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Effects of exchange relative prices on macroeconomic stability in sub-Saharan African countries

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Abstract. *This paper analyzes the effects of relative prices on macroeconomic stability in sub-Saharan African countries by considering inflation, real effective exchange rate, government deficit, and a composite index of macroeconomic stability using techniques combining a panel Vector Autoregressive (VAR) and the generalized method of moments (GMM) for 30 countries over the period 1991-2017. The results show that the terms of trade (external relative prices) have positive effects on the real exchange rate, the reduction of the public deficit, and on macroeconomic stability in general. Impulse response function analysis and variance decomposition confirm these different results.*

Keywords: sub-Saharan Africa, relative prices, macroeconomic stability, economic growth, terms of trade.

JEL Classification: B22, F43, O11, E0, F0.

Introduction

It is generally recognized that trade can be a powerful driver for any economic development of countries and any sustainable prosperity is not possible without trade (Chnaina, 2013). However, achieving strong growth and economic development requires that one strong condition be met: macroeconomic stability. The dominant literature argues that macroeconomic stability is necessary for good economic performance with a negative relationship between volatility and economic growth. Thus, improving macroeconomic stability enables low-income countries to achieve robust and sustainable growth over the medium term (IMF, 2014). For example, improved macroeconomic stability through better economic policies is among the factors that have contributed to the recent growth acceleration in fragile countries(1). Fisher (1991) concluded that macroeconomic stability is necessary to support sustainable growth and subsequently lead to good economic performance. Therefore, the traditional trade theory that advocates the benefits of specialization that brings comparative advantage can only produce the beneficial effects for nations in a stable macroeconomic environment. For Aizenman and Pinto (2005), and Hnatkovska & Loayza, (2005), a stable macroeconomic environment is necessary to support sustainable growth and good economic performance.

For African countries, however, dependence on commodities for exports is a source of vulnerability to the vagaries of the international market that can affect the fundamentals of economic development. Indeed, African exports in general and those of sub-Saharan Africa in particular are essentially composed of primary products, with manufactured goods still marginal and high-tech products residual.

Thus, this price instability can affect several variables that determine the macroeconomic stability of these countries through relative prices and, more particularly, the terms of trade. As a reminder, macroeconomic stability essentially aims at price stability (notably the reduction of inflation), fiscal consolidation (the reduction of public deficits and debt) and external payments stability (exchange rate stability) (Diarra, 2014). Burnside and Dollar (2004) consider in their model of macroeconomic stability three elements that are necessary and of primary importance in the measurement of macroeconomic stability. These are the budget surplus, the inflation rate and the openness rate.

In the Economic Report on Africa 2017, the Economic Commission for Africa (ECA, United Nations) stated that "the decline in commodity prices since 2014 has weighed on the current account and government revenues, as well as on national currencies, and created inflationary pressures" in SSA. In SSA, the widening fiscal deficits of oil-exporting countries in general are partly due to low export commodity (especially oil) prices. Indeed, it increased from 6.2 percent to 6.5 percent of GDP in 2016 while oil-importing countries experienced a slight reduction in their deficits from 5.6 percent to 5.5 percent of GDP (ECA, 2017). These facts can illustrate the influence of the international trade environment

on the economies of African countries through the price mechanism (appendix 1). In most cases, years with rising (respectively falling) terms of trade also have rising (respectively falling) inflation and real exchange rate, and falling (respectively rising) budget deficits. For the Economic Commission for Africa (ECA, 2017), in some SSA countries the decline in inflation is attributable to lower prices for imported food, fuel, and industrial raw materials. In oil-exporting SSA countries, the fall in oil prices in 2014-15 led to pronounced external imbalances. Current account deficits have narrowed to about 1 percent of GDP on average in 2018, partly due to improvements in the terms of trade. The median current account deficit in SSA fell from 7.9 percent in 2016 to 6.3 percent in 2017 thanks to the recovery in commodity prices. Shocks that can affect macroeconomic stability variables can be internal or external. We focus on external shocks such as instability in world commodity prices and terms of trade fluctuations.

Thus, this paper seeks to analyze the effects of these relative prices (using relative prices of foreign trade) on the fundamentals of economic growth, particularly macroeconomic stability, by considering the three stability variables mentioned above and a composite stability index constructed for this purpose. It will therefore be a matter of testing the hypothesis that an improvement in relative trade prices promotes macroeconomic stability. The notion of relative prices can be defined in different ways. One can focus on the international comparison of the level or variation of prices or costs, but it is also possible to narrow the analysis to the internal price relationship between internationally tradable goods (Combes and Plane, 2007). Jäggi and Parnisari (2006) represented relative prices by terms of trade(2). For them, the use of the terms of trade ensures that the adjustment of export and import prices is taken into account. They argue that the results obtained using the terms of trade are certainly more correct in terms of long-term economic logic. This is the option we adopt in this paper.

I. Literature review

1. Theoretical aspects

This section addresses the theoretical aspects and summarizes some previous work on the theoretical level. It first addresses the theoretical foundations of stabilization, then the theoretical aspects of relative prices and finally the review of theoretical literature.

1.1. Theoretical foundations of stabilization

As mentioned earlier, we use inflation, real exchange rates and budget deficits as indicators of macroeconomic stability. Changes in any of these variables affect macroeconomic stability. Theoretically, most work on relative trade prices does not take into account their influence on the fundamentals of the economy. In fact, the link between relative prices and economic variables has been the subject of several controversial results, but these results

may depend on how relative prices affect macroeconomic stability, a necessary condition for achieving sustainable economic growth and development(3). Fluctuations in commodity export prices make developing countries more vulnerable to economic instability because instability is a result of the degree of exposure to economic shocks and the magnitude of those shocks (Guillaumont and Brun, 1999).

1.2. Relative Prices and Inflation

In the history of inflation, Friedman (1968) can be cited as one of the major theorists of anti-inflationary policies whose sole purpose is to ensure price stability. According to Friedman, a central bank cannot be effective on real variables because monetary policy only affects nominal variables (nominal interest rates or the price level) in levels or growth rates. On the theoretical level, inflation is often approached using New Keynesian Phillips curves. New Keynesian Phillips curves, which present current inflation as a linear function of expected inflation and the output gap, are the most widely used in price forecasting approaches(4). To correct for the fact that this formulation of inflation does not take into account the lagged value, Kozicki and Tinsley (2002) include lagged values of inflation in the basic model. Later, other economists, notably Atkeson and Ohanion (2001), proposed taking into account other variables influencing the short-term dynamics of prices.

1.3. Relative prices and public deficit

A budget deficit is a negative balance in the government budget. It is a situation of imbalance where the amount of revenue is less than the amount of expenditure. This situation is defended by Keynesians as a means of stimulating the economy. Indeed, the Keynesian theory considers the state budget as the main and most efficient lever of economic policy. In order to get out of the sub-optimal situation of the economy, Keynes proposes the fiscal policy which consists in using the budget deficit for the purpose of stimulating and regulating economic activities. The effectiveness of this policy is based on the multiplier principle.

For classical theory, the macroeconomic equilibrium is a general equilibrium that has characteristics among which all markets are interdependent through the mechanisms of relative price adjustment. Raffmot (1991), referring to the impact of a devaluation on the public finances of developing countries, already admitted that budgetary revenues linked to foreign trade increase because of the increase in export prices (thus a change in relative prices) and that the movement in relative prices could slow down the volume of imports and reduce the advantage at this level. For him, from the point of view of debt development, it is the instability of export earnings that is the real danger, not their possible trend decline. This situation therefore shows a possible link between external relative prices and public deficit.

1.4. Relative external prices and the real exchange rate

According to the work of Balassa (1964) and Samuelson (1964), the real exchange rate depends on the relative price of non-tradable goods, which in turn depends on productivity differentials. Thus, productivity differentials are a determinant of real exchange rates. The Balassa effect (Balassa, 1964), in seeking to explain why fast-growing developing countries have a real exchange rate that tends to appreciate continuously, contrary to the conclusions of PPP theory, laid the foundations for a distinction between two sectors in the economy: an exposed sector that produces tradable goods, and a sheltered sector that produces non-tradable goods. In calculating ERER, it is often recommended that data be used for all goods and services exposed to international competition, which are referred to as "tradable goods and services". This is because changes in the real exchange rate influence economic activity mainly through their impact on the competitiveness of the tradable goods and services sector(5).

Another approach to relative prices is the terms of trade. Indeed, the international terms of trade can reflect the quality of economic specialization in international trade. Tensions over the price of oil and the sequences of appreciation or deterioration in commodity prices have led to greater consideration of relative price movements (the ratio of the price of exports to the price of imports), which were ignored as determinants of the fundamental equilibrium exchange rate until the early 1970s (Combes and Plane, 2007).

2. Empirical elements

This section summarizes some previous empirical work by focusing on our variables of interest used for macroeconomic stability.

2.1. Relative prices and inflation

Commodity prices experience peaks and troughs that can have significant effects on African countries in a variety of ways. Doe and Diallo (1997), find that imported inflation, the real interest rate differential, the relative price of imported goods, and government current expenditure explain inflation in this area. Also, Kinda (2011) found that rainfall and foreign price fluctuations helped explain inflation in Chad. Boussemart (1979), for his part, shows that the relative prices of foreign trade (terms of trade) of industrialized countries have deteriorated, creating inflationary pressures with the rise in the prices of crude oil and other commodities, and the balances of payments have worsened. Sonja and al (2006) investigate whether economic instability has increased or decreased over time in two groups of countries and whether developed countries are more stable than developing countries and find that higher terms of trade limit the volatility of Gross Domestic Product (GDP) as well as inflation and the fiscal deficit for these groups of countries. External factors such as trade or private capital flows are negligible and therefore cannot be seen to have increased economic instability. For some, in the short run, changes in commodity

prices influence inflation (Fischer and al, 2002; Diouf, 2007). Also, Simpasa and Gurara (2011), identify world food and oil prices, domestic production, monetary, fiscal and exchange rate policies as the main determinants of inflation in East African countries. Caceres and al. (2011) showed that traded commodity prices (food and oil) affect the dynamics of non-monetary inflation for a while but their impact declines over time while fluctuations in the prices of food commodities such as wheat, maize, rice, palm oil and sugar explain between 10 and 15 percent of price changes in Central Africa.

Andrews and Rees (2009) highlight the role of the terms of trade in macroeconomic instability using panel data from seventy-one countries. They find that a one standard deviation increase in terms of trade volatility increases output volatility and inflation volatility by 1.1 and 1.2 percentage points, respectively. Moreover, using a panel VAR model from 1990 to 2014, Bikai and al. (2016) show that money supply and imported inflation resulting from the increase in the general price level of imported goods are the main determinants of inflation in the CEMAC.

A significant part of the literature views terms-of-trade shocks as an important source of real uncertainty in economies based primarily on commodity exports.

2.2. Relative prices and the government deficit

If SSA countries use external debt to finance their imports, these economies have to service the debt. Commodity prices that spike (or surge) followed by longer troughs (or crashes) can have a significant impact on African countries, as export earnings are one of the main determinants of balance of payments and external debt (United Nations, 2003)[(6)]. Also, fluctuations in commodity prices are said to be at the root of large trade deficits that have to be financed in part by increased external borrowing, which would worsen the external debt of developing countries (United Nations, 2003

Several other elements in the literature tend to point to a positive link between the relative prices of products exported (terms of trade) by African countries and their public deficits. Some of the authors mentioned above on inflation have at the same time addressed deficit issues. External factors such as trade or private capital flows are negligible and therefore cannot be seen to have increased economic instability. The ECOWAS Commission (2013) made the link between budget deficit and export earnings in Sub-Saharan Africa. Indeed, the budget deficit which increased from 1.2% in 2011 to 1.8% in 2012 is linked to the reduction in the surplus of oil exporting countries, which stood at 2.7% of GDP in 2012 against 3.5% of GDP in 2011. Since relative external prices (REPs) are a determinant of export earnings, the widening of fiscal deficits would be partly related to a change in relative prices. The SSA region is highly vulnerable to terms-of-trade shocks, which affect current external balances through the trade balance. For example, a change in commodity terms of trade of 1 percent translates into a change in the trade balance of 0.3 percent to 0.6 percent of GDP (IMF, 2019). As for the fiscal deficit, it is around 3.2 percent of GDP in

2019, a worsening of the fiscal situation especially in oil-exporting countries, which now expect to see their oil revenues fall sharply as a result of lower relative prices.

2.3. Relative Prices and the Real Exchange Rate

Studies on the real exchange rate have been the subject of much research for decades and the role of relative prices has often been discussed.

Using the error correction model (ECM) technique with a three-step procedure: order of integration, estimation (Engle, Granger, Johansen) and calculation of the RER, Baffes, and al (1999) in their study of Côte d'Ivoire and Burkina Faso find that the fundamentals that influence the RER are the terms of trade, openness, trade balance, GDP/head, investment/GDP and the level of foreign prices. For the Economic Commission for Africa (ECA, 2003), commodity price collapses generally lead to currency depreciation and inflation risks, particularly under free trade. They argue that in commodity-dependent economies, commodity prices have a strong impact on the value of the local currency. Hence a causal relationship between real commodity price movements and real exchange rate movements.

Broda (2004), in studying the contribution of terms-of-trade shocks to real exchange rate movements, finds that the real exchange rate adjusts slowly after terms-of-trade shocks in fixed exchange rate regimes, whereas in floating exchange rate regimes, the real ERR responds more to terms-of-trade shocks. In particular, terms-of-trade shocks explain about 13 percent of real exchange rate fluctuations in fixed exchange rate regimes and about 31 percent in flexible exchange rate regimes. Drine and Rault (2005), used non-stationary panel developments to examine the main long-run determinants of the real exchange rate for 45 developing countries. Their findings revealed the existence of several sources of impetus influencing the long-run real exchange rate in Africa, Latin America and Asia. Indeed, an improvement in the terms of trade, an increase in per capita income, and capital flows lead to a long-term appreciation of the real exchange rate.

The literature review showed that relative prices can affect the conditions of macroeconomic stability in different ways. However, little work has been done specifically for SSA. In the following section we present the methodological approach to assessing the effects of relative prices on macroeconomic stability in SSA.

II. Methodological approach to measuring the effects of relative prices on macroeconomic stability

This section discusses the methodological approach used. It presents the nature and source of the data, the econometric model, the description of the variables and the estimation technique.

1. Theoretical model and specification

In the literature, several studies on our macroeconomic stability variables use a VAR model (Jobert and Zeyneloglu, 2006; Caceres and al, 2011; Bikai J. and al, 2016; Belmkaddem and Touijar, 2018). Following the same logic, we use a Vector Autoregressive (VAR) model but in panel data to determine the effect of external relative prices on macroeconomic stability variables. Indeed, for these models, the characteristics of the panel mean that taking into account the cross-sectional dimension increases their power over the panel particularly in explaining economic phenomena[7]. Therefore, following the example of Konté and al (2017) [8] we use the following panel VAR model:

$$Y_{i,t} = \phi\, Y_{i,t-1} + \Theta X_{i,t} + \varepsilon_{i,t} \qquad (1)$$

$Y_{i,t}$ is a vector (K,1) representing the dependent variables; $X_{i,t}$ is a vector (M,1) representing the exogenous variables, Θ is the matrix (K; M) of coefficients associated with $X_{i,t}$; $Y_{i,t-1}$ is a vector (Kp, 1) representing the endogenous variables (K in number) lagged to the order of p; ϕ is the matrix (K, Kp) containing the coefficients associated with $Y_{i,t-1}$ and $\varepsilon_{i,t}$ represents the error terms and of dimension (K, 1). In our case, K=3.

2. Specification

We include in the vector of variables inflation, the government deficit, the real effective exchange rate, and a composite indicator of macroeconomic stability (ISM). We then estimate the coefficients of the different equations by GMM and for this purpose we use a number of explanatory variables inspired by the literature. For the estimation of the overall effect, we use Principal Component Analysis (PCA) to construct a composite indicator of macroeconomic stability (ISM). Thus, we can materialize the vectors of the dependent variables of the theoretical model by :

$$Y_{i,t}=\begin{pmatrix} INF \\ DPPIB \\ TCRE \\ ISM \end{pmatrix};\ Y_{i,t-1}=\begin{pmatrix} Y_{i,t-1} \\ \cdot \\ \cdot \\ \cdot \\ Y_{i,t-p} \end{pmatrix} \qquad (2)$$

With INF: Inflation, DPPIB : Government deficit (in relation to GDP), TCRE : Real effective exchange rate and ISM : the composite indicator of macroeconomic stability.

3. Description of the variables

In addition to the variable characterizing relative prices, we introduce variables found in the literature on the determinants of each of our dependent variables.

Table 1. *Variables and expected sign*

Variables	Expected signs
Inflation model	
the money supply (MM)	+
the growth rate (Y)	+
the terms of trade (TDE)	+
the interest rate (interest)	-
the current account balance (CC)	+
Public deficit model	
The growth rate (Y)	-
The external relative price indicator (TDE)	-
Exports (Export)	-
Inflation (INF)	+
The interest rate (interest)	-
Tcre model	
The terms of trade (TDE)	+
The current account balance (CC)	+
Inflation (INF)	-
The interest rate (interest)	+
The income per capita (PIB/H)	-

Source: author.

4. Model estimation method

Accounting for lagged dependent variables, we use dynamic panel estimation techniques (Konte and al., 2017). In the literature, GMM techniques are increasingly used to estimate panel VAR models (Bond and al., 2001; Konte and al., 2017; Amat, 2019° For Beguy (2012), it is possible to use lagged dependent variables as instruments and estimate the coefficients of the VAR model by a system GMM. But in a VAR model, the interpretation of the coefficients is not sufficient, so we will also analyze the impulse response functions and the variance decomposition. Thus, to estimate our four equations, we use the GMM method in system developed by Arellano and Bond (1991) [(9)] and Blundell and Bond (1998)[(10)] frequently encountered in the literature. Arellano and Bover (1995) show that lagged dependent variables are weak instruments in the first difference model and the resulting estimator is biased in small sample. For this reason, Blundell & Bond (1998) proposed the GMM method in a system to remedy this type of problem.

5. Nature and source of data

We use a panel of 30 SSA countries in our research. The choice of these countries was dictated by the availability of data over the study period. We use data for the period from 1991 to 2017. We consider three macroeconomic stability variables and a composite macroeconomic stability index. The data used in this research comes from the World Bank and United Nations Conference on Trade and Development databases.

III. Results and discussion

This section is devoted to the presentation and discussion of the results. But before doing so, it is worth recalling the technique used to construct the composite indicator and the preliminary tests. The section is therefore structured around three points, namely the construction of the indicator, the preliminary tests and the results and interpretation.

1. Construction of the composite indicator of macroeconomic stability

For the construction of the composite stability indicator, we adopt a technique based on Principal Component Analysis (Sirimaneetham and Temple, 2009; and Keho, 2012). The equation reflecting the equality between the composite indicator of macroeconomic stability (ISM) and the different macroeconomic variables advocated in the literature is written as:

ISM = f(INFLATION, TCRE, DEFICIT)

2. Preliminary tests

2.1. Global homogeneity test

Considering panel data, we must first check the homogeneous or heterogeneous structure of the data generating process. This amounts to testing the equality of the coefficients of the model in the individual dimension. The null hypothesis here is global homogeneity. We perform this test on the macroeconomic stability indicator.

Table 2. *Results of the global homogeneity test*

F-Statistic	p-value	Decision
F1 = 3229.242	PvalF1 = 0.0000	Panel acceptance
F2 = 0.2790451	PvalF2 = 3.660	Confirmation of panel structure

Source: author calculations based on data from WDI-2018.

Fischer's overall homogeneity test rejects the overall homogeneity hypothesis.

2.2. Unit root test

We use the Im, Pesaran and Shin (IPS) (2003) test to test the stationarity of the variables. This test is convergent and efficient compared to the others when the temporal dimension of the panel is small (Hurlin and Mignon, 2006). We also perform a second test, Fisher's test based on the Augmented Dickey-Full (ADF) statistic. The null hypothesis is the presence of unit root. The stationarity tests revealed that all variables are not stationary in level (Appendix 4).

2.3. Co-integration test

We perform the Pedroni cointegration test. Pedroni's tests take into account heterogeneity through parameters that may differ between individuals and allow us to apprehend the null hypothesis of no cointegration. This test is based on seven (07) statistics, four of which are

based on the within individual dimension and three on the between individual dimension. The null hypothesis is the absence of cointegration. With the exception of the Group PP-Statistic, all other statistics do not reject the null hypothesis of non-cointegration (Appendix 2).

2.4. Autocorrelation test of the variables with the residuals

The results of the autocorrelation test are presented in Table 3. This test by Arellano and Bond (1991) is based on the null hypothesis of the absence of an AR effect for the residuals. Thus, we note the absence of second-order autocorrelation (AR2), and a negative first-order autocorrelation (AR1), which is consistent with the assumptions of the GMM estimator in system.

Table 3. *Autocorrelation test results for the four models*

	INFLATION model	TCRE model	DEFICIT model	ISM model
- Sargan test (p-value)-AR(1)	-3,006 (0,002)	-2,260 (0,023)	-2,754 (0,006)	-2,941 (0,003)
- Sargan test (p-value)-AR(2)	-0,354 (0,722)	-1,056 (0,291)	-0,1602 (0,872)	0,078 (0,938)

Source: author calculations using data from WDI-2018

3. Results and interpretations of the estimation results

3.1. Results of the estimated equations

Table 4 presents the econometric estimation results.

Table 4. *Estimation results of the VAR panel models*

Dependent variable: INF		Dependent variable: TCRE		Dependent variable: DPPIB		Dependent variable: ISM	
Var	Coef (t-stat)	Var	Coef (t-stat)	Var	Coef (t-stat)	Var	Coef (t-stat)
INF L1	0.25*** (7.10)	TCRE L1	0.148*** (5.07)	DPPIB L1	0.601*** (14.07)	ISM L1	0.357*** (10.32)
TDE	-0.002 (-1.21)	TDE	0.124*** (4.53)	TDE	-0.003*** (-3.92)	TDE	0.064*** (4.28)
interest	-0.005 (-0.10)	interest	0.286*** (2.59)	interest	0.004 (1.61)	interest	-0.0015 (-0.03)
D.IMM	0.69*** (4.22)	INF	0.556 (0.024)	INF	-0.0002 (-0.23)	D.IMM	-4.108** (-1.99)
Y	-0.009* (-1.94)	Y	-13.43*** (-4.20)	Y	-0.015** (-2.12)	Y	0.329** (2.09)
lExport	-0.16** (-2.19)	CC	0.474*** (5.01)	CC	-0.019** (-1.96)	CC	-0.384 (-1.26)
Hansen test (p-value)	375.064 (0.075)		99.89 (0.293)		63.56 (0.42)		34.70 (0.14)
Arellano-Bond test	-3.006 (0.002)		-2.260 (0.023)		-2.754 (0.006)		-2.941 (0.003)

Dependent variable: INF		Dependent variable: TCRE		Dependent variable: DPPIB		Dependent variable: ISM	
Var	Coef (t-stat)	Var	Coef (t-stat)	Var	Coef (t-stat)	Var	Coef (t-stat)
(p-value)-AR(1)							
Arellano-Bond test (p-value)-AR(2)	-0.354 (0.722)		-1.056 (0.291)		-0.1602 (0.872)		0.078 (0.938)
instruments	151		130		116		103

***. ** and * are the respective significances of 1%. 5% and 10%. The values (...) represent the values of the student t or Z of the normal distribution whereas they represent the p-values in the case of the tests.
Hansen J or Sargan test: Ho: Non-correlation of the instruments with the residuals (test of validity of the instruments).
Arellano-Bond test: Ho: absence of autocorrelation.
Source: author calculations using data from WDI (2018)

The GMM estimator in system is based on two assumptions: (i) the instruments used are valid, i.e. uncorrelated with the error term. This assumption is tested using the Sargan/Hansen over-identification test, (ii) the absence of second-order autocorrelation (AR(2)) in the residuals and the first-order negative autocorrelation (AR(1)) tested using the Arellano-Bond test. The results show that these two hypotheses are verified for each estimate. The different results presented thus confirm the absence of second order autocorrelation and the validation of the instruments. With the estimation by GMM in system, it is necessary to ensure the absence of second order autocorrelation of the perturbations. The Blundell-Bond estimator is therefore acceptable since we cannot reject the hypothesis that the instruments are valid. Furthermore, the models presented in Table 4 are globally significant with respect to the Wald Chi2 statistic.

Specifically, we note that, at the 5% threshold, relative external prices (REPs) significantly affect the real exchange rate, the public deficit and, more generally, macroeconomic stability. However, the influence of this relative price indicator on inflation is not significant at the 5% threshold. Indeed, the coefficient associated with this variable for the inflation equation is -0.002 and the absolute value of the associated statistic is 1.21.

In the other equations, the influence of this variable on the deficit, the real exchange rate and macroeconomic stability is -0.003, 0.124 and 0.064 respectively. These coefficients are statistically significant at the 5% level. Therefore, every 1 percentage point increase in the terms of trade index will result in a reduction in the deficit by 0.003 percentage points, an appreciation of the exchange rate by 0.12 percentage points, and an improvement in macroeconomic stability by 0.064 percentage points. These results are consistent with those of Cashin and Pattillo (2000), who identify terms of trade instability as a key determinant of macroeconomic performance in DCs. For them, trade openness would increase a country's exposure to external shocks, thus accentuating the effects of terms of trade instability on growth instability. These results also support the position of Raffinot (1991),

who accepted that trade-related budgetary revenues increase as a result of higher export prices (and thus a change in relative prices) and that the movement in relative prices could curb the volume of imports and reduce the advantage at that level. The same is true of Edwards (1989), who identified the terms of trade among the most important variables affecting the level of the real exchange rate in developing countries.

For our control variables, the coefficient associated with the money supply is positive and statistically significant. Exports have a negative influence on inflation. In the real effective exchange rate equation, the interest rate and the current account balance have a positive influence on the REER while GDP per capita has a negative influence on the real effective exchange rate. In the government deficit model, the growth rate and the current account act in favor of a reduction in deficits in SSA.

3.2. Robustness test

To test the robustness of the results, we estimate the models with a lag of order 2, the results of which are presented in Table 5. By varying the number of lags, we obtain similar results. Indeed, the results of the estimation with a lag of 2 confirm that relative prices have significant effects on macroeconomic stability at the 5% threshold.

Table 5. *Results of the robustness test*

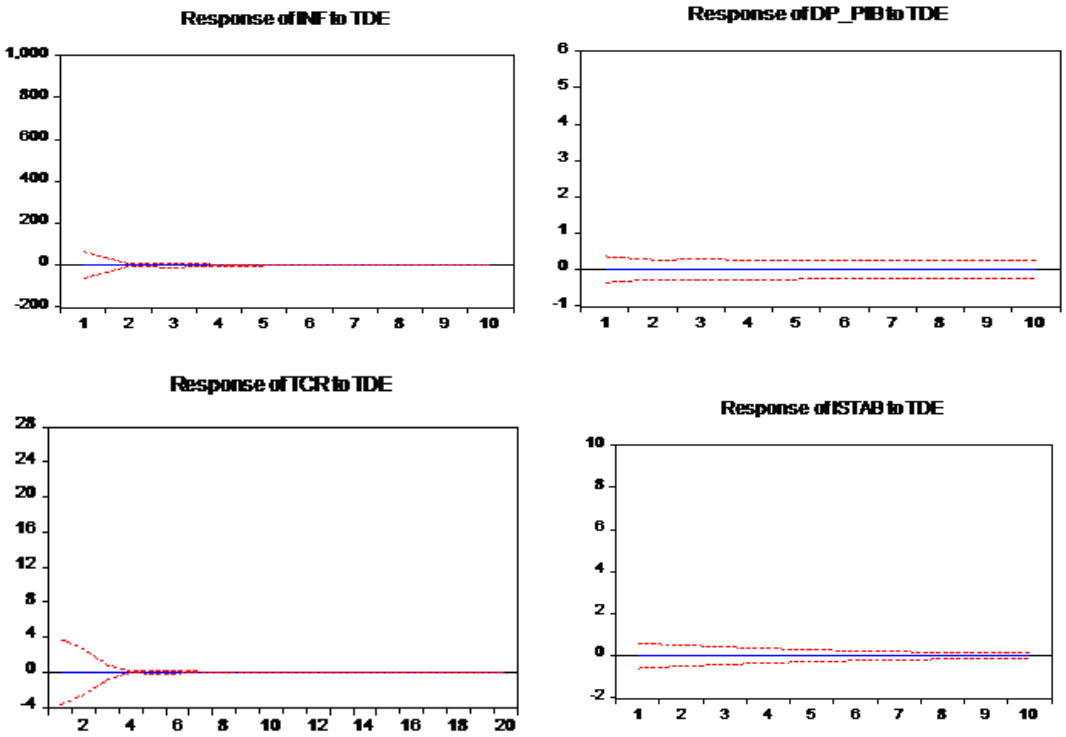
Dependent variable: INF		Dependent variable: TCRE		Dependent variable: DPPIB		Dependent variable: ISM	
Var	Coef (t-stat)	Var	Coef (t-stat)	Var	Coef (t-stat)	Var	Coef (t-stat)
INF L2	-0.67*** (-17.32)	TCRE L1	-0.22*** (-4.68)	DPPIB L1	-0.20*** (-5.30)	ISM L2	-0.29*** (-8.10)
TDE	-3.11*** (-2.67)	TDE	0.15*** (3.94)	TDE	-1.16 (-0.65)	TDE	0.164*** (8.86)
interest	4.95 (0.09)	interest	0.28 (0.52)	interest	0.15*** (5.20)	interest	-3.445 (-1.48)
D.IMM	250*** (24.52)	INF	-0.081 (-0.09)	INF	0.40*** (11.33)	D.IMM	-1.46*** (-4.34)
Y	5.27*** (5.84)	Y	-10.92*** (-3.28)	Y	-10.27*** (-4.24)	Y	9.08*** (11.62)
lExport	211* (1.83)	CC	0.40*** (9.32)	CC	-0.28 (-0.49)	CC	-4.61*** (-3.82)
Hansen test (p-value)	1198.2 (0000)		99.89 (0.293)		320.33 (0000)		268.31 (000)
Arellano-Bond test (p-value)-AR(1)	6.10 (0.000)		-2.81 (0.013)		1.40 (0.001)		9.81 (0.000)
Arellano-Bond test (p-value)-AR(2)	0.11 (0.91)		-1.23 (0.05)		-0.1602 (0.87)		1.72 (0.08)
instruments	151		130		116		103

***. ** and * are the respective significances of 1%. 5% and 10%. The values (...) represent the values of the student t or Z of the normal distribution whereas they represent the p-values in the case of the tests.
Hansen J or Sargan test: Ho: Non-correlation of the instruments with the residuals.
Arellano-Bond test: Ho: absence of autocorrelation.
Source: author calculations using data from WDI (2018).

3.3. Impulse response functions

In this section, we analyze the impulse response functions and the decomposition of the variance of the forecast error from the results of the VAR model. These results allow us to determine the delay and magnitude of the relative price shocks on our different variables. The following figures represent the response functions that are the maximum variation as a function of time of each endogenous variable following a shock to the exogenous variable with the order for the Cholesky decomposition.

Graph 1. *Impulse response functions*



Source: author calculations using data from WDI (2018).

By analyzing the impulse response functions of our VAR models, it emerges that a shock on the terms of trade has a weak impact on inflation, the public deficit but stronger on the real exchange rate and macroeconomic stability in general. We also note that the impact on macroeconomic stability is long-lasting because the effect of the shock stabilizes practically after six (6) periods. We also note that in the case of the deficit, this variable no longer returns to equilibrium in the event of a shock. These results tend to confirm the GMM.

3.4. The decomposition of the variance

The interpretation of the impulse response functions can be completed by an analysis of the variance decomposition of the forecast error. We summarize in Appendix 3 an analysis of the decomposition of the 10-year forecast error. By decomposing the variance, we arrive at results similar to the previous ones. Indeed, the results show the contribution of the terms of trade to the variance of the forecast error of each of these variables. Thus, the decomposition of the variance indicates that the variance of the forecast error from the terms of trade is respectively 0.01% for inflation, 0.92% for the exchange rate, 0.03% for the deficit and 0.48% for macroeconomic stability in general. We can therefore see that the contribution of relative external prices (terms of trade) to the explanation of the variance of macroeconomic stability is non-negligible in Sub-Saharan Africa.

Conclusion

Knowledge of the effects of relative prices on macroeconomic stability is of great importance for Sub-Saharan African countries. Macroeconomic instability can be of internal or external origin. The objective of this paper was to determine the influence of the international environment on macroeconomic stability by assessing the effects of external relative prices, as measured by the terms of trade, on macroeconomic stability in SSA countries. Three variables were used for macroeconomic stability. To do this, the use of a panel VAR model and the estimation of the econometric model by the Generalized Method of Moments (GMM) made it possible to obtain a number of results. The results showed that at the 5% threshold the terms of trade effect is positive and significant on macroeconomic stability in general. Specifically, the terms of trade effect is not significant on inflation but significant on the deficit and the exchange rate. Relative prices (terms of trade) have a positive effect on the real exchange rate and a negative effect on the public deficit in Sub-Saharan Africa. The methodology used also consisted of generating impulse functions and variance decomposition to test the robustness of the results. The results obtained by these different tools are similar. These results show how the terms of trade as relative prices have a significant influence on macroeconomic stability in Sub-Saharan Africa. In the analysis of macroeconomic stability and stabilization policies in Sub-Saharan Africa, it therefore seems necessary to integrate the fluctuation of relative prices of international trade in order to better account for the sources of macroeconomic stability.

Notes

(1) See Macroeconomic and Operational Challenges of Countries in Fragile Situations, IMF (2011)

(2) Discussion paper by S. P. Jäggi et B. Parnisari, 2006, " Does the Marshall-Lerner condition hold in Switzerland?, Short- and long-term relationship between foreign trade, exchange rate and the

terms of trade, SECO Working Paper No 17," Analysen und Zahlen " : http://www.seco.admin.ch/publikationen/arbeitspapiere/index.html?lang=de#zahlen

(3) See World Bank Report, (1990) on World Development. Oxford University Press.

(4) See Mathurin Dembo TOE, (2010) "Modelés de prévision de l'inflation dans les pays membres de l'UEMOA" Banque Centrale des Etats de l'Afrique de l'Ouest (BCEAO), December 2010

(5) See Robert Lafrance and Pierre St-Amant, BANK OF CANADA REVIEW (FALL 1999). They argue that exchange rate movements can also affect economic activity through their effects on the relative prices of tradable and non-tradable goods and services.

(6) See Report of the United Nations Conference on Trade and Development (Trade performance and commodity dependence), Geneva, 2003

(7) Economic Community of West African States (ECOWAS). Macroeconomic Convergence Report. Abuja, August 2013.

(8) Konte and al. in their study on the determinants of the stock market in Sub-Saharan Africa used a Vector Autoregressive (VAR) panel model to account for the interdependence between the stock market, economic growth and the banking market.

(9) GMM in difference (Arellano and Bond 1991) consists in estimating the equation written in first difference while considering as instruments of the explanatory variables in first differences, their values in level delayed by one period or more.

(10) The GMM in system consists in estimating a system formed by the level and first difference equations. In this system, the level equation is instrumented by the lagged explanatory variables written in differences and the difference equation is instrumented by the lagged explanatory variables in levels.

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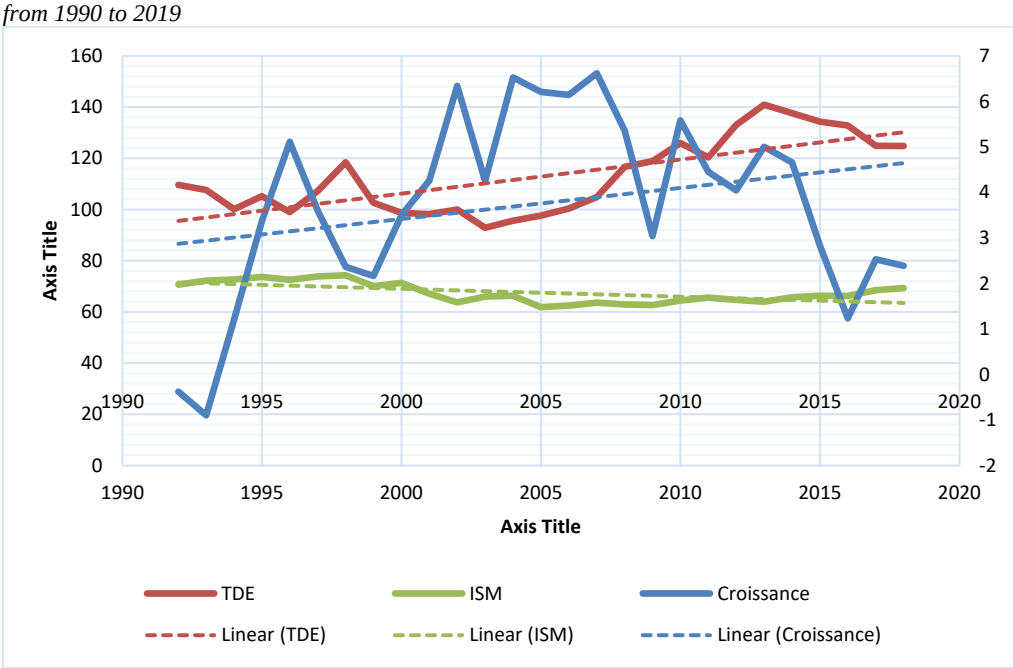
Appendix

Appendix 1. *Joint evolution of the relative price index, growth rate and macroeconomic stability in SSA from 1990 to 2019*



Source: Author's calculations based on WDI-2019 data.

Appendix 2. *Results of cointegration tests*

Pedroni Residual Cointegration Test H0 : non cointégration			
Dimension Intra		Dimension Inter	
Pedroni Residual Cointegration Test H0: non cointégration			
Panel v-Statistic	-1.092 (0.86)	Group rho-Statistic	3.201 (0.99)
Panel rho-Statistic	2.576 (0.99)	Group PP-Statistic	-1.838** (0.03)
Panel PP-Statistic	0.041 (0.51)	Group ADF-Statistic	0.772 (0.78)
Panel ADF-Statistic	1.514 (0.93)		

Source: Author's calculations based on WDI-2019 data.

Appendix 3. *Extract from the variance decomposition of the 4 models*

Variance due to relative prices			
INF	TCRE	DP/PIB	ISM
0.0000	0.0000	0.0000	0.0000
0.0051	0.6383	0.0073	0.0229
0.0100	0.8173	0.0279	0.5210
0.0132	0.7773	0.0375	0.4382
0.0143	0.7140	0.0391	0.5271
0.0146	0.6876	0.0368	0.5025
0.0147	0.7069	0.0335	0.5201

Source: Author on eviews software.

Appendix 4. *Results of the unit root test*

	IPS						ADF-Fisher					
	In level			In first difference			In level			In first difference		
Varia-bles	stat	p-value	results	stat	p-value	results	stat	p-value	results	stat	p-value	results
ISM	-3.081	0.001	stationary	-	-	-	-20.312	0.000	stationary	-	-	-
INF	-8.730	0.000	stationary	-	-	-	-8.730	0.000	stationary	-	-	-
TCRE	-4.412	0.000	stationary	-	-	-	-9.611	0.000	stationary	-	-	-
DPPIB	-1.853	0.031	stationary	-	-	-	-9.746	0.000	stationary	-	-	-
TDE	-3.331	0.000	stationary	-	-	-	-8.858	0.000	stationary	-	-	-
MM	12.851	1.000	No stationary	-2.355	0.009	Stationary	23.431	1.000	No stationary	-7.882	0.000	Stationary
interest	-9.677	0.000	stationary				-17.735	0.000	stationary			
CC	-5.108	0.000	stationary	-	-	-	-8.508	0.000	stationary	-	-	-
Export	-3.105	0.001	stationary	-	-	-	-1.333	0.091	stationary	-23.644	0.000	Stationary
Y	-5.108	0.0000	stationary	-	-	-	-11.005	0.0000	stationary	-	-	-

Source: author's calculations using data from WDI (2018).

Data availability statement

The data that support the findings of this study are openly available in:
https://databank.worldbank.org/source/world-development-indicators
This is the World Bank database: World Development Indicators (WDI).

COI statement

I declare that I have no conflicts of interest to declare.