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Exchange Rate Volatility and Economic Growth in the Democratic Republic of Congo (DRC)

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Abstract

This paper studied the effects of exchange rate volatility on economic growth. Our empirical analysis focuses on the Democratic Republic of Congo (DRC) from 1990 to 2021 and is based on the vector autoregression (VAR) model. The results show that economic growth is a function of its own innovations, the exchange rate and trade openness. Also, a depreciation of the domestic currency against the foreign currency hinders economic growth. These results suggest a strengthening of resilience through the diversification of economic activity in order to improve the international competitiveness of the Congolese economy.

Keywords

Exchange Rate Volatility, VAR, Economic Growth, DRC

1. Introduction

In developing countries, the search for economic growth is one of the fundamental objectives that every state includes in its national development policy. However, the acceleration of growth and the accumulation of capital have an impact on the balance of payments and on the exchange rate. The determination of the exchange rate, therefore, appears to be one of the major issues in international macroeconomics (Ghosh, 2014).

In recent years, a significant amount of research has focused on the relationship between the exchange rate and economic growth (Hatmanu et al., 2020;

Ioan et al., 2020; Vo & Zhang, 2019; Latief & Lefen, 2018; Alagidede & Ibrahim, 2017; Dal Bianco & Loan, 2017). The results of these studies are not unanimous. Indeed, the specificities of the countries or the methodologies used are at the root of these divergences. Also, some research leads to the finding that undervalued and competitive exchange rates are positively associated with higher economic growth. There are two reasons for this: on the one hand, an undervalued exchange rate favors the reallocation of resources to the trade sector, the locus of learning-by-doing externalities and technological spillovers (Rodrik, 2008; Eichengreen, 2008). On the other hand, the role of competitive exchange rates in loosening the exchange rate constraint influences growth (Porcile & Lima, 2010; Razmi et al., 2012).

As a small, open, dollarized and extroverted economy, the economy of the Democratic Republic of Congo (DRC) is dependent on international trade with the mining sector being the mainstay of the economy in terms of foreign exchange reserves. Since the beginning of the 1990s, the Congolese economy has been characterized by a deterioration of its fabric, resulting in a loss of value of the national currency and negative economic growth rates. In 2002, with the implementation of economic reforms instituted by the Congolese government and the resumption of cooperation with donors (IMF), the Congolese economy recovered from its slump. The international financial crisis that hit in 2008 was the cause of the scarcity of foreign currency on the foreign exchange market, with the national currency losing 41.2% of its value against the US dollar between 2008 and 2009. This situation led on the one hand to disruptions in the foreign exchange market and on the other hand to a decline in economic growth explained by the drop in exports (6.2% in 2008 against 2.8% in 2009) (Central Bank of Congo, 2010-2020).

Given the continuing divergence on the impacts of the exchange rate on economic growth in the literature, while the issue of continued depreciation of the national currency (Congolese Franc) is attracting the attention of both policymakers and researchers in the DRC, the discussions surrounding it focus primarily on inflation and are generally without reference to the real sphere. As a result, there is a virtual lack of attention to the role of exchange rate management in promoting economic growth and maintaining external competitiveness. It is in this context that this study aims to contribute effectively to macroeconomic policy recommendations by conducting an empirical investigation of the effects of exchange rate volatility on economic growth in the DRC.

To this end, the paper is structured as follows: Section 2 provides a brief review of the literature on the interrelationships between exchange rate volatility and economic growth. Section 3 presents the data and methodology, and results and discussions are discussed in Section 4 and Section 5 focuses on the conclusion of this study.

2. Review of the Literature

An extensive literature has evaluated the relationship between the exchange rate

and economic growth.

Rodrik (2008) found that there is a positive relationship between real exchange rate undervaluation and growth, especially in developing countries. However, the instability of the real exchange rate relative to its equilibrium can have a positive or negative effect on economic growth. Also, the discussion on how real exchange rate appreciation (or depreciation) affects the economic growth of the host country (region) is essential, but no consistent conclusions have been drawn.

Rapetti et al. (2012) confirmed the promoting effect of real exchange rate depreciation on economic growth. Aizenman and Lee (2010) and Benigno et al. (2015) admit that there are learning effects through practice external to the individual industry in the traded goods sector; therefore a low real exchange rate is necessary to support the production of tradable goods. In these models, an undervalued exchange rate acts as a subsidy to the tradable goods sector. A low real exchange rate compensates for institutional weaknesses and market failures.

A different channel is proposed by Glüzmann et al. (2012) where he finds that a low exchange rate leads to higher savings and investment through lower labor costs and income redistribution. By shifting resources from consumers to financially constrained firms, real devaluation stimulates savings and investment. Zhao et al. (2014) found in their research that the total effect of real exchange rate appreciation is that it contributes to the transformation of the economic growth pattern at both the Chinese and regional levels. Habib et al. (2017) found the same results and confirmed that real exchange rate depreciation increases annual GDP growth in DCs and real exchange rate appreciation decreases GDP growth. Meanwhile, Ybrayev (2021) claimed that there is a positive relationship between real exchange rate undervaluation and the growth of manufactured exports and high-tech manufacturing industries, but that real exchange rate overvaluation increases the growth rate of primary product industries.

Other studies, however, have reached contradictory conclusions. Indeed, in a study on the effects of the exchange rate on economic growth in Morocco between 1988 and 2016, Haoudi and Rabhi (2020) found that the short-run impact of the exchange rate on economic growth is significant after one period, but does not exert the effect in the long-run, which negates the expected effect of price competitiveness in the long-run.

Fluctuations in macroeconomic factors and the dynamic nature of the business environment lead to exchange rate volatility (Anyanwu et al., 2017). The theories that explain this up and down movement of the exchange rate are real options theory, interest rate parity theory, purchasing power parity, traditional flow theory, etc.

Thus, the volatility of the exchange rate as an indicator of uncertainty explains the behavior of investors' decisions. Stable exchange rates become more attractive for firms that decide to increase their investments. Jamil et al. (2012) examined the effect of volatility on growth over 2 periods for 11 European countries in the European monetary union and 4 countries that have not adopted the

euro as their common currency. The results are mixed for the countries in the analysis, but the common currency reduces the adverse impact of exchange rate volatility on industrial output. Moreover, for Germany and Denmark, the impact of exchange rate volatility is negative for both periods, before and after the introduction of a common currency.

Rapetti (2020) estimated the effect of real exchange rate volatility on economic growth and found a positive relationship between the two, especially in DCs. He also mentioned that overvaluation is harmful to economic growth and that real exchange rate volatility has a negative effect on growth. Theoretical and empirical work on developed and developing countries shows mixed results on the relationship between exchange rate volatility and economic growth. Given these results, the study of this relationship in the DRC remains crucial.

3. Data and Methodology

To achieve the objective of this research, we have favoured an econometric approach, using Vector Autoregressive Modelling (VAR). This modelling makes it possible to determine the direction of causality between the variables studied and to capture the impacts of one on the other, through the impulse response functions.

3.1. Data

Using Eviews 9, this study employs Vector Autoregressive modeling (VAR) for the period 1990 to 2021. The study variables are presented in **Table 1**.

3.2. Model Specification

This is a VAR (vector autoregression) model that accounts for the dynamic relationship between the change in the exchange rate and inflation (referred to in this model as the consumer price index) and by taking into account other macroeconomic variables.

Sims (1980) criticisms of simultaneous equations (traditional macroeconomic models), in particular the main problem of identification, led to the development of the standard VAR model. This new model has a particular advantage, that of capturing the variation of the parameters (system of equations) over time, and thus allows for a better restitution of the dynamics of the system, which adjusts and adapts to the variations or shocks (innovations) experienced by the economic environment. This model justifies its choice in that it allows us to better grasp the interdependencies between the variables in their long-term dynamics, through impulse response functions.

Thus, a VAR model (1) with seven variables can be specified as follows:

$$y_t = \phi_0 + \phi_1 y_{t-1} + \phi_2 y_{t-2} + \cdots + \phi_{t-p} + u_t \tag{1}$$

$$\text{With} \quad y_t = \begin{bmatrix} y_t \\ \vdots \\ y_{Nt} \end{bmatrix}, \quad \phi_0 = \begin{bmatrix} a_t^o \\ \vdots \\ a_N^o \end{bmatrix}, \quad \phi_0 = \begin{bmatrix} a_1^1 & a_1^2 & \cdots & a_{1P}^N \\ \vdots & \vdots & \ddots & \vdots \\ a_{NP}^1 & a_{NP}^2 & \cdots & a_{NP}^N \end{bmatrix}$$

Table 1. Survey variables.

Variables	Description of variable	Characteristic	Source
GDP/capita	It is the gross domestic product per capita that represents the economic growth, it represents our dependent variable.	Continue	WDI, 2021
Exc.r	This variable determines the nature of the relationship between the exchange rate and economic growth. Thus, if the coefficient of the exchange rate is positive, this indicates that a depreciation of the currency improves economic growth and vice versa.	Continue	WDI, 2021
Gfcf	The ratio of gross fixed capital formation to GDP measures physical investment in a given year.	Continue	WDI, 2021
Trade	This indicator is obtained by the rate of trade in relation to GDP to measure the degree of openness of the economy. It includes: exports and imports of goods and services relative to GDP.	Continue	WDI, 2021
Infl	This variable is taken into account to highlight the effect of inflation. High inflation is a structural factor that negatively affects economic growth by reducing investor incentives.	Continue	WDI, 2021
Govt	It is the ratio of total government expenditure to GDP. This variable captures capital accumulation or public investment formation as a source of growth.	Continue	WDI, 2021
Ms	This variable measures the degree of monetization of the economy or the depth of the financial system.	Continue	WDI, 2021

Thus Equation (1) can be rewritten:

$$\left(I-\phi_1 L-\phi_2 L^2-\cdots+\phi_p L^P\right) y_t=\phi_0+u_t \tag{2}$$

Which can be rewritten as follows:

$$E(L)y_t = \phi_0 + u_t \tag{3}$$

With the identity matrix, the delay operator, $\phi(L) = 1 - \sum \phi_0 L^i$ and where u_t satisfies the properties of white noise.

This model as specified in our study is written as follows:

$$\begin{bmatrix} \frac{\text{GDP}}{\text{capita}} \\ \text{Infl} \\ \text{gfcf} \\ \text{Govt} \\ \text{Exc.r} \\ \text{Trade} \\ \text{Ms} \end{bmatrix} = \begin{bmatrix} a_1^o \\ a_2^o \\ a_3^o \\ a_4^o \end{bmatrix} + \begin{bmatrix} a_{11}^1 & a_{11}^3 & a_{11}^5 & a_{11}^7 \\ a_{21}^1 & a_{21}^3 & a_{21}^5 & a_{21}^7 \\ a_{31}^1 & a_{31}^3 & a_{31}^5 & a_{31}^7 \\ a_{41}^1 & a_{41}^3 & a_{41}^5 & a_{41}^7 \end{bmatrix} \begin{bmatrix} \frac{\text{GDP}}{\text{capita}_{t-1}} \\ \text{Inf}_{t-1} \\ \text{Govt}_{t-1} \\ \text{Exc.r}_{t-1} \\ \text{Govt}_{t-1} \\ \text{Trade}_{t-1} \\ \text{Ms}_{t-1} \end{bmatrix}$$

$$+ \begin{bmatrix} a_{12}^2 & a_{12}^4 & a_{12}^6 & a_{12}^8 \\ a_{22}^2 & a_{22}^4 & a_{22}^6 & a_{22}^8 \\ a_{32}^2 & a_{32}^4 & a_{32}^6 & a_{32}^8 \\ a_{42}^2 & a_{42}^4 & a_{42}^6 & a_{42}^8 \end{bmatrix} \begin{bmatrix} \frac{\text{GDP}}{\text{capita}_{t-2}} \\ \text{Inf}_{t-2} \\ \text{Govt}_{t-2} \\ \text{Exc.r}_{t-2} \\ \text{Govt}_{t-2} \\ \text{Trade}_{t-2} \\ \text{Ms}_{t-2} \end{bmatrix} + \begin{bmatrix} u_t \\ u_t \\ u_t \\ u_t \end{bmatrix}$$

4. Results and Discussion

4.1. Descriptive Analysis

In order to know the description of the variables (Table 2), we must calculate some central tendency parameters, but also analyze the correlation between these variables. Note that with regard to the Jarque-Bera test, the variable is normally distributed when the probability associated with this statistic is greater

Table 2. Descriptive statistics.

Statistiques	GDP/capita	Exc.r	Gfcf	Trade	Infl	Govt	Ms
Moyenne	15.14553	765.3805	−0.949593	962.5939	797.9621	50.77500	1.313333
Médiane	0.000000	21.50000	0.000000	45.50000	22.54929	23.25000	3.150000
Maximum	451.6122	9796.900	924.2500	13729.00	9796.900	238.0000	9.500000
Minimum	−6.701200	0.850000	−736.2200	−377.6000	0.820000	2.000000	−13.50000
Ecart type	58.36250	2006.623	136.1157	2560.809	2050.658	56.93790	6.250834
Jarque Bera	4906.679	876.1582	3251.099	1917.641	201.8516	17.72310	3.122503
Probabilité	0.000000	0.000000	0.000000	0.000000	0.000000	1523.250	0.209873
Somme	1862.900	94141.80	−116.8000	118399.1	23938.86	94015.79	39.40000
Nbre d'Obs	32	32	32	32	32	32	32

Note: Author's calculations.

than the critical significance level of 5%.

It is important to note from the characteristics of the variables under study that not all variables are normally distributed.

4.2. Analysis on Correlation

Economic statistics makes it possible to discover and measure the various phenomena observed. The strength of linkage or the degree of association between variables is studied with the help of correlation. In other words, it is to know the degree of interdependence between the variables under examination (Table 3).

Using Table 3, we note that overall there is:

- A negative correlation between the exchange rate and economic growth;
- A positive correlation between gross fixed capital formation and economic growth;
- A negative correlation between trade openness and economic growth;
- A negative correlation between public expenditure and economic growth;
- A negative correlation between money supply and economic growth.

Taken as an absolute value, at the 5% threshold, we notice that the value of the ADF statistic for each series is higher than the VCM statistic. With the exception of the series GDP/capita and Gov are stationary at first difference; the other series are level with Dickey-Fuller-Augmented values higher than the VCM statistic in absolute value at the 5% threshold.

Table 4 shows that the series are initially non-stationary at level and become stationary after a single differentiation.

4.3. Stationarity Tests

It is necessary to verify the properties of the selected series in terms of stationarity (Table A1). In the context of our study, we opt for a significance threshold α = 5%. We apply the Dickey-Fuller-Augmented (DFA) test to determine the individual order of integration of the series as shown in Table 4.

Table 3. Correlation matrix.

Correlation Coefficient	GDP/capita	Exc.r	Gfcf	Trade	Infl	Govt	Ms
GDP/capita	1.000000	−0.093999	0.010310	−0.050440	−0.165086	0.827317	0.311295
Exc.r	−0.093999	1.000000	−0.074056	0.003454	−0.541912	0.311295	0.408713
Gfcf	0.010310	−0.074056	1.000000	−0.012726	−0.516831	0.459812	0.781239
Trade	−0.050440	0.003454	−0.012726	1.000000	0.982436	0.123897	0.421398
Infl	−0.165086	−0.541912	−0.516831	0.982436	1.000000	0.598723	0.123565
Govt	−0.827317	0.311295	0.459812	0.123897	0.598723	1.000000	0.895623
Ms	−0.311295	0.408713	0.781239	0.421398	0.123565	0.895623	1.000000

Note: Author's calculations.

Table 4. ADF tests for stationarity.

Series	Statistics			Models	Decision	Degree of integration
	DFA	MCV 5%	MCV 10%			
GDP/capita	−4.809160	−2.971853	−2.625121	With intercept	Stationary to the first difference	I(1)
Infl	−17.77835	−2.991878	−2.635542	With intercept	Stationary in level	I(0)
gfcf	−4.684143	−2.967767	−2.622989	With intercept	Stationary in level	I(0)
Govt	−5.529374	−2.971853	−2.625121	With intercept	Stationary to the first difference	I(1)
Exc.r	−3.184414	−2.938987	−2.607932	With constant and trend	Stationary in level	I(0)
Trade	−5.085750	−3.612199	−3.243079	With constant and trend	Stationary in level	I(0)
Ms	−10.04050	−2.998064	−2.638752	With intercept	Stationary in level	I(0)

Author's calculations.

4.4. Determination of the Optimal Lag Number

To determine the number of lags p of a VAR model, we use the criteria of Akaike and Schwartz. We will use the criteria of Akaike (AIC) and Schwarz (SC) for lags p ranging from 0 to 8.

Taking into account all the different criteria mentioned above, we retain the first-order lag. This means that our model will be estimated with the first-order lag. Before estimating the VAR itself, it is recommended that we carry out a causality test in order to know which equations are the most relevant to analyse (see Table A2 in the appendix).

4.5. Granger Causality Test

The notion of causality plays a very important role in economics in that it allows us to better understand the relationships between variables. However, one of the specificities of the VAR model is that it allows the study of impacts and causalities between related variables. Table A3 of the Granger causality test shows that the exchange rate, the inflation rate and trade openness cause economic growth at the 1%, 5% and 10% threshold respectively.

4.6. Estimation

4.6.1. Estimation Results of the VAR Model

The results of the estimation obtained from the VAR model with a lag number of 1 are reported in Table A4.

4.6.2. Dynamics of the VAR Model

This is the crucial part of the model; it is the very purpose of the model. The VAR model is often analysed through its dynamics, via the simulation of ran-

dom shocks (impulse responses) (Table 5) and the variance decomposition of the error (Table 6).

1) Impulse response analysis

The aim is to demonstrate the extent to which economic growth reacts (responses) to shocks or innovations (impulses) on the inflation rate, public spending, the exchange rate, the growth rate of the money supply, investment and trade openness.

Table 5. Impulse responses.

Response of GDP/Capita							
Period	GDP/Capita	Infl	Gfcf	Govt	Exc.r	Trade	Ms
1	58.10235	−373.4973	31.45795	108.45772	0.000000	24.39200	456.99452
2	89.57898	−105.9236	31.39814	95.60982	−20.12919	24.37100	372.31226
3	109.34227	−54.56273	31.51232	53.93090	−6.50353	136.1028	214.38290
4	123.16666	−17.46282	31.26835	32.5222	5.956485	177.9470	159.43603
5	132.03898	25.68258	48.520955	29.68694	28.94066	189.3474	159.47463
6	153.94566	43.974686	5918.51032	14.04185	43.11671	−19.214493	126.50289
7	176.87727	−35.20243	81.30138	−22.31557	58.19079	−30.83441	119.52361
8	188.82704	76.30034	111.61686	−44.58501	72.66344	−26.45725	98.53883
9	198.79007	153.78368	136.96581	−68.74068	143.0976	−6.406550	32.55004
10	201.76280	225.72965	147.46074	−109.07700	181.7087	8.731103	−46.55831

Note: Author's calculations.

Table 6. Results on variance decomposition.

Variance Decomposition of GDP/Capita								
Period	S.E.	GDP/Capita	Infl	Gfcf	Govt	Exc.r	Trade	Ms
1	58.99452	77.44043	1.672598	0.000000	0.00000	21.102368	5.429770	0.000000
2	59.31226	61.85642	2.330381	1.725141	0.94923	23.41844	9.59119	0.129198
3	59.38290	38.31935	6.675885	1.614805	1.491997	35.63869	15.76742	0.491858
4	59.43603	35.32981	6.619731	1.559979	2.421324	36.110215	17.15059	0.808351
5	59.47463	30.34473	6.718546	1.738083	2.904645	37.91719	18.40578	1.971083
6	59.50289	27.08764	6.694582	1.987773	2.935486	39.92458	20.21537	2.020102
7	59.52361	22.02076	5.689815	2.020278	2.918333	40.95896	24.077291	2.314563
8	59.53883	18.02656	6.694864	2.021794	2.967543	41.95165	26.22852	2.410235
9	59.55004	15.98881	4.693327	2.026854	2.992674	42.98434	29.25250	2.521034
10	59.55831	12.97772	6.694146	2.026406	3.026406	42.99587	31.25969	2.003258

Note: Author's calculations.

A shock to fiscal and monetary policy in terms of increased government spending and money supply growth respectively results in a general decrease in

economic growth throughout the period. The economic growth rate per capita is positively related to its past in all periods. A 1% shock to the exchange rate in terms of growth on the per capita economic growth rate results in a zero effect in the 1st period and an increase for the other 9 periods. A shock to GFCF results in a zero effect in period 1 to period 4 and an increase from period 5 to period 10. A shock of 1% to the inflation rate on the economic growth rate per capita results in a zero effect in the first period and a decrease in the other nine periods. A shock to trade policies in terms of trade openness results in a zero effect, an increase and a decrease in the economic growth rate per capita throughout the period.

2) Decomposition of variance

Based on the results of the variance decomposition, it appears that the variance of the GDP/capita forecast error is mainly influenced on average by its own innovations (33.95%) and by the shock to the exchange rate (36.31%) but also by the shock due to trade openness (19.75%). GDP/capita reacts less significantly to variations in the GFCF, public expenditure and the growth rate of the money supply.

The remarkable contribution of the exchange rate and trade openness on economic growth is justified by the extraversion of the Congolese economy (small open economy) characterised mainly by the export of raw materials and the import of value added products. Theoretically, a depreciation of the national currency (high exchange rate volatility) should make exports relatively cheaper, leading to an increase in demand for exports and, by extension, economic performance and vice versa.

However, in the context of the DRC, the depreciation of the national currency is a brake on economic growth. These results corroborate the work of Rapetti (2020); Ziadi and Abdallah (2007) who argue that exchange rate volatility has a negative effect on economic growth in developing countries because of the high external dependence of the economy.

5. Conclusion

The economic performance of a country depends on its competitiveness in international trade. The effects of exchange rate volatility on economic growth have always been a controversial issue in the economic literature. With an extroverted, dollarized and commodity-dependent economy, the exchange rate is an important determinant of the Congolese economy. Indeed, since the early 1990s, the Congolese economy has suffered from a continuous depreciation of its national currency due to its dependence on the outside world, which has made economic activity unstable.

Using the VAR model, the empirical results showed a significant impact of exchange rate volatility on economic growth. These results suggest that the resilience of the Congolese economy should be strengthened by diversifying economic activity to boost its international competitiveness. Nevertheless, taking

into account the determinants of the exchange rate in the relationship between the exchange rate and economic growth will help refine the results of future work.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendices

Table A1. Stationarity tests.

Economic Growth Series

Null Hypothesis: D(GDP/capita) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic—based on SIC, maxlag = 7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−5.508260	0.0003
Test critical values:	1% level	−4.603564	
	5% level	−2.902357	
	10% level	−2.862354	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Inflation Series

Null Hypothesis: Infl has a unit root

Exogenous: Constant

Lag Length: 5 (Automatic—based on SIC, maxlag = 7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−13.20135	0.0006
Test critical values:	1% level	−3.023452	
	5% level	−2.452103	
	10% level	−2.412034	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Gross fixed capital formation series

Null Hypothesis: Gfcf has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic—based on SIC, maxlag = 7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−5.403587	0.0006
Test critical values:	1% level	−3.120358	
	5% level	−2.542089	
	10% level	−2.622989	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Public expenditure series

Null Hypothesis: D(Govt) has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic—based on SIC, maxlag = 7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−5.4120387	0.0003
Test critical values:	1% level	−2.645201	
	5% level	−2.421302	
	10% level	−2.621489	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Exchange rate series

Null Hypothesis: D(Exc.r) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic—based on SIC, maxlag = 9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−4.110235	0.0465
Test critical values:	1% level	−2.459876	
	5% level	−2.421688	
	10% level	−2.456897	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Commercial Opening Series

Null Hypothesis: Trade has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 5 (Automatic—based on SIC, maxlag = 7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−5.452100	0.0002
Test critical values:	1% level	−3.469863	
	5% level	−3.986329	
	10% level	−3.853146	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Money supply growth rate series

Null Hypothesis: Ms has a unit root

Exogenous: Constant

Lag Length: 6 (Automatic—based on SIC, maxlag = 7)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		−10.42013	0.0001
Test critical values:	1% level	−3.489536	
	5% level	−2.963542	
	10% level	−2.875423	

*MacKinnon (1996) one-sided *p*-values. Note: Author's calculations.

Table A2. Determining the optimal shift number.

VAR Lag Order Selection Criteria

Endogenous variables: GDP/Capita Infl gfcf Govt Exc.r Trade Ms

Exogenous variables : C

Date: 28/02/22 Time: 10:25

Sample: 1990 2021

Included observations: 32

Lag	LogL	LR	FPE	AIC	SC	HQ
0	−3451.419	NA	1.47e+21	60.09424	60.18972	60.13299
1	−3309.190	272.0905	1.64e+20*	57.89895*	58.37633*	58.09272*
2	−3307.569	2.988290	2.11e+20	58.14902	59.00830	58.49780
3	−3305.524	3.627581	2.70e+20	58.39172	59.63290	58.89551
4	−3281.723	40.56430*	2.37e+20	58.25606	59.87915	58.91486
5	−3268.613	21.43321	2.51e+20	58.30630	60.31130	59.12012
6	−3267.786	1.294335	3.30e+20	58.57018	60.95708	59.53901
7	−3266.813	1.453973	4.36e+20	58.83154	61.60034	59.95538
8	−3264.079	3.898910	5.61e+20	59.06225	62.21296	60.34111

*indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Note: Author's calculations.

Table A3. Granger causality test.

Pairwise Granger Causality Tests

Date: 28/02/22 Time: 13:57

Sample: 1990 2021

Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
GDP/Capita does not Granger Cause Infl	32	0.09021	0.9138
Infl does not Granger Cause GDP/Capita		0.71253	0.0425
GDP/Capita does not Granger Cause gfcf	32	0.03267	0.9679
gfcf does not Granger Cause GDP/Capita		0.20492	0.8150
GDP/Capita does not Granger Cause Govt	32	0.37524	0.8995
Govt does not Granger Cause GDP/Capita		0.00624	0.9938
GDP/Capita does not Granger Cause Exc.r	32	0.02997	0.9705
Exc.r does not Granger Cause GDP/Capita		0.00045	0.0019
GDP/Capita does not Granger Cause Trade	32	0.37516	0.6880
Trade does not Granger Cause GDP/Capita		0.02505	0.0973
GDP/Capita does not Granger Cause Ms	32	0.00557	0.9944
Ms does not Granger Cause GDP/Capita		0.00226	0.9977
Infl does not Granger Cause gfcf	32	0.51873	0.5349
gfcf does not Granger Cause Infl		0.03218	0.2458
Infl does not Granger Cause Govt	32	0.03201	0.1485
Govt does not Granger Cause Infl		0.01285	0.9995
Infl does not Granger Cause Exc.r	32	0.37516	0.6880
Exc.r does not Granger Cause Infl		0.02505	0.9753
Infl does not Granger Cause Exc.r	32	0.07524	0.1257
Exc.r does not Granger Cause Infl		0.00205	0.7412
Infl does not Granger Cause Trade	32	0.04102	0.9938
Trade does not Granger Cause Infl		0.02038	0.7705
Infl does not Granger Cause Ms	32	0.34106	0.9995
Ms does not Granger Cause Infl		0.04879	0.1280
gfcf does not Granger Cause Govt	32	0.00126	0.8752
Govt does not Granger Cause gfcf		0.03685	0.6521
gfcf does not Granger Cause Exc.r	32	0.03527	0.7125
Exc.r does not Granger Cause gfcf		0.05011	0.8541
gfcf does not Granger Cause Trade	32	0.63250	0.2413
Trade does not Granger Cause gfcf		0.10232	0.3541
gfcf does not Granger Cause Ms	32	0.63251	0.7432
Ms does not Granger Cause gfcf		0.03210	0.3258

Continued

Govt does not Granger Cause Exc.r	32	0.00350	0.4123
Exc.r does not Granger Cause Govt		0.02320	0.3896
Govt does not Granger Cause Trade	32	0.03205	0.7474
Trade does not Granger Cause Govt		0.03652	0.3592
Govt does not Granger Cause Ms	32	0.06320	0.2987
Ms does not Granger Cause Govt		0.69832	0.1875
Exc.r does not Granger Trade	32	0.41035	0.7410
Trade does not Granger Cause Exc.r		0.06320	0.5369
Exc.r does not Granger Ms	32	0.02045	0.7459
Ms does not Granger Cause Exc.r		0.03210	0.2589
Trade does not Granger Ms	32	0.00158	0.6523
Ms does not Granger Cause Trade		0.15892	0.1963

Table A4. Estimation of the VAR model.

Vector Autoregression Estimates

Date: 02/03/22 Time: 12:20

Sample (adjusted): 1990 2021

Included observations: 31 after adjustments

Standard errors in ( ) & t-statistics in [ ]

	GDP/Capita	Infl	Gfcf	Govt	Exc.r	Trade	Ms
GDP/Capita(−1)	1.418854	−3.786012	−111.1354	−3.786012	−111.1354	3.103907	117.9032
	(0.20764)	(2.48259)	(39.5720)	(2.48259)	(39.5720)	(3.47090)	(55.3256)
	[6.83331]	[−1.52503]	[−2.80843]	[−1.52503]	[−2.80843]	[0.89427]	[2.13108]
Infl(−1)	−0.960195	−0.075746	−0.428607	0.003982	−0.488403	−0.488403	−0.488403
	(0.29030)	(0.09357)	(1.61868)	(0.22045)	(2.49056)	(2.49056)	(2.49056)
	[−3.30762]	[−0.00850]	[−0.26479]	[0.11806]	[−0.19610]	[−0.19610]	[−0.19610]
Gfcf(−1)	0.255994	−0.002815	0.865075	0.000201	−0.000929	−0.000929	−0.000929
	(0.17501)	(0.00268)	(0.04636)	(0.00631)	(0.07133)	(0.07133)	(0.07133)
	[1.46275]	[−1.05036]	[18.6605]	[0.03187]	[−0.01303]	[−0.01303]	[−0.01303]
Govt(−1)	0.011458	0.004104	−0.118666	−0.000262	−0.010208	−0.010208	−0.010208
	(0.01431)	(0.03999)	(0.69181)	(0.09422)	(1.06444)	(1.06444)	(1.06444)
	[0.80078]	[0.10263]	[−0.17153]	[−0.00278]	[−0.00959]	[−0.00959]	[−0.00959]
Exc.r(−1)	−0.001356	0.001674	−0.021657	−0.000490	0.798297	0.798297	0.798297
	(0.00471)	(0.00209)	(0.03613)	(0.00492)	(0.05559)	(0.05559)	(0.05559)
	[−0.28808]	[−0.00161]	[−0.59945]	[−0.09965]	[14.3609]	[14.3609]	[14.3609]
Trade(−1)	−0.000226	0.001674	−0.021657	−0.000490	0.798297	0.798297	0.798297
	(0.00098)	(0.00209)	(0.03613)	(0.00492)	(0.05559)	(0.05559)	(0.05559)

Continued

	[−0.23067]	[0.80161]	[−0.59945]	[−0.09965]	[14.3609]	[14.3609]	[14.3609]
Ms(−1)	−0.001024	0.001674	−0.021657	−0.000490	0.798297	0.798297	0.798297
	(0.00100)	(0.00209)	(0.03613)	(0.00492)	(0.05559)	(0.05559)	(0.05559)
	[−1.01980]	[0.80161]	[−0.59945]	[−0.09965]	[14.3609]	[14.3609]	[14.3609]
C	−0.000312	16.99410	129.5185	−0.702794	211.9346	211.9346	211.9346
	(0.00095)	(6.29739)	(108.938)	(14.8362)	(167.617)	(167.617)	(167.617)
	[−0.32760]	[2.69859]	[1.18892]	[−0.04737]	[1.26440]	[1.26440]	[1.26440]
R-squared	0.794468	0.019555	0.751795	0.000097	0.638993	0.638993	0.638993
Adj. R-squared	0.717393	−0.013965	0.743310	−0.034088	0.626651	0.626651	0.626651
Sum sq. resids	25.38916	407201.4	1.22E+08	2260131.	2.88E+08	2.88E+08	2.88E+08
S.E. equation	1.028534	58.99452	1020.544	138.9869	1570.248	1570.248	1570.248
F-statistic	10.30778	0.583382	88.59632	0.002842	51.77344	51.77344	51.77344
Log likelihood	−43.27926	−668.0061	−1015.785	−772.5522	−1068.354	−1068.354	−1068.354
Akaike AIC	3.134074	11.03289	16.73418	12.74676	17.59597	17.59597	17.59597
Schwarz SC	3.583004	11.14781	16.84910	12.86168	17.71089	17.71089	17.71089
Mean dependent	5.958824	15.26967	769.7426	−0.957377	970.4840	970.4840	970.4840
S.D. dependent	1.934761	58.58686	2014.313	136.6769	2569.868	2569.868	2569.868
	Determinant resid covariance (dof adj.)		1.56E+20				
	Determinant resid covariance		1.32E+20				
	Log likelihood		−3518.442				
	Akaike information criterion		58.00725				
	Schwarz criterion		58.46692				