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Analysing the dynamic interplay of remittance inflows, manufacturing output and foreign direct investment (FDI) on Gross Domestic Product (GDP) of Zimbabwe: VAR and VECM Approach spanning 1980-2022

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Abstract

This paper employs Vector Autoregressive model (VAR) to estimate the short-run impacts and the Vector Error Correction Model (VECM) to estimate the long-run impacts of foreign direct investment (FDI), remittance inflows, manufacturing output on Zimbabwe's economic growth. Time series annual data for the period 1980 -2022 were used to examine whether selected macroeconomic variables impact positively or negatively on Zimbabwe's economic growth. Stationarity, Granger causality, Cointegration tests were carried out. There was also evidence of cointegration among variables that became stationary after first difference $I(1)$ using the Johansen Cointegration Test. Evidence from the results showed that foreign direct investment (FDI), remittance inflows, manufacturing output do positively stimulate economic growth in Zimbabwe both in the short run and long run. Impulse Response Function (IRF) has also explained that GDP positively respond to shocks amongst the explanatory variables. In order to promote sustainable and inclusive economic growth in Zimbabwe, it is suggested the government should protect and give incentives to the local industries to enhance production capacity, prioritise the implementation of institutional reforms and remittance-funded projects that encourage diasporas' participation in economic growth, create a favourable environment for foreign investors.

Keywords: Remittances, manufacturing output, FDI, GDP, VAR, VECM, cointegration, granger causality

Introduction

Background of the problem

Zimbabwe's economic decline since 1997 has seen country's macro-economic deteriorating in to a hyperinflationary economy. This has resulted in an unsustainable socio-economic condition that forced 37.8% of the population to migrate internationally (International migration organization 2008). According to C.L, Mnangagwa (2009) past researchers have concluded that the economic decline was caused by poor monetary policies, failure of fiscal policies to control budget deficit though some officials put blame on other factors such as corruption, sanctions, droughts. The average GDP in Zimbabwe averaged 8.44USD billion from 1960-2022, Agriculture and mining largely contribute to the government's exports with a large margin of contribution in GDP. The government officials have been left fingering different sectors, introducing policy after policy of the economy as they continue to fight the economic recession some of the policies include ESAP 1990, ZIMPREST 1996-2000, etc. Other factors ie natural disasters such as Cyclone Idai, COVID-19, Elnino droughts, floods continue to draw back efforts being made to improve economic performance of Zimbabwe.

The research problem

Zimbabwe, a developing country located in Southern Africa, has faced significant economic challenges since gaining independence in 1980. The country's economy has experienced periods of high inflation, currency fluctuations, and declining economic growth.

In recent years, Zimbabwe has become increasingly dependent on remittance inflows, manufacturing output, and foreign direct investment (FDI) to drive economic growth and development. Remittances inflows have become a vital source of foreign exchange earnings for Zimbabwe, with millions of Zimbabweans living and working abroad sending money back home to support their families as way to alleviate poverty back home. Manufacturing output has also been identified as a key sector for economic growth, with the government implementing policies to revitalize the industry. Foreign Direct Investment (FDI) has also played a crucial role in Zimbabwe's economic development, with foreign investors attracted to the country's natural resources and strategic location. Despite the importance of these factors, there is limited research on the dynamic interplay between remittance

inflows, manufacturing output, FDI, and GDP in Zimbabwe. This study aims to address this knowledge gap by statistically analyzing the short-run and long-run relationships between these variables using Vector-Autoregression (VAR) and Vector Error Correction (VECM) models.

Aim

This study aims to conduct a comprehensive analysis of the relationships and impact of remittance inflows, manufacturing output, foreign direct investments on real GDP of Zimbabwe using VAR and VECM models with the ultimate goal of informing evidence-based decision.

\subsection {Economic growth of Zimbabwe from independence:}

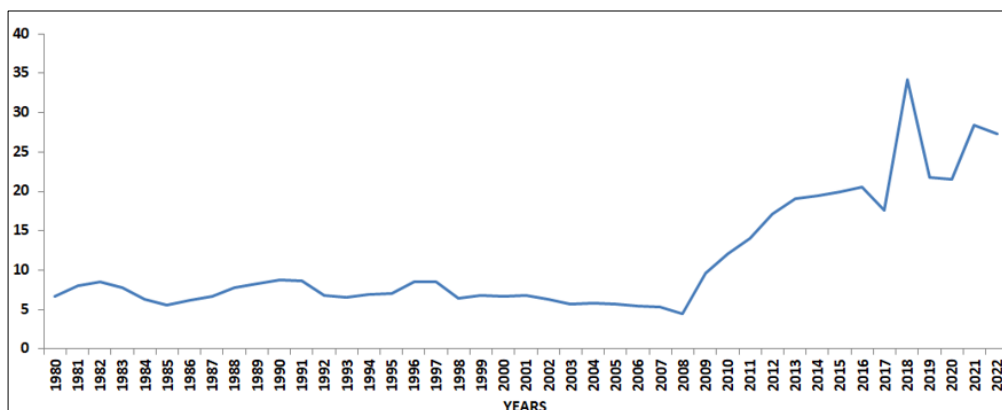


Fig 1: GDP in billions US\$

Real GDP of Zimbabwe 1980-2022

From 1980 since the British flag was ceremonially pulled down it is thus an appropriate moment to reflect country's performance and to see how far hopes of many Zimbabweans and other nations who wished her independence before 1980 have been fulfilled. According to Rodger C Rodinell in his analysis of the performance of the economy 4 years after independence he showed that Zimbabwe economy performed so much better than its neighbours.

However, depressed foreign demand for the country's mineral exports and the onset of drought cut sharply into the growth rate in 1982, 1983, and 1984. In 1985, the GDP rebounded strongly due to a 30% jump in agricultural production. However, it falls in 1986 to a zero-growth rate and registered a negative of about 3% in 1987, primarily because of drought and the foreign exchange crisis faced by the country.

In 1997, Zimbabwe's economic decline began to visibly take place. It began with the crash of the stock market on November 14, 1997. This was mainly due to private sector that was suffering from decreasing output and increasing competition from cheap imported products. The average growth of the economy from 1980 - 1990 was about 4.5%.

According to Mandivamba (2006), Between 2000 and 2007, GDP slowly declined with inflation vaulted to over 66,000%, and there were persistent shortages of hard currency, fuel, medicine, and food. GDP per capita dropped by 40%, agricultural output dropped by 51% and industrial production dropped by 47%, the government however blamed sanctions.

According to world bank indicators. The country experienced hyperinflationary conditions in 2008-09 however the government of national unity introduced the de-dollarization which resulted in the economy appreciating foreign currency transactions. In 2009, Zimbabwe recorded a period of

economic growth for the first time in a decade. The GDP experienced a sharp increase up-to 2016 when the bond notes were introduced. Staff Reporter (2019-02-20). In August 2014, Zimbabwe began selling treasury bills and bonds to pay public sector salaries that have been delayed as GDP growth weakens while the economy experiences deflation.

In June 2019 the use of foreign currencies in local transactions was prohibited as part of the prospective plan for a new national currency and thus ended the dollarization period, Samaita, K (15 July 2019) ^[21]. In 2019 midyear, After the adoption of a new Zimbabwe dollar, inflation had increased to 175% and banning the use of foreign currency thereby sparking fresh concerns that the country was entering a new period of hyperinflation. The GDP experienced a low increase up-to 2016, however from 2019 the economy experience an increase in economic growth this can be attributed to the economy appreciating the foreign currency transactions and re-industrialisation through foreign investment.

Manufacturing output (% to GDP) continue to show large percentage during the entire period this implies that the sector's growth is more significant part of the economic growth. Comparing the plots, it is clear that percentage contributions of FDI and remittance inflows are below production output. However, the slight decrease from 1990 to year 2000 this can be attributed to lack of investment during that period, investors lacking confidence in investing in Zimbabwe, lack of infrastructure such as roads and electricity. During 2008 the decline was caused by hyperinflation that was experienced by nation, many industries closed. However during and after the government of national unity the manufacturing output recorded an increase this was due to effective policies introduced during that period.

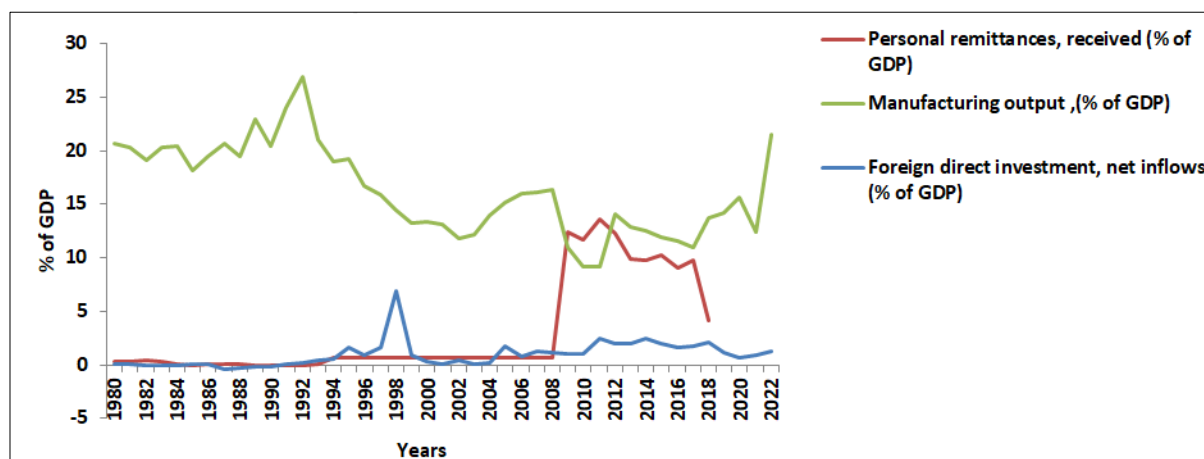


Fig 2: Net inflows of personal remittances, FDI and manufacturing output to GDP of Zimbabwe 1980-2022

The plot of remittance inflows, shows a low to negative personal remittance inflows % of economic growth from 1980 to 1993 with a steady weak increase from 1993 to 2008. During that period the economy was performing normal to an extent that majority of Zimbabweans would find no reason to migrate. Factors such as the economic crisis (2000-8) which was characterised by high unemployment levels and hyperinflation in 2008 (ZimStat, 2009) [32] has led to many Zimbabweans living the country in search for greener pastures, the economy recorded remittance inflow's sharp increase in 2008 for the first time since attaining independence. The steady increase in worker's remittances over the years in specific 2008 going forward, can be attributed to factors such as increase Zimbabweans migrating to other countries and lowering of transactions costs. Low inflows might be due to money is being send through unofficial channels because people lacks confidence to send money through the formal channels.

The graph makes it abundantly evident that between 1980 and 1990, Zimbabwe saw very little net foreign direct investment (FDI) inflows. This was because of a policy environment that was unfavorable to international investors at the time. Gwenhamo (2011) [10] claims that the late 1980s saw a shift in Zimbabwe's government's policies toward foreign investors, which resulted in a marginal improvement in FDI. The Zimbabwe Investment Centre (ZIC), which was set up as a one-stop shop for approvals, was the reason for the spike in FDI that was observed between 1992 and 1997. FDI decreased from a positive to a negative percentage of GDP between 1985 and 1990.

FDI net inflows increased from 1990, when they were negative, to 1995, when they were positive. The net inflow of foreign direct investment (FDI) into Zimbabwe increased between 2000 and 2005, while its contribution to the Zimbabwean economy decreased between 2005 and 2010. The country saw a positive improvement from 2020 to 2022, although the FDI contribution to GDP had a negative rise from 2018 to 2020. This can be linked to multinational corporations closing because of a lack of confidence in the local currency at that time.

Literature review

The impact of remittances inflows on GDP

Optimistic view examines remittance inflows as with a positive implication to both the sending and receiving households and their nations and was pioneered under the Laws of migration by Ravenstein in 1889. Migrant remittances are viewed as an instrument that stimulate savings

and investment and also as an instrument for restoring balance of payment at the country of origin. Ratha (2007) [19] supported the neo-classicalist, by emphasising that remittances assume an important role in raising the capital market sector activities and help in giving profitable foundation and also in raising the viable interest for products and administration.

By applying the Auto-Regressive Distributed Lagged model (ARDL), Odionye and Emerole (2015) identified that remittances positively impact the economic development of the receiving country. The study postulated that proper utilisation of international remittances flow enhances development of the receiving economies and this can be achieved through diversification of proceeds into productive purposes. A three staged least squares estimation (OLS) technique was used by Tambama to see the impact of remittances on poverty alleviation in Zimbabwe from 1980 to 2007. The study provided evidence that a unit increase in the share of remittances on GDP reduces poverty by 52% and increases human capital accumulation by 11.5% in Zimbabwe. She concluded that remittances contribute significantly to development objectives such as Millennium Development Goals (MDGs).

Akonji and Wakoli (2013) [3] conducted research on impact of net migrant remittances on economic growth of Nigeria, which used the Seemingly Unrelated Regression (SUR) analysis and Error Correction Model (ECM). Their finds established a significant relationship between net migrant remittances on Nigerian economic growth. However, they also concluded that impact of migrant remittances can be more meaningful and contribute to economic growth only if financial institutions are well organised and be made more competitive to provide remittances services at low cost so that remittances flow into the country through official channels.

Production output impact on GDP

According to Su and Yao, who looked at the role of manufacturing during the middle-income development phase, manufacturing continues to be the primary driver of economic growth for middle-income economies during this phase, pulling alongside all other sectors, including the service sector. The Attiah research, which looked at how the manufacturing and service sectors contribute to economic growth in emerging nations, produced a similar finding. The findings indicate a favorable correlation between economic growth and the manufacturing sector's GDP share.

Within the African context, Moyo and Jeke investigated the connection between economic growth and manufacturing in

37 African nations. The findings demonstrate that industrial value contributes to economic growth in African nations. To boost production output, policymakers are advised to take action.

Impact of FDI on economic growth

Numerous researches have attempted to establish the link between FDI and macroeconomic performances including GDP, however, the results are rather mixed. Balasubramanyam, Salisu and Sapsford (1996)^[5] argued that FDI can speed up growth of the receiving countries through improving foreign trade and ensuring stability of macroeconomic variables. Further, they concluded that FDI inflows can effectively boost economic growth than local investments in developing economies which implement export promotion policies. For nations with high institutional competence, FDI has a significant beneficial influence on their growth. (Olofsdotter, 1998)^[16].

Akiri, Vehe and Ijuo (2016)^[2] used VECM and determined positive impact of inward FDI to Nigeria's GDP growth during from 1981 to 2014. Stoneman (1975)^[24] investigated the effect on growth caused by foreign direct investment in the growing economies from 1945 to 1970. He came to the conclusion that FDI had a detrimental effect on economic growth. However the FDI can be have a negative impact on economic growth, The effect of FDI on Nigeria's GDP was negative and negligible when ECM was used (Akinlo, 2004)^[1].

Methodology and Data analysis

Research Design

The research design encompasses the aims, approach, type of design, experimental research design. Quantitative research will be used in this study. According to (Kisely and Kendal 2011) quantitative research entails using numerical data from a group of people or using the secondary data and statistical techniques to achieve research objectives.

Data collection and Data source

The study employs secondary annual time series data set to examine the influence of the selected variables on GDP of Zimbabwe from 1980 to 2022. The data was obtained from the following websites which are official boards for disseminating national data such as ZIMSTAT (Zimbabwe Statistics Agency)^[32], IMF (International Monetary Fund) and World Bank. Direct links are www.macrotrends.co.zw, <https://www.fred.stlouisfed.org> (Federal Reserve Economic Data).

Table 1: Software: R-Studio and STATA

Variable coded as	Description
GDP	Real Gross Domestic Product
REM	Remittances inflows
MAN	Manufacturing output
FDIs	Foreign Direct Investments

Table 2: Descriptive statistics

Variable	Min	1 st Qu	median	Mean	3 rd Qu	Max
GDP	4.416	6.483	7.815	11.214	15.608	34.156
FDIs	-0.4525	0.0533	0.7348	0.9503	1.6195	6.9401
REM	0.004048	0.252396	0.633979	3.474671	8.774826	13.611451
MAN	9.172	13.032	15.879	16.324	19.904	26.899

Year Length- 43 class -character mode-character

The first line summary' shows the summary statistics of the data with first variable year' as character class with 43 rows, GDP, REM and MAN are all numeric'. Head' shows the

first 6 rows of the data set, while tail' shows the last 6 rows of the dataset. Str' shows the variable class and data size with 43 rows and 5 columns (43 by 5).

Model specifications.

The researcher adopts the 'principle of parsimony' which states that the model used should require the smallest possible number of parameters that will actually represent the data. Models that capture all of the signal and none of the noise provide the best possible predictions to unseen data from the same source. More simplistic models, may, fail to capture part of the signal and these models under-fit the data and provide poor predictions however overly complex models, over-fit the data and again provide poor predictions. Thus, parsimony is essential because it helps discriminate the signal from the noise, allowing better prediction and generalization to new data. In addition, most people feel naturally attracted to models and explanations that are easy to understand and interpret.

1. Vector Autoregressive model (VAR model).

Sims (1980)^[22] established the VAR model as a method that macroeconomists might use to analyze the joint dynamic behavior of a group of variables without the requirement for stringent constraints, such as those required to uncover underlying structural factors. In reality, the VAR model is a synthesis of multiple autoregressive (AR) models, which create a vector between the variables that influence one another. A quantitative forecasting method that is typically used with multivariate time series data is the VAR model. The VAR model is a kind of stochastic model that compares the current observations of a variable to its historical data as well as those of other variables in the system.

It records the evolution and interdependencies among many time series. One of the most popular, adaptable, and user-friendly models for analyzing multivariate time series is the vector auto regression model. The univariate autoregressive model is a logical progression to dynamic multivariate time series. The Vector Autoregressive (VAR) model is a potent tool in econometrics and time series analysis for comprehending and predicting the dynamic interrelationships among several variables.

Because they can capture intricate relationships between variables, VAR models have become increasingly popular. This has allowed them to shed light on financial trends, economic system behavior, and other dynamic processes. Let m be variables that are described as a linear function of p -lags of itself and of all the other $m-1$ variables, plus an error term, and consider the VAR(p) model of x and y variables:

$$x_t = c_1 + \sum_{i=1}^p \alpha_i x_{t-p} + \sum_{i=1}^p \beta_i y_{t-p} + \epsilon_{1t}$$

$$y_t = c_2 + \sum_{i=1}^p \gamma_i x_{t-p} + \sum_{i=1}^p \delta_i y_{t-p} + \epsilon_{2t}$$

where;

x_t and y_t are variables x and y at time t

c_1 and c_2 are constants

α , β , γ and δ are coefficients

ϵ_{1t} and ϵ_{2t} are error terms

p is the number of lags
Similarly the equations can be expressed as:

$$\begin{bmatrix} x_t \\ y_t \end{bmatrix} = \begin{bmatrix} c_1 \\ c_2 \end{bmatrix} + \begin{bmatrix} \alpha_1 & \beta_1 \\ \gamma_1 & \delta_1 \end{bmatrix} \begin{bmatrix} x_{t-1} \\ y_{t-1} \end{bmatrix} + \dots + \begin{bmatrix} \alpha_p & \beta_p \\ \gamma_p & \delta_p \end{bmatrix} \begin{bmatrix} x_{t-p} \\ y_{t-p} \end{bmatrix} + \begin{bmatrix} \epsilon_{1t} \\ \epsilon_{2t} \end{bmatrix}$$

The VAR model of the data understudy is to be presented as follows:

$$GDP_t = c_1 + \alpha_1 GDP_{t-1} + \alpha_2 GDP_{t-2} + \dots + \alpha_p GDP_{t-p} + \beta_1 REM_t + \beta_2 REM_{t-1} + \dots + \beta_p REM_{t-p-1} \\ + \gamma_1 MAN_t + \gamma_2 MAN_{t-1} + \dots + \gamma_p MAN_{t-p-1} + \delta_1 FDI_{t-1} + \delta_2 FDI_{t-2} + \dots + \delta_p FDI_{t-p-1} + \epsilon_1 t$$

Where, GDP, REM, MAN and $FDIs$ are variables

t is time period

$c_1 = \text{constant}$

γ, δ and α are coefficients

$\epsilon = \text{error terms}$

Note: The researcher will select one equation of interest out of four equations, in this case the equation which models GDP as a response variable.

Stationarity test.

In time series analysis it is important to check stationarity on the variables, non stationary variables can lead to false correlations and relationships, biased and inconsistent estimates of a model parameters. Stationarity ensures that the results of time series analysis are meaningful and influenced by trends or seasonality.

Table 3: Unit root test at level

Variable	ADF		Phillips-Perron PP	
	Test Statistic	Critical Value at 5%	Test Statistic	Critical Value at 5%
GDP	1.298	-1.950	1.216	-1.950
FDIs	-2.021	-1.950	-2.923	-1.950
REM	-0.279	-1.950	-0.428	-1.950
MAN	-0.444	-1.950	-0.348	-1.950

Alternative: The variable does not have a unit root(its stationary)

From the ADF and PP test results above we fail to reject null hypothesis and conclude that manufacturing output, remittance inflows were all non-stationary at level $I(0)$ at 5% level of significance, only FDIs was stationary at 0.05, Since the test has concluded that other variables are non-stationary at their level therefore we proceed to difference these variables if they became stationary at their first difference $I(1)$ then the variables can fit VECM once there exists a cointegration among them.

Differencing non-stationary series:

Differencing makes a non-stationary series stationary, which is a requirement for time series models such as VEC and VAR. Differencing also stabilize the variance making it constant overtime.

Table 4: Unit root test after first difference

Variable	ADF		Phillips-Perron PP	
	Test Statistic	Critical Value at 5%	Test Statistic	Critical Value at 5%
dGDP	-6.791	-1.950	-10.261	-1.950
dREM	-4.095	-1.950	-6.952	-1.950
dMAN	-4.604	-1.950	-6.587	-1.950

Table 5: Select the optimal lag length to fit VAR model on the differenced data

Criteria	Lags	1	2	3
AIC(n)		7.613410	7.590347*	7.802967
HQ(n)		7.775681	7.874321	8.208644
SC(n)		8.198471	8.614203	9.265618
FPE(n)		2042.092824	2072.351876	2821.038798

Based on the results above the VAR model will be fitted with a lag of 2 according 'AIC'. The AIC (Akaike Information Criteria) strikes a balance between model fit and complexity avoiding over fitting and under fitting therefore it estimates

better models, this means the VAR model (Short run model) will be lagged with the previous two years.

Granger Causality test

Granger causality, as described by Clive Granger, can be used to clarify the direction of potential causality between pairs of variables under certain contentious assumptions. It is crucial for statisticians and econometricians to understand that "correlation does not imply causality." Since correlation or covariance is a symmetric, bivariate connection, we cannot simply determine the presence or direction of causality between x and y by looking at non-zero covariance; $\text{cov}(x, y) = \text{Cov}(y, x)$. Granger causality defines whether past values of x help anticipate y_t provided that the effects of past values of y on y_t have already been taken into consideration. They are said to "Granger cause" y if they do.

Assuming that x and y are variables, the first equation represents y_t as a linear function of both x 's and its own historical values. Some or all of the lagged x values have non-zero impacts if x Granger causes y (which we write as x implies y): lagged x influences y_t conditional on the effects of lagged y . In the VAR model of variables x and y , testing for Granger causation entails checking to verify if the joint blocks of coefficients β_{xy} and β_{yx} are zero. H_0 is the null hypothesis in the VAR, which states that x does not Granger cause y . The formula is $\beta_{yx} = \beta_{yx} = \dots = \beta_{yxp} = 0$.

A typical Wald F or χ^2 test can be used to test that. In the same way, H_0 for the null hypothesis y implies x is $\beta_{xy} = \beta_{xy} = \dots = \beta_{xyp} = 0$. There are four possible results from these two tests. When analyzing VAR models, the Granger Causality test is crucial because it facilitates the identification of cause-and-effect linkages between variables. The economics community has made extensive use of the test.

Null Hypothesis	F	Pr(>F)	Decision
Manufacturing output doesn't granger cause GDP	9.3228	0.02337*	Reject
FDIs doesn't granger cause GDP	19.42	0.00599**	Reject
Remittance inflows doesn't granger cause GDP	6.2602	0.04705*	Reject

Alternative: REM, MAN and FDIs does granger cause GDP (they are independent variables of GDP).

From the results above, p-value is less 5% significant level for all variables, therefore we reject the null hypothesis with sufficient evidence to conclude that REM, MAN and FDIs, they do cause GDP meaning changes, shocks or innovations on these variables do affect the real GDP of Zimbabwe.

Table 6: VAR model Estimates

Vector AutoRegressive Model					
Sample:1883-2022			No of Obs :40		
Log-Likelihood:-331.6994			AIC:18.38497		
FPE:1170.041			HQIC:18.93455		
Det(Sigma.ml:187.4405)			SBIC:19.90496		
Variable _{t-p}	Coef.	Std.Error	z	95% Conf.	Interval
$dGDP_{t-1}$	-0.6129228	0.147205	-4.16	-0.9014394	-0.3244062
$dGDP_{t-2}$	-0.317297	0.1424633	-2.23	-0.5965199	-0.0380741
$dREM_{t-1}$	0.5166966	0.2319996	2.23	0.0619858	0.9714074
$dREM_{t-2}$	0.4158722	0.24441237	1.70	-0.0626014	0.8943459
$dMAN_{t-1}$	0.0488719	0.2335083	0.21	-0.408796	0.5065399
$dMAN_{t-2}$	0.0800298	0.2389244	0.33	-0.3882534	0.54831331
FDI_{t-1}	0.3323567	0.3905515	0.85	-0.4331101	1.09782
FDI_{t-2}	0.226365	0.3844397	0.59	-0.5271229	0.979853
const	0.1738817	0.6200846	0.28	-1.041462	1.389225
Equation	Parms	RMSE	R-sq	chi2	P>chi2
dGDP	9	3.19038	0.4191	28.86021	0.0003

Interpretation

These are short run impacts estimated after first difference except for FDIs that was stationary at level. The dependent variable is a function of its lagged values (AR) and the lagged values of other variables in the model. The positive coefficients in remittance, manufacturing and foreign direct investment indicates the impact of the lagged values of these variables on the current value of GDP. The positive coefficient suggests that a positive relationship meaning the past value of positively influence the current value of GDP.

2. Vector Error Correction model (VECM model)

For non-stationary series that are known to be co-integrated, a vector error correction (VEC) model is a constrained VAR model with cointegration restrictions incorporated into the specification. Multivariate time series modeling includes the Vector Error Correction Model (VECM). ECM (Error Correction Modelling), which examines the long-term relationship between a few non-stationary variables in the original data, is the most straightforward type of univariate modelling. With a combination of linear variables, the formation of this cointegration is like a new hope for the long-term establishment of a stationary situation. Therefore, if the point eventually reaches the equilibrium point, it is said to be cointegrated.

ECM can be employed if cointegration analysis is feasible. Testing will encounter the Error Correction Term (ECT) if it reaches the ECM analysis (short-term relationship). This is employed because the equilibrium state's adjustment speed is anticipated to be negative (convergent). While permitting a broad range of short-term dynamics, the VEC specification limits the endogenous variables' long-term behavior to converge to their cointegrating relationships. Since the departure from long-run equilibrium is gradually corrected through a succession of partial short-run adjustments, the cointegration component is also referred to as the error correction term.

Since there is a long-term relationship between variables if there is co-integration of variables in a series, we use VECM to assess the short-term characteristics of the co-integrated series; if co-integration is absent, we use the Granger Casualty test to look for casual relationships between variables. The cointegration rank in VECM indicates how many co-integrating vectors there are. Any short-term variations between independent and dependent variables will result in a stable long-term relationship between them, according to an ECM coefficient that is both negative and significant.

As a result, we may estimate short-term behavior, long-term cointegrating relationships, and short-term adjustment coefficients using the VECM model. The adjustment coefficients indicate the rate at which the short-term departures from long-term equilibrium are adjusted. The VECM model is provided in the following form after taking into account the short- and long-term relationships between y_t , the dependent variable, and x_1 and x_2 , the independent variables, together with their lagged values:

$$\Delta y_t = \alpha_1 + \beta_{11}\Delta y_{t-1} + \beta_{12}\Delta x_{1,t-1} + \beta_{13}\Delta x_{2,t-1} + \gamma_1 y_{t-1} - \delta_1 x_{1,t-1} - \delta_2 x_{2,t-1} + \epsilon_{1t}$$

$$\Delta x_{1,t} = \alpha_2 + \beta_{21}\Delta y_{t-1} + \beta_{22}\Delta x_{1,t-1} + \beta_{23}\Delta x_{2,t-1} + \gamma_2 y_{t-1} - \delta_3 y_{t-1} - \delta_4 x_{2,t-1} + \epsilon_{2t}$$

$$\Delta x_{2,t} = \alpha_3 + \beta_{31}\Delta y_{t-1} + \beta_{32}\Delta x_{1,t-1} + \beta_{33}\Delta x_{2,t-1} + \gamma_3 x_{2,t-1} - \delta_5 y_{t-1} - \delta_6 x_{1,t-1} + \epsilon_{3t}$$

Where,
 Δ denotes the first difference operator (e.g. $\Delta y_t = y_t - y_{t-1}$)

y_t is the dependent variable
 $x_{1,t}$ and $x_{2,t}$ are the independent variables
 α_1, α_2 and α_3 are constants
 $\beta_{11}, \beta_{12}, \dots, \beta_{33}$ are short term dynamics
 γ_1, γ_2 and γ_3 are error correction coefficients
 $\delta_1, \delta_2, \dots, \delta_6$ are long term relationship coefficients
 $\epsilon_{1t}, \epsilon_{2t}$ and ϵ_{3t} are error terms

For the data understudy the model is given as:
 1). Short-term dynamics

$$\Delta GDP_t = \alpha_1 + \beta_{11}\Delta GDP_{t-1} + \beta_{12}\Delta REM_{t-1} + \beta_{13}\Delta FDI_{t-1} + \beta_{14}\Delta MAN_{t-1} + \epsilon_{1t}$$

2). Long term relationships (Error Correction Terms)ECT

$$GDP = y_1 GDP - \delta_1 REM - \delta_2 FDI_s - \delta_3 MAN + \epsilon_{1t}$$

Where,

Δ denotes the first difference operator e.g. $\Delta_t = GDP_t - GDP_{t-1}$

Table 7: Lag length selection

Lags	1	2	3	4
Criteria				
AIC(n)	7.401242	7.845348	7.430245	6.875297
HQ(n)	7.563513	8.129322	7.835922	7.402677
SC(n)	7.986303	8.869203	8.892896	8.776743
FPE(n)	1651.703479	2674.292243	1943.291836	1357.412491

Interpretation: the best lag is selected on the basis of “AIC” which is 4 with a p value less 0.05 according the results in the above table,

Too many lags lead to loss of degrees of freedom, statistically insignificant coefficient and multicollinearity while too few lag lead to under parametrisation and specification errors.

Test for co-intergration with p-1 which 3

In VECM cointegration is an important aspect, variables are cointegrated when there is a long run relationship between multiple non-stationary time series variables. The variables may individually follow random walks(non –stationary), but there exists a combination of them that is stationary.

Table 8: But there exists a combination of them that is stationary.

Trend :Constant		No of Obs:39			
Sample :19					lags:4
Maximum	Parms	LL	Eigenvalue	Trace	Critical value 5%
0	30	-259.74116		37.5963	29.68
1	35	-248.93646	0.42540	15.9869	15.41
2	38	-241.0199	0.33367	0.1538*	3.76
3	39	-240.94301	0.00393		

Two variables m produce $m-1$ co-intergration equation so with three variables the number of cointegrating equations is $m-1$ which is 2, as selected by the trace statistic at 0.05 critical value.

According to Green, WH(2003), If the variables are cointegrated, construct both short-run (VAR) and the long-run model(VEC).

ECT term

After the shortrun VEC model was estimated the adjustment term was (-0.2848578) statistically significant at 5% level of significance, suggesting that the previous year's errors (or deviations from the long run equilibrium) are corrected for within the current year at the convergence of 28.48%.

Table 9: VECM Estimates

Vector Error-correction Model					
Sample:1884-2022				No of Obs :39	
Log-Likelihood:-248.9365				AIC:14.56084	
				HQIC:15.0965	
Det(Sigma_ml:70.26974)				SBIC:16.05378	
Short-run estimates					
$Variable_{t-p}$	Coef.	Std.Error	z	P>(Z)	
$ECT(1)$	-0.2848578	0.1379724	-2.06	0.039	
GDP_{t-1}	-0.5144482	0.1821205	-2.82	0.005	
GDP_{t-2}	-0.3887788	0.2035471	-1.91	0.056	
GDP_{t-3}	-0.0378853	0.1880114	-0.20	0.840	
REM_{t-1}	-0.0399028	0.3475924	-0.11	0.909	
REM_{t-2}	-0.0002835	0.3391508	0	0.999	
REM_{t-3}	0.0105933	0.3212139	0.03	0.974	
MAN_{t-1}	-0.1308589	0.2866824	-0.46	0.648	
MAN_{t-2}	-0.0242566	0.2676731	-0.09	0.928	
MAN_{t-3}	-0.1036731	0.2737883	-0.38	0.705	
const	0.4074398	0.5437971	0.75	0.454	
Long-run estimates					
GDP	1				
REM	-2.100625	0.3022113	-6.295	0.000	
MAN	-0.6915317	0.2867434	-2.41	0.016	
Const	5.664086	0.2867434	-2.41	0.016	
Equation	Parms	RMSE	R-sq	chi2	P>chi2
GDP (Short-run)	11	3.08204	0.5171	30.05407	0.0016
ECT(long-run)	2			54.2522	0.0000

Table 10: Short run Equation

$$GDP = 0.4074 - 0.51GDP_{t-1} - 0.388GDP_{t-2} - 0.037GDP_{t-3} - 0.30MAN_{t-1} - 0.024MAN_{t-2} - 0.103MAN_{t-3} - 0.039REM_{t-1} - 0.00028REM_{t-2} + 0.0105REM_{t-3}$$

Long –run equation (Co-integration equation)

$$GDP = 2.200REM + 0.6915MAN + 5,664$$

Note: The signs of the coefficients are reversed in the long-run hence interpreted as positive if negative or vice-versa. GDP variable is always positioned first as the dependent variable.

In the long-run Personal remittances, Manufacturing output, have a positive impact on GDP of Zimbabwe, all the coefficients are statistically significant at 5% level of significant.

In conclusion: Personal remittances, Manufacturing output have asymmetric effects on Zimbabwe's Real GDP in the long run on average ceteris paribus.

Model selection

After fitting the VAR and the VEC model, it is good to decide which model performs well than the other. The best model was selected on the basis of AIC and model coefficients significance. Based on the results above VAR has AIC" of 18.38497 while VECM has AIC" of 14.56084 the best model is the one with the smaller AIC, in addition VEC coefficients are statistically significant in the long run, indicating the VEC model as the preferred choice that has a better fit to the data and the parameters are more efficient in capturing the relationship between variables hence we proceed to diagnostics and model predictions with the VEC model.

Model Diagnostics**Arch Effects**

The Arch effects test checks for the presence of Autoregressive Conditional Heteroscedasticity (ARCH) effects (it tests whether the variance of the residuals changes over time) in the residuals of the VEC model.

Table 10: Data: Resident of VECM model

Degree of freedom	Chi-squared	p-value
540	60	1

Alternative: Arch effects are present in the residuals (heteroscedasticity)

Based on the results provided above, fail to reject null hypothesis and conclude that there is clear indication that there are no significant arch effects in model residuals, it suggests that the variance of the residuals is relatively constant over time and the model is not missing any significant time varying volatility patterns. In conclusion the model is capturing the relationship between variables reasonably well.

Test serial correlation(autocorrelation)

It is important to check autocorrelation of the model in order to avoid inaccurate estimation because serial correlation can lead to in accurate forecasting and violation of the assumption of independent errors.

Table 11: Lagrange-Multiplier test

lag	Chi2	df	Prob > chi2
1	3.0772	9	0.96114
2	13.9074	9	0.12566
H_0 : No autocorrelation at lag order			

The results above are from Breusch-Godfrey test for autocorrelation in the residuals of the VEC model with moving average (MA).

At lag order 1 we fail to reject the null hypothesis and conclude that there is no significant autocorrelation in the residuals at lag order 1, indicating that MA(1) is sufficient to capture any short-term dynamics. At lag order 2 we fail to reject the null hypothesis and conclude that there is no significant autocorrelation in the residuals at lag order 2, indicating that MA (2) is sufficient to capture any short-term dynamics. In conclusion the test indicate that there is no autocorrelation assuring that the assumption of independent errors is not violated.

Normality of residuals

Testing normality of residuals is a very crucial step in model diagnostics test as it checks if the assumption of normality of residuals is not violated, also normality of residuals ensures reliable inferences and hypothesis testing.

Alternative: Residuals are normally distributed

Based on the above Jarque-Bera test for residuals normality, all variables have significant values at 1% except for Manufacturing output, however the test further conclude that

ALL (0.0000) residuals are normality distributed, we reject the null hypothesis and conclude that the residuals are normally distributed ALL at 1% level of significance meaning the model assumption is satisfied allowing valid inferences and forecasting.

Table 11: Jarque-Bera test

Equation	Chi2	df	Prob > chi2
GDP	425.205	2	0.000
REM	1098.845	2	0.000
REM	0.019	2	0.99063
ALL	1524.068	2	0.000

Stability test:

Stability test ensures the VECM is reliable and produces accurate forecasts (it is used to asses forecasting performance of a model). The graph shows the representation of the companion matrix on the complex plane, the y axis shows the imaginery while the x axis shows the real. The unit circle (Radius 1) provides the guideline for interpretation, roots points inside unit circle indicate stability whilst roots outside circle indicate instability.

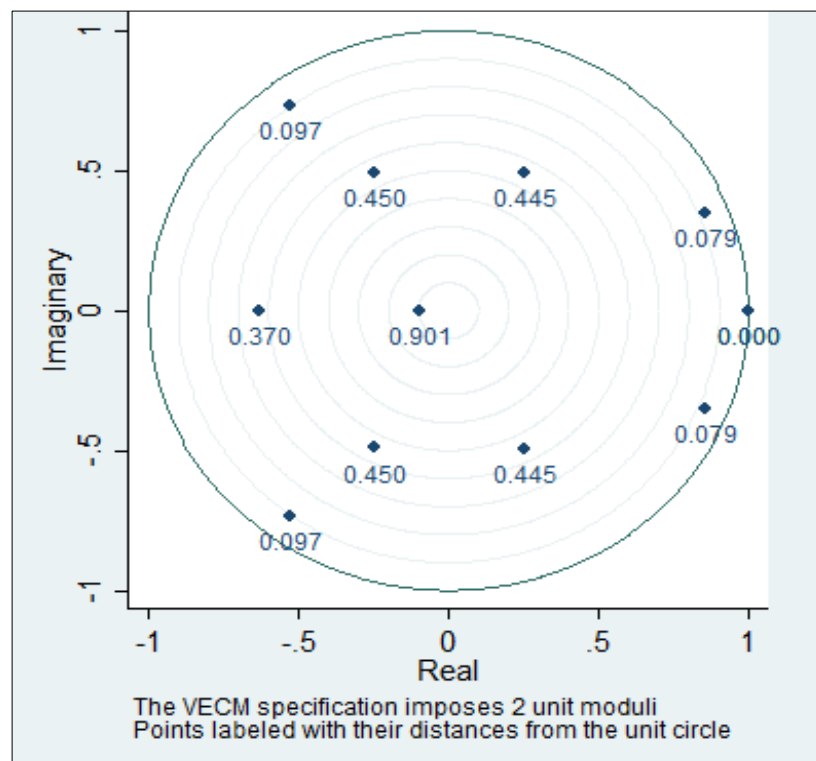


Fig 1: Roots of the companion matrix

The results above shows the results of the stability test, All roots are inside the unit circle, indicating the system is very stable and VECM is properly specified, no evidence of non-

stationarity, co-integrating relationships are valid and model is reliable for forecasting.





Fig 2: Impulse Response Function

The irfs above displays the response of GDP to a one-time standard deviation shock in Remittance inflow and production output, the irfs represents how a shock to Remittance inflows and production output, affects the GDP over time. The black line represents the response of GDP to the shock, the black line being above the horizon line (Zero boundary) indicates a positive response of GDP to a shock. The two red dotted lines represents the 95% confidence interval. The results show that an increase in remittance inflows and production output, leads to an increase in economic activity (GDP), the fact that the black line is above and between the dotted lines suggests that the positive response is statistically significant. In conclusion the effect of remittance inflows and production output, on GDP is positive and significant hence remittances and production output, are an important driver of economic growth.

Conclusions

Recommendations

Strategies to improve the Zimbabwe Remittance inflows towards economic growth. Based on the above findings, remittances are a source of capital that can stimulate economic growth of Zimbabwe. The government of Zimbabwe should strengthen efforts to attract more remittances inflows into the country. The objectives of the diaspora policy should include developing mechanisms for dialogue and partnership with Zimbabweans abroad and should develop trust between community diaspora and government and then focus on availing incentives to those who wish to invest back home however uncertain macro-economic conditions which include inflation, unfavourable exchange rates, high black-market premiums which might implicate on remittance flow must be corrected first before the maximisation of policies.

Finally the government of Zimbabwe must adopt a policy that was used in Philippine, the government of Philippine through the Executive Order Number 857 which was issued in 1982. This required all workers who work outside the country of Philippines to remit back seventy percent of their monthly salary through banks, the compliance of the order was compulsory before the worker's passport, VISA could be renewed. That's making remitting mandatory for those workers who are abroad this will increase inflow volumes of remittances. It is also important that mere collection of remittances through banks and other outlays cannot bring forth a desirable progress in the economy but those funds must be utilised properly in the economy so as to sustainably develop the economy of Zimbabwe and for poverty alleviation purpose.

Strategies to improve the Zimbabwe manufacturing output.

The government of Zimbabwe has a bigger role to play in improving the capacities of manufacturing sector as indicators show that manufacturing sector plays a critical role in

economic growth of Zimbabwe. The government of Zimbabwe needs to remain alert, monitoring and evaluating its policies towards manufacturing sector in a globalised economy where competition from other countries matters a lot. The government should therefore ensure strict industrialisation policies, develop a comprehensive policy frame work to guide industrial development. The Zimbabwean government should offer incentives like tax breaks, investment subsidies and streamlined regulatory to attract foreign and local investors. Although capacity utilisation had widely been used as a measure of manufacturing performance, the reality on the ground is that some of the existing plants which are still in use are old and it is no longer possible for such plants to operate at full capacity (CZI).

The infrastructure in the industrial hubs must be improved, in Zimbabwe Bulawayo city has been established as the national manufacturing hub but however the general infrastructure like electricity, water and railways remain in the current pathetic state in Zimbabwe as experienced in 2019 with 24 hour load shedding, water is also being a major crisis in Bulawayo these drawbacks continue to reduce industrial capacity to fully reflect change in economic growth of Zimbabwe.

Strategies to improve the Zimbabwe Foreign Direct Investment (FDI) inflows towards economic growth.

FDI flows to Zimbabwe are far below the country's potential. According to the UNCTAD's World Investment Report 2023 despite Zimbabwe's conducive environment, with large market opportunities, abundant mineral resources, agricultural wealth, tourism resorts. The government officials should continue to push NDS1 and NDS2 targets towards Vision 2030, 'Zimbabwe is open for business' mantra and the re-engagement policy should be monitored frequently. The effort has seen many international companies invading Zimbabwe production sector the likes of Indian companies taking food and medicine industries i.e. PEPSI VERUN Beverages, Willott on company and Chinese companies taking mining sector. According to Zimbabwe Investment and Development Agency (ZIDA), the country attracted USD 8 million in announced projects in 2023, the majority of which were directed to the mining and energy sectors.

According to Thabani Nyoni, the government of Zimbabwe need to revisit the investment legislation in the country, the consistent and transparent application of the Indigenisation Act in the country is very critical in attracting both foreign direct investment and domestic private investment as it limits the scope of discretion and reduces uncertainty with regards to the regulatory framework. The government should implement macroeconomic policies that improve the investment climate in the country such as reviewing the indigenization policy to make it attractive and to quicken the introduction of Special Economic Zones as well as industrial parks. Such policies are imperative as they will attract foreign investors.

The government of Zimbabwe need to enhance good governance and corruption free environment by ensuring there is transparency in paperwork and sound accountability. The respect of property rights should also be prioritised, especially concerning agricultural land foreigners are inadequately protected, with instances of land expropriation without compensation, it shouldn't be a risk to invest in Zimbabwe.

Conclusions

The Zimbabwe manufacturing sector is facing serious challenges but however the sector can still recover in the long term. Although many challenges can be cited, it is generally the hyperinflation period that has placed the manufacturing companies at a disadvantage compared to their counterparts from other countries. All sectors of the economy including the manufacturing sector must redefine the key economic drivers which will be necessary to take Zimbabwe to the next level of economic growth. The government should turn the conducive environment to attract foreign direct investment provided that operational costs are favourable. Remittance inflows amounts should also reflect the large number of people abroad therefore policies, proper formal channels must be put in place to realize the economic development brought by remittances.

Recommendations for Future Research

For future studies, researchers should attempt to use other macro-economic variables such as inflation, money supply, exchange rate, tax revenue, government expenditure, trade balance effects on the economic growth of Zimbabwe. It is of great interest that researchers would analyse the role being played by politics in shaping the economic trajectory in Zimbabwe. In respect to the extension of this research methodology, researchers should attempt applying artificial intelligence (AI) and machine learning techniques such as Support Vector Mechanisms (SVM), Neural networks to forecast GDP. In the context of modelling, researchers should try using panel data models like Spatial Panel Data Model (SPDM) to account for individual heterogeneity, use other econometric models like 2SLS (Two – Stage Least Squares), 3SLS (Three – Stage Least Squares), use other non-linear models such as smooth transition models, markov models and threshold models.

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