable (see Appendix 7) and formulated through Appendix 8.

Equation 6: Imports

Equation 6 reflects the relationship between imports, income, and the real effective exchange rate. All the information criteria argue for an optimal delay equal to one (see Annex 9). With this optimal delay, we obtain an ARDL model (1,1,0) with a long-term relationship confirmed by the bounds test. This shows that there is a long-term relationship between imports, income and the real effective exchange rate in the CEMAC zone (see Annex 10), but the real effective exchange rate has a weak effect on imports in the short and long term. Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to the Cusum test, the equation would be stable (see Appendix 11) and formulated through Appendix 12.

Equation 7: Exports

Equation 7 reflects the relationship between imports, partner countries' income and the real exchange rate. All the information criteria argue for an optimal delay equal to one (see Appendix 13). With this optimal delay, we obtain an ARDL model (1,1,0) with a long-term relationship confirmed by the bounds test. There is thus a long-term relationship between exports, the income of partner countries and the real effective exchange rate in the CEMAC zone (see Annex 14), but the real effective exchange rate has a weak effect on exports in the short and long term, while the income of partner countries has greater short-term than long-term effects on exports. Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to the Cusum test, the equation would be stable (see Appendix 15) and formulated through Appendix 16.

Equation 8: Real Effective Exchange Rate

Equation 8 reflects the nominal exchange rate effect between the US dollar and the CFA franc on the real effective exchange rate of the CEMAC. Apart from the LR, which opts for an optimal delay of four, all the information criteria argue for an optimal delay equal to one (see Appendix 17). With this optimal delay, we arrive at an ARDL model (1,1) with a long-term relationship confirmed by the terminal test. There is a long-term relationship between the real effective exchange rate and the nominal exchange rate between the US Dollar and the CFA franc in the CEMAC zone (see Appendix 18), and the short- and long-term effects of this nominal exchange rate are very significant. Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to the Cusum test, the equation would be stable (see Appendix 19) and formulated through Appendix 20.

Equation 9: Nominal Exchange Rate

Through equation 9, the aim is to capture the effect of the CEMAC and US real interest rate differential on the nominal exchange rate between the US dollar and the CFA franc. All the information criteria argue for an optimal delay of six (see Appendix 21). With this optimal delay, we arrive at an ARDL model (6.6) with a long-term relationship confirmed by the terminal test. There is a long-term relationship between the real effective exchange rate in the CEMAC zone and the nominal exchange rate between the US dollar and the CFA franc (see Appendix 22). Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to the Cusum test, the equation would be stable (see Appendix 23) and formulated through Appendix 24.

Equation 11: Public Consumption

Equation 11 highlights the link between fiscal policy and potential growth, and it is assumed that the CEMAC fiscal authorities increase public spending under conditions of full employment. All the information criteria argue for an optimal delay of four (see Appendix 25). With this optimal delay, we arrive at an ARDL model (1,4) with a long-term relationship confirmed by the bound test. There is a long-term relationship between the variation in public spending and potential GDP in the CEMAC zone (see Annex 26). Analysis of the residues shows that they are homoscedastic, non-autocorrelated and normal. According to the Cusum test, the equation would be stable (see Appendix 27) and formulated through Appendix 28.

Equation 14: Inflation

Equation 14 illustrates the determinants of inflation in the CEMAC zone (Bikai et al, 2016). Indeed, it would be a function of the change in the money supply and imported inflation, so we assume here that it is indeed a function of the currency change, the prices of imported commodities (energy and food) and the output gap. All the information criteria argue for an optimal delay of four (see Appendix 29). With this optimal delay, we arrive at an ARDL model (4,3,4,4,4) with a long-term relationship confirmed by the bounds test. There is a long-term relationship between inflation and its determinants in the CEMAC zone (see Annex 30), but these do not have a significant long-term effect, but rather considerable short-term effects. According to the Cusum test, the equation would be stable (see Appendix 31) and formulated through Appendix 32.

Equation 15: Domestic Nominal Interest Rate

Finally, equation 15 breaks down the standard Taylor rule by illustrating the fact that the fact that the domestic nominal interest rate, in this case the TIAO, would be a function of the inflation differential, the output gap and the long-run domestic nominal interest rate. All the information criteria argue for an optimal delay of four (see Annex 33). With this optimal delay, we arrive at an ARDL model (1,0,0,3) with a long¬term relationship confirmed by the bound test. There is a long-term relationship between the WAIR, the inflation differential, the output gap and the long-term domestic nominal interest rate (see Appendix 34), but these have no significant long-term effect apart from the long-term domestic nominal interest rate, but rather considerable short-term effects, except for the output gap, which has no significant short- and long¬term effect on the WAIR. According to the Cusum test, the equation would be stable (see Appendix 35) and formulated through Annex 36.

Verification of the Identification Condition

With regard to the ARDL models estimated above, we deduce a model with simultaneous equations formed by (18) endogenous variables and (42) exogenous variables.

Before estimating the above model, we first present the conditions for its identification. We focus here on the presentation of the necessary conditions of identification. Taking into account the number of endogenous and exogenous variables of the model, and therefore the size of the matrices in the matrix writing of the model, the sufficient conditions will be presented in the appendix.

Let g and k respectively be the number of endogenous variables and the number of exogenous variables contained in the model. It follows that g = 18 and k = 42. For an equation i, we denote by gi and ki the number of endogenous variables and the number of exogenous variables contained in equation i. In addition, ri will represent the number of non-exclusion restrictions on the parameters in equation i.

For an Equation I, the Identification is as Follows

- $g - 1 > g - g_i + k - k_i + r_i$ equation i is under-identified ;
- $g - 1 = g - g_i + k - k_i + r_i$ equation i is Just-identified ;
- $g - 1 < g - g_i + k - k_i + r_i$ equation i is over-identified ;

The results of the necessary conditions for the identification of the equations as well as the system are recorded in Table 3 :

Equation	g_i	k_i	r_i	g-1	$g - g_i + k - k_i + r_i$	Decision
Equation 1	5	0	4	17	57	Over-identified
Equation 2	3	0	2	17	57	Over-identified
Equation 3	3	0	2	17	57	Over-identified
Equation 4	2	1	0	17	55	Over-identified
Equation 5	3	2	0	17	53	Over-identified
Equation 6	3	2	0	17	53	Over-identified
Equation 7	2	3	0	17	53	Over-identified
Equation 8	2	2	0	17	54	Over-identified
Equation 9	2	12	0	17	44	Over-identified
Equation 10	3	0	2	17	57	Over-identified
Equation 11	1	7	1	17	51	Over-identified
Equation 12	2	2	1	17	55	Over-identified
Equation 13	2	1	1	17	56	Over-identified
Equation 14	2	22	0	17	34	Over-identified
Equation 15	3	5	0	17	50	Over-identified
Equation 16	1	2	2	17	57	Over-identified
Equation 17	3	0	2	17	57	Over-identified
Equation 18	1	2	2	17	57	Over-identified

Table 3: Results on the Model Identification Conditions

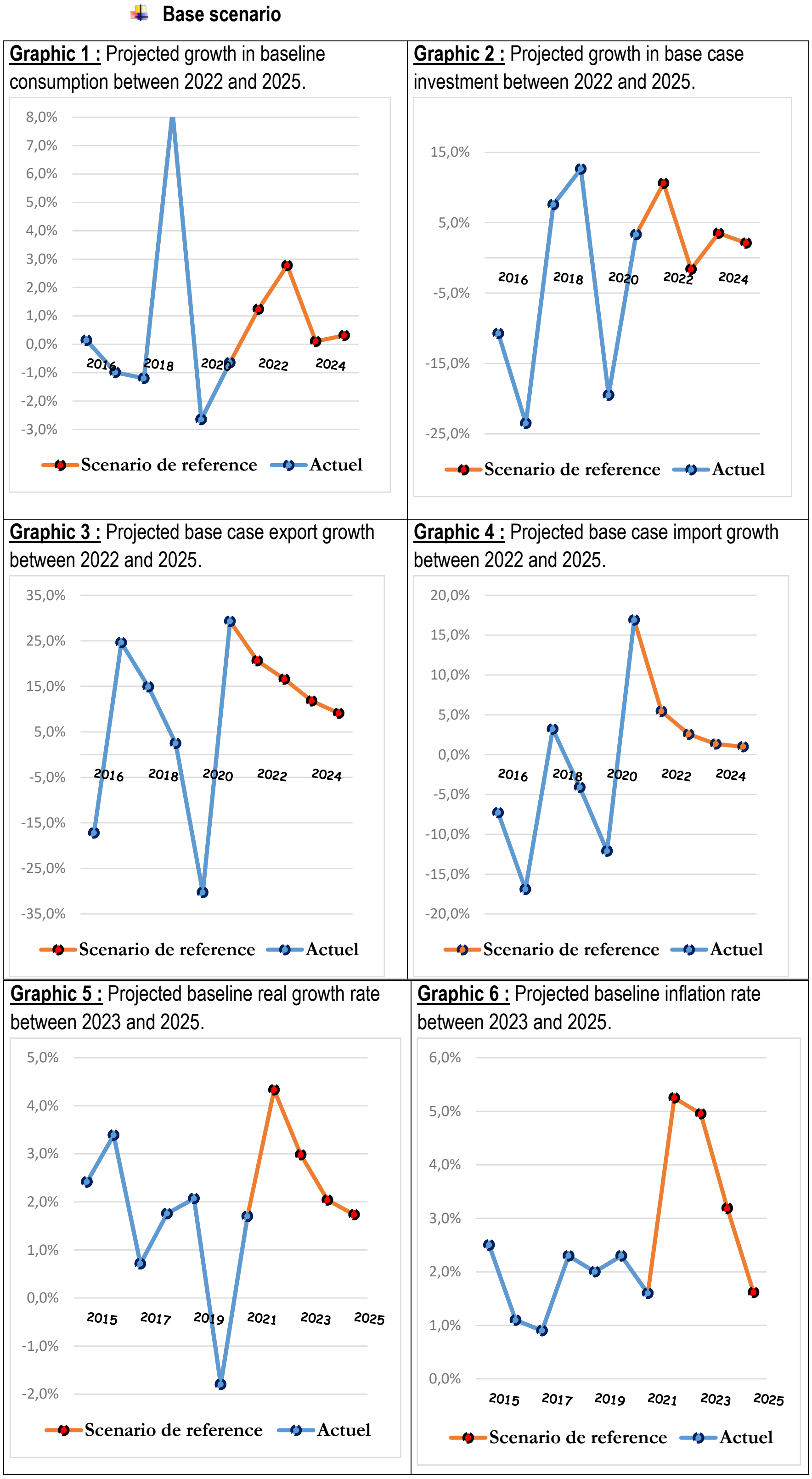
Source: Authors

It is clear from the table above that all the equations of the model are over-identified. It is deduced that the present system is over-identified, and therefore the method of double or triple least squares is suitable for its estimation. The estimates by this method provide the results below :

Results

Regarding the presentation of the results, we will focus on 06 main variables, namely consumption, investment, exports and imports in the first instance, then the 02 variables of interest which are real GDP and inflation, the different results will be presented by scenario.

Base Scenario



Graphic 1-6

Source: Authors

In this baseline scenario, without the Ukrainian conflict, economic activity would have grown at an average annual rate of 2.8% over the period 2022-2025 with a slowdown between 2023-2025, this performance would have been the result of the COVID effect that persists through the disruption of the supply markets for commodities (energy and food) and whose effects have just been amplified by the war in Ukraine. One would have thought that due to the rise in the price of oil, the CEMC would have been able to benefit, but unfortunately the positive effect would have been short-lived, i.e. for 2021 and 2022, but from 2023 onwards, there would have been a contraction in economic activity without the occurrence of this conflict. Regarding the components of demand, there was an average growth of 1.11%, 3.65%, 14.52% and 2.58% respectively for consumption, investment, exports and imports.

Scenario 1

Variables	Average growth	Deviation from baseline
Consumption	0,91%	-0,2%
Investment	2,43%	-1,22%
Exports	11,71%	-2,81%
Imports	2,02%	-0,56%
Real GDP	2,5%	-0,3%
CPI	4,5%	0,75%

Table 4: Effects of the Conflict Via the Rise in Commodity Prices Between 2022 and 2025

Source: Authors

According to Table 5, between 2022 and 2025, all components of demand will be in decline, mainly exports and investment. This will result in an average growth loss of 0.3%. Regarding inflation, there was an increase of 0.75% on average over the period.

Scenario 2

Reading Table 5 assesses the impact of the conflict via the increase in the Fed's key rate, which induces the depreciation of the nominal exchange rate between the US Dollar and the FCFA. Overall, not all the signals are red as in the first scenario, particularly for imports and investment, where there would be a lower performance, on the other hand for consumption and exports, performance would remain below the base scenario but lower than the first scenario. The result would be a decrease in average growth of 0.1% compared to the baseline scenario, and for the general price level, inflation is still more pronounced than the baseline scenario but lower than the first scenario.

Variables	Average growth	Deviation from baseline
Consumption	0,86%	-0,25%
Investment	3,83%	0,18%
Exports	12,71%	-1,81%
Imports	2,7%	0,12%
Real GDP	2,7%	-0,1%
CPI	4,0%	0,25%

Table 5: Effects of the Conflict Via the Increase in the Fed's Key Rate

Source : Authors

Summary of Results

In short, in the light of these analyses, it seems clear that both for the BEAC and the governments of the member states of the sub-region it is necessary to pay much more attention to the rise in commodity prices without neglecting the monetary policy of the Fed, which is not without effect on the CEMAC economy, although less so it could increase imports and further discourage consumption.

Conclusion and Economic Policy Recommendations

At the end of our work, it appears that this conflict induces, through the soaring prices of agricultural and energy raw materials, the depreciation of the CFA-dollar-USD exchange rate, supply and demand shocks that have an impact on the cost of living, the supply of basic food products, the functioning of companies and the public finances of member states, five of which are oil producers. In fact, all CEMAC countries will be impacted to varying degrees. . The 16th Ordinary Session of the CEMAC Economic and Financial Reform Program Monitoring Unit (Pref-CEMAC) was held on April 11 and 12, 2022 in Douala, Cameroon. The objectives of these meetings were to take stock of, among other things, the implementation of the decisions and recommendations of the Steering Committee (Copil); the economic and financial impacts of the war in Ukraine on the economies of the CEMAC and outlines of solutions; the import-substitution strategy of raw goods produced in the CEMAC; and the strengthening of the statistical systems of the CEMAC countries. Indeed, since its establishment by the Heads of State of the sub-region at the summit held in Malabo on July 30, 2016, the Pref-CEMAC has given overall positive results over the period 2017 to 2021. These results have enabled CEMAC economies to return to growth and be more resilient. As proof, the growth rate of the Community's real GDP is estimated at 1.4% in 2021 compared to -1.7% in 2020. But then, the CEMAC is now facing the negative impacts of the Russian-Ukrainian conflict. Based on a model with simultaneous equations on the real sector of the economy, this study shows that the effect of the conflict via commodity inflation (food and energy) would reduce growth forecasts in the CEMAC zone by -0.3% on average for the region to 2.5% on average between 2023 and 2025, while the effect of the conflict via the depreciation of the FCFA against the US dollar would reduce growth projections by an average of 0.1% in the CEMAC zone to 2.7% on average between 2023 and 2025. CEMAC states could put in place import/substitution procedures to reduce imported inflation and economic fragility caused by external dependence. They could accentuate the process of structural transformation in order to diversify their source of income, which would make their GDP more resilient to external shocks while seeking the optimum of the agricultural sector. Monetary authorities should consider measures to mitigate the shocks caused by the depreciation of the euro against currencies linked to fixed parity with the euro. A study on the particular case of Cameroon should be considered.

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Appendix

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-601.1122	NA	9.93e+14	40.20748	40.30089	40.23736
1	-513.9576	156.8783*	3.89e+12*	34.66384*	34.94408*	34.75349*
2	-513.4747	0.804772	4.94e+12	34.89831	35.36538	35.04773
3	-509.9304	5.434665	5.15e+12	34.92869	35.58258	35.13788
4	-505.1463	6.697637	4.99e+12	34.87642	35.71714	35.14538
5	-503.1038	2.587174	5.88e+12	35.00692	36.03447	35.33564

Appendix 1: Determining the Optimal Delay of the Equation 4

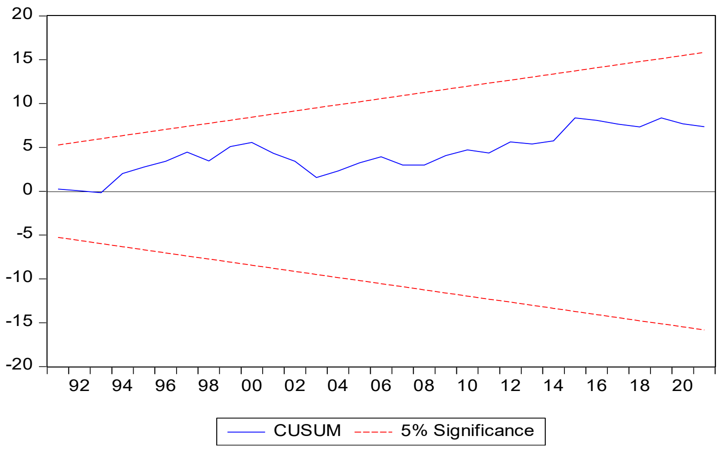
ARDL Bounds Test
Date: 04/11/23 Time: 02:38
Sample: 1988 2021
Included observations: 34
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	2.879258	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

Appendix 2: Bounding Equation Test 4



Appendix 3: Cusum Test of the Equation 4

Dependent Variable: CP
Method: ARDL
Date: 04/11/23 Time: 02:10
Sample (adjusted): 1988 2021
Included observations: 34 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): PIB_REEL
Fixed regressors: C
Number of models evalulated: 20
Selected Model: ARDL(1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CP(-1)	0.849015	0.107364	7.907819	0.0000
PIB_REEL	0.119821	0.083333	1.437852	0.1605
C	233.3232	766.5038	0.304399	0.7629

R-squared	0.961718	Mean dependent var	16615.68
Adjusted R-squared	0.959249	S.D. dependent var	8531.037
S.E. of regression	1722.160	Akaike info criterion	17.82464
Sum squared resid	91940888	Schwarz criterion	17.95932
Log likelihood	-300.0189	Hannan-Quinn criter.	17.87057
F-statistic	389.3933	Durbin-Watson stat	1.999139
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 4: Specification of the Equation 4

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-530.1391	NA	5.48e+11	35.54260	35.68272	35.58743
1	-441.2335	154.1031*	2.67e+09*	30.21556*	30.77604*	30.39487*
2	-438.4349	4.291147	4.13e+09	30.62899	31.60983	30.94277
3	-435.2078	4.302760	6.40e+09	31.01385	32.41505	31.46211
4	-430.1484	5.734040	9.24e+09	31.27656	33.09811	31.85929
5	-419.4135	10.01924	9.90e+09	31.16090	33.40281	31.87811

Appendix 5: Determining the Optimal Delay of the Equation 5

Source: : Authors

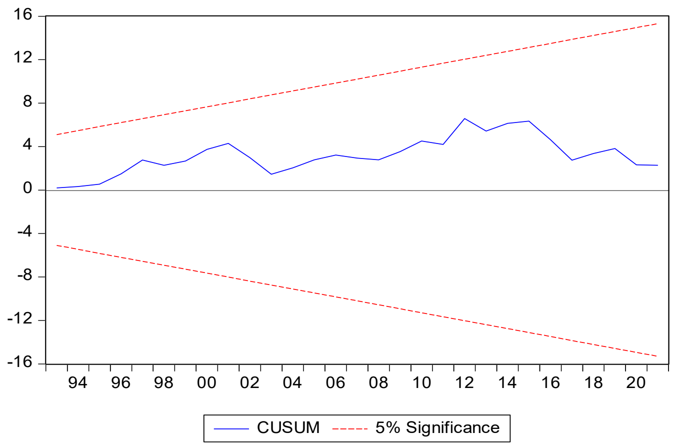
ARDL Bounds Test
Date: 04/11/23 Time: 03:55
Sample: 1988 2021
Included observations: 34
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	1.405849	2

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.63	3.35
5%	3.1	3.87
2.5%	3.55	4.38
1%	4.13	5

Appendix 6: Bounding Equation Test 5



Appendix 7: CUSUM Test of the Equation 5

Dependent Variable: IP
Method: ARDL
Date: 04/11/23 Time: 03:41
Sample (adjusted): 1988 2021
Included observations: 34 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): PIB_REEL TIRD
Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(1, 1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
IP(-1)	0.735191	0.127445	5.768671	0.0000
PIB_REEL	0.367855	0.224681	1.637234	0.1124
PIB_REEL(-1)	-0.334911	0.209762	-1.596621	0.1212
TIRD	-7906.946	4220.641	-1.873399	0.0711
C	1338.424	597.3654	2.240545	0.0329

R-squared	0.913482	Mean dependent var	7515.088
Adjusted R-squared	0.901549	S.D. dependent var	3353.936
S.E. of regression	1052.362	Akaike info criterion	16.89051
Sum squared resid	32116477	Schwarz criterion	17.11498
Log likelihood	-282.1387	Hannan-Quinn criter.	16.96706
F-statistic	76.54797	Durbin-Watson stat	1.956464
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 8: Specification of the Equation 5

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-690.8004	NA	2.46e+16	46.25336	46.39348	46.29818
1	-582.0344	188.5276*	3.19e+13*	39.60230*	40.16277*	39.78160*
2	-579.4182	4.011569	4.99e+13	40.02788	41.00872	40.34166
3	-574.8321	6.114796	7.06e+13	40.32214	41.72334	40.77040
4	-563.4295	12.92292	6.68e+13	40.16197	41.98352	40.74470
5	-554.0246	8.777904	7.82e+13	40.13498	42.37689	40.85218

Appendix 9: Determining the Optimal Delay of the Equation 6

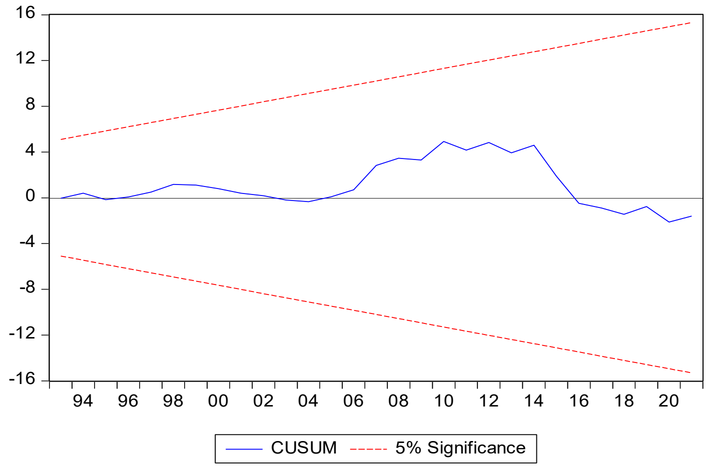
ARDL Bounds Test
Date: 04/11/23 Time: 04:13
Sample: 1988 2021
Included observations: 34
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	0.818516	2

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.63	3.35
5%	3.1	3.87
2.5%	3.55	4.38
1%	4.13	5

Appendix 10: Bounding Equation Test 6



Appendix 11: Cusum Test of the Equation 6

Dependent Variable: IMPORTATION
Method: ARDL
Date: 04/11/23 Time: 04:12
Sample (adjusted): 1988 2021
Included observations: 34 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): PIB_REEL ITCER
Fixed regressors: C
Number of models evalulated: 100
Selected Model: ARDL(1, 1, 0)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
IMPORTATION(-1)	0.841569	0.110001	7.650563	0.0000
PIB_REEL	0.359735	0.200557	1.793679	0.0833
PIB_REEL(-1)	-0.337315	0.195637	-1.724192	0.0953
ITCER	11.62744	16.85293	0.689936	0.4957
C	-381.1506	1405.097	-0.271263	0.7881

R-squared	0.934529	Mean dependent var	8774.875
Adjusted R-squared	0.925499	S.D. dependent var	3716.963
S.E. of regression	1014.543	Akaike info criterion	16.81732
Sum squared resid	29849633	Schwarz criterion	17.04178
Log likelihood	-280.8944	Hannan-Quinn criter.	16.89387
F-statistic	103.4861	Durbin-Watson stat	1.888407
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 12 : Specification of the Equation 6

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-923.6065	NA	1.35e+23	61.77377	61.91389	61.81859
1	-826.9079	167.6109*	3.92e+20*	55.92719*	56.48767*	56.10649*
2	-823.7326	4.868782	5.91e+20	56.31551	57.29634	56.62929
3	-816.5350	9.596781	7.03e+20	56.43567	57.83686	56.88392
4	-806.0118	11.92633	7.05e+20	56.33412	58.15568	56.91685
5	-799.4674	6.108079	9.99e+20	56.49783	58.73974	57.21504

Appendix 13: Determining the Optimal Delay of the Equation 7

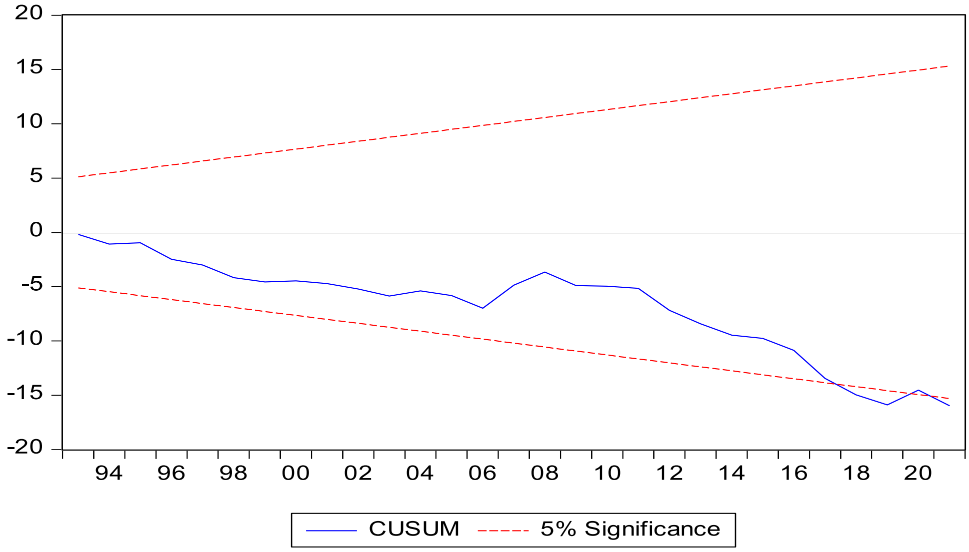
ARDL Bounds Test
Date: 04/11/23 Time: 04:59
Sample: 1988 2021
Included observations: 34
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	1.857090	2

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.63	3.35
5%	3.1	3.87
2.5%	3.55	4.38
1%	4.13	5

Appendix 14: Bounding Equation Test 7



Appendix 15: Cusum Test of the Equation 7

Dependent Variable: EXPORTATION
Method: ARDL
Date: 04/11/23 Time: 04:57
Sample (adjusted): 1988 2021
Included observations: 34 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): PIB_PARTENAIRES ITCER
Fixed regressors: C
Number of models evalulated: 4
Selected Model: ARDL(1, 1, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
EXPORTATION(-1)	0.805468	0.121878	6.608807	0.0000
PIB_PARTENAIRES	0.000477	0.000212	2.255778	0.0318
PIB_PARTENAIRES(-1)	-0.000495	0.000224	-2.211170	0.0351
ITCER	-15.42230	29.48285	-0.523094	0.6049
C	2291.203	2782.348	0.823478	0.4170

R-squared	0.636077	Mean dependent var	5466.775
Adjusted R-squared	0.585881	S.D. dependent var	2963.632
S.E. of regression	1907.159	Akaike info criterion	18.07967
Sum squared resid	1.05E+08	Schwarz criterion	18.30413
Log likelihood	-302.3544	Hannan-Quinn criter.	18.15622
F-statistic	12.67181	Durbin-Watson stat	2.169345
Prob(F-statistic)	0.000004		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 16: Specification of the Equation 7

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-269.8561	NA	254749.5	18.12374	18.21715	18.15362
1	-245.5719	43.71165	65975.88*	16.77146*	17.05170*	16.86111*
2	-243.5255	3.410658	75525.17	16.90170	17.36876	17.05112
3	-241.4827	3.132313	87023.78	17.03218	17.68607	17.24136
4	-234.4313	9.871838*	72481.03	16.82876	17.66947	17.09771
5	-233.3657	1.349770	91146.87	17.02438	18.05193	17.35310

Appendix 17: Determining the Optimal Delay of the Equation 8

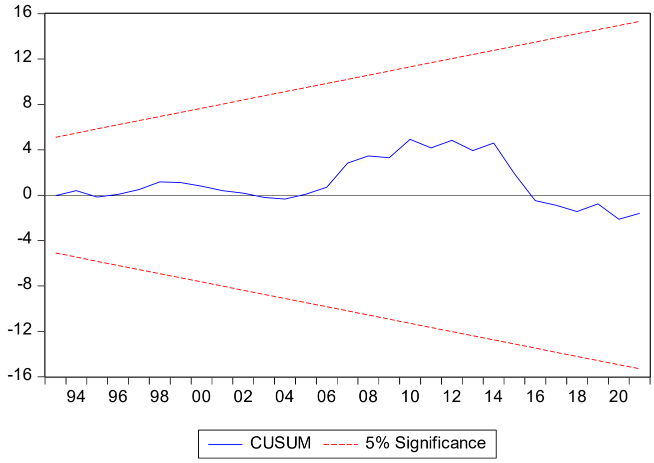
ARDL Bounds Test
Date: 04/11/23 Time: 02:38
Sample: 1988 2021
Included observations: 34
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	2.879258	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

Appendix 18: Bounding Equation Test 8



Appendix 19: Cusum Test of the Equation 8

Dependent Variable: ITCER
Method: ARDL
Date: 04/11/23 Time: 05:36
Sample (adjusted): 1988 2021
Included observations: 34 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): TCN
Fixed regressors: C
Number of models evaluated: 2
Selected Model: ARDL(1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
ITCER(-1)	0.741277	0.115703	6.406714	0.0000
TCN	0.058838	0.012955	4.541683	0.0001
TCN(-1)	-0.043674	0.014220	-3.071315	0.0045
C	17.40724	5.768393	3.017693	0.0052

R-squared	0.901516	Mean dependent var	95.54459
Adjusted R-squared	0.891667	S.D. dependent var	12.96746
S.E. of regression	4.268101	Akaike info criterion	5.850346
Sum squared resid	546.5006	Schwarz criterion	6.029918
Log likelihood	-95.45588	Hannan-Quinn criter.	5.911585
F-statistic	91.53909	Durbin-Watson stat	2.560150
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 20: Specification of the Equation 8

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-111.3812	NA	11.27925	8.098658	8.193816	8.127749
1	-88.52448	40.81561	2.937755	6.751748	7.037221	6.839020
2	-77.11526	18.74372	1.741079	6.222518	6.698306	6.367971
3	-72.96740	6.221789	1.746920	6.211957	6.878059	6.415591
4	-67.43543	7.507676	1.606439	6.102530	6.958948	6.364346
5	-59.25698	9.930967	1.243070	5.804070	6.850802	6.124067
6	-49.23355	10.73939*	0.862407*	5.373825*	6.610872*	5.752002*
7	-46.03346	2.971510	1.004863	5.430961	6.858323	5.867320

Appendix 21 : Determining the Optimal Delay of the Equation 9

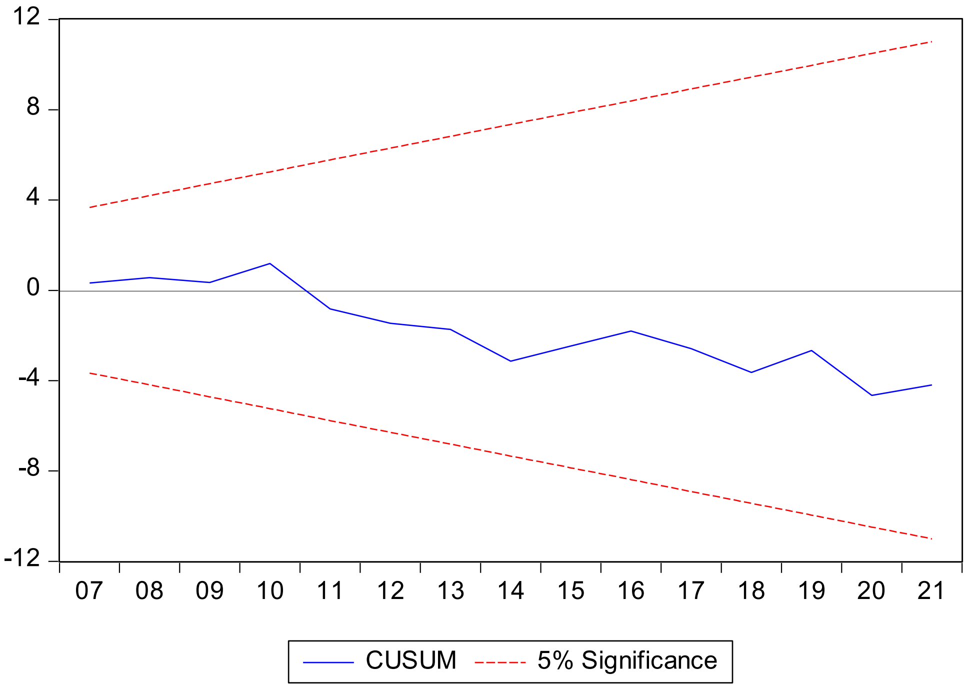
ARDL Bounds Test
Date: 04/11/23 Time: 06:21
Sample: 1993 2021
Included observations: 29
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	8.659393	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

Appendix 22: Bounding Equation Test 9



Appendix 23: Cusum Test of the Equation 9

Dependent Variable: TCN
Method: ARDL
Date: 04/11/23 Time: 06:19
Sample (adjusted): 1993 2021
Included observations: 29 after adjustments
Maximum dependent lags: 6 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (6 lags, automatic): DIFF_INT
Fixed regressors: C
Number of models evalulated: 42
Selected Model: ARDL(6, 6)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TCN(-1)	0.777927	0.195710	3.974897	0.0012
TCN(-2)	-0.067213	0.257779	-0.260739	0.7978
TCN(-3)	-0.010110	0.209728	-0.048208	0.9622
TCN(-4)	-0.020215	0.201069	-0.100537	0.9212
TCN(-5)	0.343860	0.201529	1.706258	0.1086
TCN(-6)	-0.478375	0.141161	-3.388872	0.0040
DIFF_INT	-899.7250	173.3640	-5.189803	0.0001
DIFF_INT(-1)	108.9427	225.7568	0.482567	0.6364
DIFF_INT(-2)	-170.3884	193.2759	-0.881581	0.3919
DIFF_INT(-3)	-480.2230	200.2376	-2.398266	0.0299
DIFF_INT(-4)	127.1005	195.1803	0.651195	0.5248
DIFF_INT(-5)	-171.9148	184.0597	-0.934016	0.3651
DIFF_INT(-6)	-431.9222	187.4858	-2.303760	0.0360
C	294.4048	57.97899	5.077784	0.0001

R-squared	0.942658	Mean dependent var	549.8292
Adjusted R-squared	0.892961	S.D. dependent var	91.96390
S.E. of regression	30.08768	Akaike info criterion	9.952380
Sum squared resid	13579.02	Schwarz criterion	10.61245
Log likelihood	-130.3095	Hannan-Quinn criter.	10.15911
F-statistic	18.96820	Durbin-Watson stat	2.491465
Prob(F-statistic)	0.000001		

Appendix 24 : Specification of the Equation 9

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-522.1740	NA	1.72e+13	36.14993	36.24423	36.17946
1	-423.0168	177.7991	2.43e+10	29.58737	29.87026	29.67596
2	-359.9876	104.3242	4.17e+08	25.51639	25.98787	25.66405
3	-317.2762	64.80347	29218630	22.84664	23.50671	23.05336
4	-293.7682	32.42486*	7785932.*	21.50125*	22.34992*	21.76705*
5	-290.1900	4.441887	8321601.	21.53035	22.56760	21.85520

Appendix 25: Determining the Optimal Delay of the Equation 11

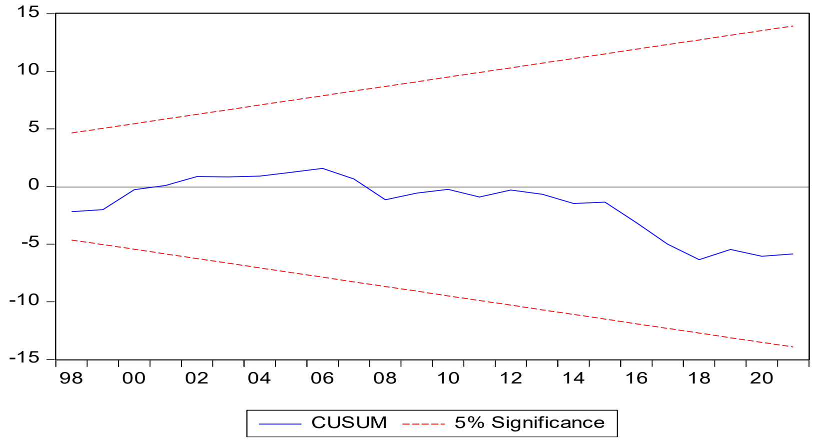
ARDL Bounds Test
Date: 04/11/23 Time: 08:24
Sample: 1991 2021
Included observations: 31
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	17.79769	1

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.02	3.51
5%	3.62	4.16
2.5%	4.18	4.79
1%	4.94	5.58

Appendix 26 : Bounding Equation Test 11



Appendix 27: CUSUM Test of the Equation 11

Dependent Variable: D(CG)
Method: ARDL
Date: 04/11/23 Time: 08:26
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
Maximum dependent lags: 5 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (5 lags, automatic): PIB_POT
Fixed regressors: C
Number of models evalulated: 30
Selected Model: ARDL(1, 4)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D(CG(-1))	-0.108220	0.157165	-0.688576	0.4977
PIB_POT	-29.93111	10.69935	-2.797469	0.0100
PIB_POT(-1)	129.6516	40.28014	3.218747	0.0037
PIB_POT(-2)	-213.0913	59.20760	-3.599052	0.0014
PIB_POT(-3)	157.5931	40.36793	3.903918	0.0007
PIB_POT(-4)	-44.25713	10.75903	-4.113486	0.0004
C	415.4270	344.8644	1.204610	0.2401

R-squared	0.447298	Mean dependent var	158.0716
Adjusted R-squared	0.309123	S.D. dependent var	406.2363
S.E. of regression	337.6597	Akaike info criterion	14.67763
Sum squared resid	2736337.	Schwarz criterion	15.00144
Log likelihood	-220.5033	Hannan-Quinn criter.	14.78319
F-statistic	3.237176	Durbin-Watson stat	2.273128
Prob(F-statistic)	0.017856		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 28: Specification of the Equation 11

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-104.2479	NA	0.001002	7.283195	7.516728	7.357904
1	-48.22598	89.63512	0.000130	5.215065	6.616263*	5.663320
2	-24.02907	30.64941	0.000160	5.268605	7.837467	6.090406
3	2.636436	24.88781	0.000221	5.157571	8.894097	6.352918
4	68.13296	39.29791*	4.28e-05*	2.457803*	7.361994	4.026696*

Appendix 29: Determining the Optimal Delay of the Equation 14

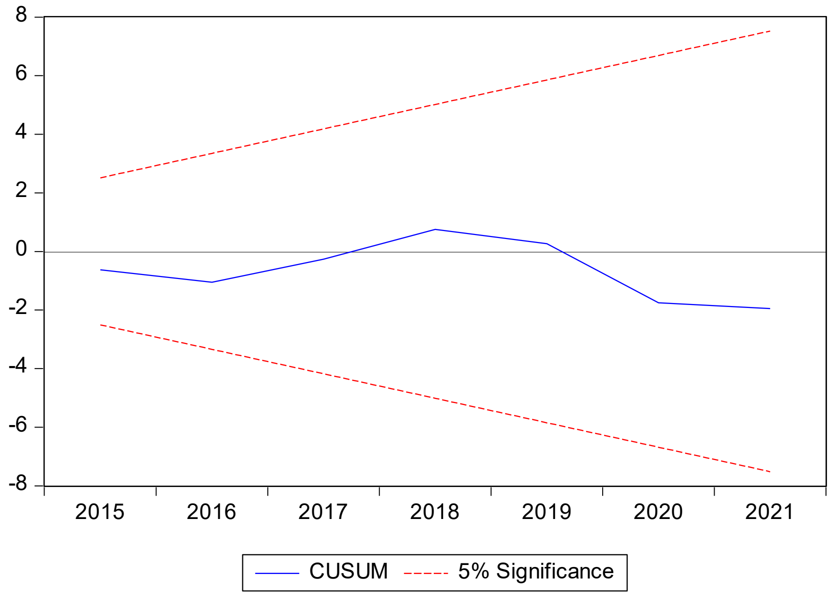
ARDL Bounds Test
Date: 04/11/23 Time: 08:50
Sample: 1991 2021
Included observations: 31
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	0.975736	4

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Appendix 30: Bound Equation Test 14



Appendix 31: CUSUM Test of the Equation 14

Dependent Variable: INFLATION
Method: ARDL
Date: 04/11/23 Time: 08:48
Sample (adjusted): 1991 2021
Included observations: 31 after adjustments
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (4 lags, automatic): TCM EP INDISCE_PB_E INDISCE_PB_NE
Fixed regressors: C
Number of models evalulated: 2500
Selected Model: ARDL(4, 3, 4, 4, 4)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
INFLATION(-1)	0.570855	0.408627	1.397009	0.2051
INFLATION(-2)	0.325071	0.386831	0.840344	0.4285
INFLATION(-3)	-0.126022	0.251880	-0.500324	0.6322
INFLATION(-4)	0.191237	0.232600	0.822170	0.4381
TCM	0.649673	0.177919	3.651512	0.0082
TCM(-1)	-0.285466	0.255660	-1.116587	0.3010
TCM(-2)	-0.122796	0.154066	-0.797037	0.4516
TCM(-3)	0.050477	0.132525	0.380891	0.7146
EP	0.780810	0.291420	2.679328	0.0316
EP(-1)	-0.494710	0.297733	-1.661591	0.1405
EP(-2)	0.398310	0.265418	1.500691	0.1771
EP(-3)	-0.140550	0.254770	-0.551674	0.5983
EP(-4)	0.257106	0.212240	1.211394	0.2650
INDISCE_PB_E	-0.001067	0.000783	-1.362045	0.2154
INDISCE_PB_E(-1)	0.002128	0.000969	2.197161	0.0640
INDISCE_PB_E(-2)	-0.002498	0.001270	-1.967566	0.0898
INDISCE_PB_E(-3)	0.002828	0.001157	2.443371	0.0445
INDISCE_PB_E(-4)	-0.002371	0.001124	-2.110610	0.0727
INDISCE_PB_NE	-0.001599	0.003363	-0.475413	0.6490
INDISCE_PB_NE(-1)	0.001855	0.005227	0.354921	0.7331
INDISCE_PB_NE(-2)	0.002839	0.005013	0.566241	0.5889
INDISCE_PB_NE(-3)	-0.006693	0.003874	-1.727683	0.1277
INDISCE_PB_NE(-4)	0.005939	0.002603	2.281428	0.0565
C	-0.145759	0.100791	-1.446158	0.1914

R-squared	0.859947	Mean dependent var	0.029503
Adjusted R-squared	0.399772	S.D. dependent var	0.039563
S.E. of regression	0.030651	Akaike info criterion	-4.072003
Sum squared resid	0.006576	Schwarz criterion	-2.961819
Log likelihood	87.11605	Hannan-Quinn criter.	-3.710111
F-statistic	1.868741	Durbin-Watson stat	2.075519
Prob(F-statistic)	0.201053		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix 32: Specification of the Equation 14

Lag	LogL	LR	FPE	AIC	SC	HQ
0	291.3030	NA	5.65e-14	-19.15353	-18.96671	-19.09377
1	408.9512	196.0804	6.52e-17	-25.93008	-24.99595	-25.63124
2	518.8947	153.9208	1.32e-19	-32.19298	-30.51154	-31.65507
3	549.7803	35.00372	5.81e-20	-33.18535	-30.75661	-32.40838
4	1082.882	462.0211*	8.91e-35*	-67.65877*	-64.48272*	-66.64272*

Appendix 33: Determining the Optimal Delay of the Equation 15

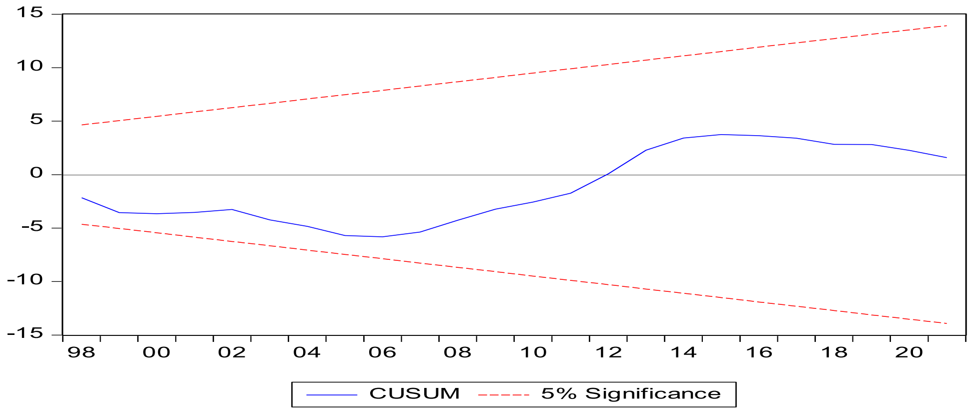
ARDL Bounds Test
Date: 04/11/23 Time: 09:43
Sample: 1990 2021
Included observations: 32
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	k
F-statistic	18.69029	3

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	2.37	3.2
5%	2.79	3.67
2.5%	3.15	4.08
1%	3.65	4.66

Appendix 34: Bounding Equation Test 15



Appendix 35: Cusum Test of the Equation 15

Dependent Variable: TIAO
Method: ARDL
Date: 04/11/23 Time: 09:28
Sample (adjusted): 1990 2021
Included observations: 32 after adjustments
Maximum dependent lags: 3 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (3 lags, automatic): EC EP TIR_LT
Fixed regressors: C
Number of models evaluated: 192
Selected Model: ARDL(1, 0, 0, 3)
Note: final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
TIAO(-1)	-0.922776	0.259653	-3.553886	0.0016
EC	-0.045229	0.031198	-1.449756	0.1601
EP	-0.003642	0.015189	-0.239748	0.8126
TIR_LT	-112.6582	16.87845	-6.674678	0.0000
TIR_LT(-1)	286.8307	42.75278	6.709055	0.0000
TIR_LT(-2)	-236.3107	37.32093	-6.331856	0.0000
TIR_LT(-3)	63.62962	11.65846	5.457806	0.0000
C	0.017263	0.004713	3.662499	0.0012

R-squared	0.985435	Mean dependent var	0.058979
Adjusted R-squared	0.981188	S.D. dependent var	0.026017
S.E. of regression	0.003568	Akaike info criterion	-8.221085
Sum squared resid	0.000306	Schwarz criterion	-7.854651
Log likelihood	139.5374	Hannan-Quinn criter.	-8.099623
F-statistic	231.9774	Durbin-Watson stat	1.903245

Appendix 36 : Specification of the Equation 15