INFLATION, MONEY SUPPLY AND ECONOMIC GROWTH IN SUB SAHARAN AFRICA

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Abstract

This study analyzes the effect of inflation on economic growth, and granger causality between price, output and money supply, using unbalanced panel data on Sub Saharan African countries from 1990-2016. A fixed effects estimation using 5-year averaged data shows that inflation significantly and negatively affects economic growth. Similarly, government expenditure as a percentage of GDP has a significant negative effect. Investment as a percentage of GDP has a positive significant impact while share of trade in GDP and convergence (ratio of GDP of South Africa to other countries) have insignificant effect. Robustness checks using 3 year averaged and annual data estimation show similar results as the base estimation using 5-year averaged data. Estimation using inflation between 5 and 95, and 1 and 99 percentiles give similar results suggesting the estimations are robust to outliers. In addition, instrumental variable regression using lagged money supply growth as an instrument for inflation show a significant and negative impact of inflation on all models. The study finds a co-integrating relationship between the logs of real GDP, consumer price index and broad money supply but the variables do not granger cause each other.

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List of Abbreviations

LCU	Local currency unit
AIC	Akaike Information Criterion
SIC	Schwarz (Bayesian) Information Criterion
APEC	Asia-Pacific Economic Cooperation
CCEMG	Common Correlated Effects Mean Group estimator
FE	Panel Fixed Effects Estimation
FE	Panel Fixed Effects estimation
GLS	Generalized Least Squares
IRF	Impulse Response Functions
IV	Instrumental Variables Regression
LCU	Local currency unit
MG	Mean Groups Estimation
OECD	Organization for Economic Cooperation and Development
SSA	Sub Saharan Africa
VAR	Vector Auto-regression
VEC/M	Vector Error Correction Model
WDI	World Development Indicators (World Bank)

1 Introduction

Inflation is a key political and economic issue in many countries. Citizens do not like inflation since it reduces their purchasing power, while governments dislike inflation since it can cost them elections. Higher inflation leads to the substitution of labor by leisure and the redistribution of wealth. In addition, it causes price distortion leading to allocation inefficiency. Fischer (1983) and Tobin (1965) conducted early studies of the dynamics between inflation and economic growth. Recent studies on advanced and transition economies (Gillman & Harris, 2010; Gillman & Nakov, 2004; Gillman, Harris, & Mátyás, 2004) showed inflation has a negative effect on economic growth.

This study analyzes the impact of inflation on economic growth in Sub Saran African (SSA) countries. The paper has two goals. First, the study enriches the literature on dynamics of inflation, money and economic growth in SSA. Current studies (Kasidi & Mwakanemela, 2013; N'dri, 2007) focus on country level studies with limited studies on panel data (Nodricimpa, 2017). Second, the study answers the following questions.

1. What is the effect of inflation on economic growth?
2. Are price, money supply, and real GDP co-integrated?
3. Is there granger causality between price, money supply and real GDP?

I use data on Sub Saharan Africa (SSA) from the World Bank World Development Indicators (WDI) database from 1990 – 2016 which includes 27 years of data for 45 countries. Since fixed effects (FE) estimation on 25 years of data might give inconsistent results, as it does not account for time series properties in the series, I use two approaches. In the first, baseline, approach I take 5-year averaged data from 1991-2015 and estimate FE. In the second approach robustness of the results is checked using 3-year averaged data and annual data

estimation. I use FE to analyze 5-year and 3-year averaged data and both FE and mean groups (MG) estimators for annual data. In addition, all models include instrumental variable regression using lagged money growth as instrument for inflation. The paper assesses the existence of granger causality between the logs and growth rates of output, prices and money supply.

Results from 5 year averaged data fixed effects estimation show that inflation has a significant and negative effect on economic growth. The negative effect of inflation is similar to the ones found in other studies (Gillman & Nakov, 2004; Kasidi & Mwakanemela, 2013; Nodricimpa, 2017). Investment as a share of GDP has a significant positive impact while government expenditure as a share of GDP has a significant negative effect. Results using 3-year averaged and annual data show similar results except for MG estimation using annual data, which gave insignificant negative effect of inflation. The study finds an insignificant effect of share of trade as a percentage of GDP and a convergence variable (ratio of GDP per-capita of South Africa to GDP per-capita of each country) on economic growth.

The levels of the variables (logs of consumer price index, real GDP and money supply) are co-integrated but the null of no-granger causality is not rejected. All of the growth variables are found to be stationary, I(0). Granger causality tests show that inflation positively granger causes money supply growth and negatively granger causes economic growth. Money supply is found to positively granger cause inflation. The study is structured as follows. Section 2 provides a brief overview of the relevant theoretical and empirical literature. In the following section, I will discuss the data and methodology used. Estimation results and robustness checks are available in section four followed by conclusion in section 5.

2 Literature Review

2.1 Theoretical Review

Money demand function is the main economic tool used to analyze the effect of money supply on price, inflation, output and interest rate (Romer, 2012). Equilibrium in the money market implies the demand for money (which is a function of nominal interest rates and real GDP) and supply of real money balances are equal as shown below.

$$\frac{M}{P} = L(i, Y) \tag{2.1}$$

where L(i,Y) is the money demand function with $L^1{}_i < 0, and\ L_y > 0$. In the long-run an increase in money supply is results in inflation while the short run effects depend on whether prices are flexible or not (Romer, 2012) . With flexible prices, an increase in the money supply will not affect real interest rates and output. This implies that based on equation 2.1 equilibrium implies price growing by the same rate as money supply growth. This means inflation equals the growth rate of money supply.

$$i = r + \pi^e$$

$$P = \frac{M}{L(r + \pi^e, Y)} \tag{2.2}$$

The relationship in 2.2 implies that with flexible prices, money supply growth leads to increased prices and inflation. Contrary to the case of flexible prices, the impact of money with sticky prices is not clear in the short run. With sticky prices, the short run impact of money

[1] First derivative of the money demand function with respect to interest rate

supply fluctuation depends on the relative size of the effects on the real interest rate against the effects on expectations (Romer, 2012). With rigid prices, an increase in money supply results in reduced nominal interest rates in the short-run due to liquidity effect. This is because with rigid prices an increase in money supply will lead to higher output, which need to be supported by lower real interest rates. On the other had increased money supply will increase inflation expectations.

The quantity theory of money is another theoretical tool used to assess the relationship between money, prices and output (Mankiw, 2016). The theory states that individuals use money to buy goods and services. This implies that demand for money will depend on the amount of transactions individuals want to make. The amount of money available for the purchase of goods and services is determined by the supply of money (M) and velocity (V) while the value of goods and services purchased equals price (P) times output (Y) as shown in 2.3

$$M\ x\ V = P\ x\ Y \tag{2.3}$$

The income velocity (V) shows the number of times a given money rotates in the economy in a given year. Equation 2.3 gives different dynamics in the short run depending on the assumption on velocity. If velocity is assumed fixed in the short run an increase in money supply results in a proportional increase in P x Y. In the long run only M and P vary and changes in money supply lead to a one-to-one change in prices.

Tobin (1965) used a monetary model of economic growth to show the effect of money growth on economic growth. He argued that inflation leads to increased capital in the long-run and economic growth. Tobin used portfolio approach where individuals held equal shares of

money and capital in total wealth in equilibrium. Using growth model with utility maximizing individuals (Sidrauski, 1967) finds that in the long run the capital stock is independent of money supply. In the long run an increase in money supply leads to a proportionate increase in prices and it does not influence steady state consumption. In the short run an increased money supply increases consumption and reduced investment.

Fisher (1983) argued that higher inflation leads to lower growth because it leads to inefficiencies in factors of production and inflation tax. He used a monetary maximizing model including three potential links between inflation and economic growth. These are reduced factor productivity due to lower real balances, government deficit financing by printing money and supply shocks effect on prices. All the three channels imply negative relationship between inflation and growth. Gillman & Kejack (2005) used an extended endogenous growth model including credit as a payment mechanism to assess the link between inflation and growth. They used a model that allows money and credit as alternative payment mechanisms. Including credit results in nonlinearity of inflation-growth relationship as now when inflation increases the exchange cost of goods rises by less since the availability of credit reduces substitution towards leisure.

The theoretical review provides three insights. First, it shows inflation arises due to increase in the money supply. Second, it helps identify the transmission channels between inflation and economic growth. Inflation hurts growth by substituting labor for leisure or diverting savings from capital to government debt. Finally, the money demand equation in 2.1 shows that money, prices, output and interest rates have long run relationship. This study finds a co-integrating relationship between the logs of consumer price index, real GDP, and money supply.

2.2 Empirical Review

Studies show a negative effect of inflation on growth (Gillman & Nakov, 2004; Kasidi & Mwakanemela, 2013; Nodricimpa, 2017). Gillman & Harris (2010) used panel data set for 13 transition countries over the period 1990-2003. They found a significant negative effect of inflation and inflation volatility on economic growth. The results also show a diminishing effect as the inflation rate increases. Another study by (Gillman, Harris, & Mátyás, 2004) on OECD and APEC countries over 1961-1997 showed similar result. Using endogenous growth model, they showed a negative inflation-growth effect stronger at lower levels of inflation.

In his (Barro, 1995) analyzed the dynamics of inflation and growth across 100 countries from 1960 – 1990. Barro finds that short-run effects of inflation are small but the long-run effects are higher. He founds that a 10 %-point increase in inflation lowers the level of real GDP by 4-7% over 30 years, though the effect is found to be insignificant when high inflation samples are dropped.

Khan & Senhadji (2000) examined the presence of threshold effect between inflation and economic growth in 140 countries from 1960-1998. The authors found significant threshold effect of 1-3% for industrial countries and 7-11% for developing countries. Inflation was found to have a positive impact below the threshold and negative impact above the threshold. Instrumental variable regression to control for the endogeneity of inflation and investment also provide similar results. A similar study by (Sepehri & Moshiri, 2004) used data for 92 countries from 1960 to 1996. They used different thresholds for countries at different stages of development (OECD, upper middle income, lower middle income and low-income countries). They found different turning points for the country groups ranging from 15% for

low income countries to 5% for upper-middle income countries. Inflation was found to have a significant and negative effect for high levels of inflation for all country groups except OECD.

Using co-integration on Tanzanian data from 1990-2011 (Kasidi & Mwakanemela, 2013) found no long-run (co-integrating) relationship between inflation and economic growth. However, they found a significant and negative impact of inflation on economic growth in the short run. A panel study on African economies by (Nodricimpa, 2017) used dynamic panel threshold regression and found that inflation hurts growth at higher levels. The author found inflation to have a positive impact on growth when it is below 6.7% while for higher levels inflation have a negative effect. Another study on African country, Cote d'Ivoire, conducted by (N'dri, 2007) used annual data from 1985 -2010 to test for long-run relationship between inflation and economic growth. The author finds a significant positive long-run impact of inflation on growth while a negative and insignificant short run effect. The long-run positive impact of inflation in Cote d'Ivoire found in the study is contrary to expectations.

A study by (Hossain, 2005) used annual data from 1954-2002 on Indonesia to see the granger causality between growth rates of money, prices, economic output and exchange rates. The author found short-run bi-directional causality between money supply growth and inflation and between currency devaluation and inflation, but the author did not find granger causality between inflation and economic growth. Another study on Bangladesh, India, Pakistan and Sri Lanka by (Mallik & Chowdhury, 2001) founds a positive long run relationship between inflation and economic growth.

There are two insights from the empirical literature review. First, most studies agree on the significant and negative effect of inflation on growth. In addition, studies also found non-linear effect of inflation with cutoffs being lower for developed countries and higher for low-

income countries. Another insight from the reviews is the effect of inflation on growth in the long run. The reviews shows that inflation and economic growth has different long-run relationships depending on the different countries studied. This implies that similar to the theoretical review, empirical results are not conclusive about the direction of the relationship between inflation and economic growth.

3 Data and Methodology

3.1 Data

The study used an unbalanced panel data on 45 SSA countries from 1990 – 2016 from World Bank World Development Indicators database. List of countries included[2] in the study is available in the appendix in Table 18 . Data on variables relevant for the study including broad money growth rate, broad money to GDP ratio, GDP growth rate, Inflation, exchange rates, trade, government expenditure, and population growth were available starting from 1960 with data on around 10 countries on money and inflation. Most data points are available for around 30 countries starting from 1980's while this figure goes to 40 starting from 1990's (though there is frequent missing data). Table 1 describes the variables used in the study.

I used both the level and log of inflation as explanatory variable. This is because the distribution of inflation is not symmetric (as can be seen from the table below) and using logs will have two advantages. First, it will make the distribution of inflation symmetric. In addition, interpretations in logs are more plausible than with the linear model. The linear model assumes that a given change in inflation will have the same impact when inflation is at lower and higher levels but the log model allows for multiplicative interpretation.

[2] Only Eritrea, South Sudan and Somali are excluded from the study mainly because they have no or less than 8 years data on the key independent variable, inflation.

Table 1: Variables used in the study

variable	World Bank Code	Description
Data downloaded from World Bank		
m_lcu	FM.LBL.BMNY.CN	Broad money (current LCU)
m_gr	FM.LBL.BMNY.ZG	Broad money growth (annual %)
gdp_lcu	NY.GDP.MKTP.KN	GDP (constant LCU)
gdp_gr	NY.GDP.MKTP.KD.ZG	GDP growth (annual %)
gdp_pc	NY.GDP.PCAP.KD	GDP per capita (constant 2010 US$)
inv	NE.GDI.TOTL.ZS	Investment, gross capital formation (% of GDP)
inf_cpi_idx	FP.CPI.TOTL	Consumer Price Index
inf_cpi	FP.CPI.TOTL.ZG	Inflation measured by consumer price index
inf_def	NY.GDP.DEFL.KD.ZG	Inflation, GDP deflator (annual %)
trade_pct	NE.TRD.GNFS.ZS	trade (% of GDP)
gov	NE.CON.GOVT.ZS	government final consumption expenditure (% of GDP)
Other variables (generated from the above variables)		
Dlgdp_pc	Growth rate of per-capita GDP **(dependent variable)**	
converge	Defined as (GDP per capita South Africa/GDP per capita of each country). used as a measure of growth convergence, catchup	
LGDP, LP, LM	Log of real GDP per-capita, consumer price index and money supply (**used in VAR/VECM estimation)**	
DLGDP, DLP, DLM	Growth rate (computed as first difference of logs of the variables) of GDP per-capita, consumer price index and money supply	

3.2 Descriptive statistics and trends

Table 2 provides descriptive statistics from 1990-2016. On average, SSA countries were growing at a modest growth rate of 4%. The volatility of the growth rate was more than 8%, which implies that the growth trajectory was quite diverse with some countries showing higher rates of growth and others showing declines. Similarly, inflation (measured by consumer price index change) was on average around 74% but the median inflation level is below 7%. This shows that the higher average inflation is due to few countries.

Table 2: Descriptive Statistics

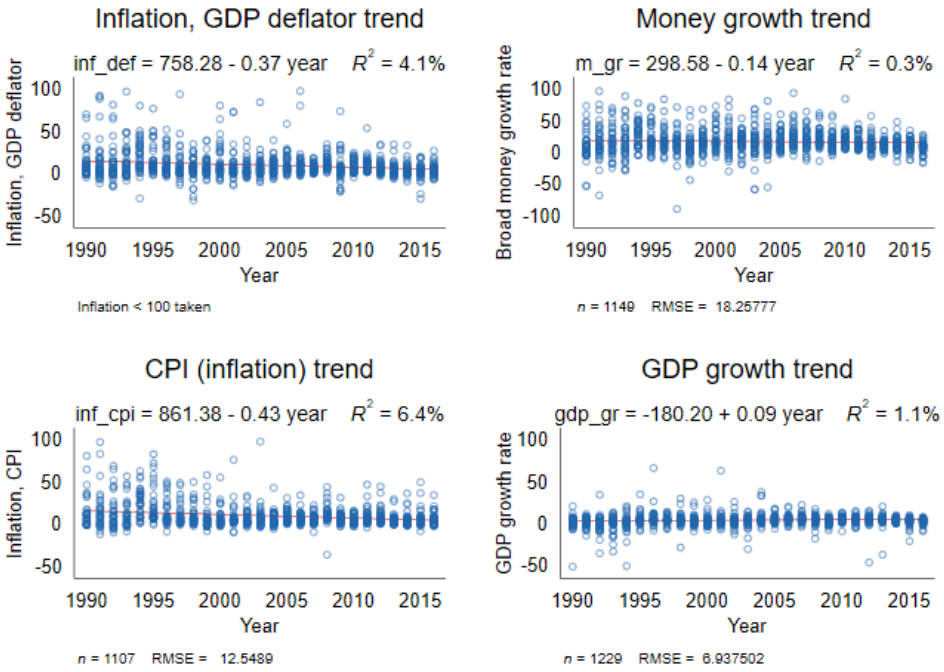
	min	mean	median	max	sd	N
Broad money (% of GDP)	2.19	29.96	23.00	151.55	22.15	1174
Broad money LCU	2.89	1.01E+12	1.54E+11	2.29E+13	2.62E+12	1184
Broad money growth rate	(88.79)	37.67	15.29	6,968.92	283.69	1173
GDP per capital, US$	115.79	1,935.39	808.89	20,333.94	2,881.67	1233
Real GDP, local currency	1.12E+08	4.31E+12	8.11E+11	6.98E+13	9.56E+12	1234
GDP growth rate	(51.03)	4.23	4.22	149.97	8.62	1231
Investment (% of GDP)	(2.42)	21.40	19.74	219.07	16.42	1135
Inflation, CPI	(35.84)	73.55	6.61	24,411.03	1,028.96	1145
Inflation, GDP deflator	(31.57)	52.78	6.70	26,762.02	799.17	1230
Trade as % of GDP	11.09	75.34	64.30	531.74	46.19	1154
Government Expenditure (% of GDP)	2.05	15.75	14.45	69.54	7.52	1116
Population growth rate	(6.18)	2.54	2.69	7.92	1.08	1291

Broad money supply growth rate was volatile in SSA with average growth rate of 38% and median country growth rate of 15%. The average per-capita GDP of SSA countries during the period under study is 1,935 US $ with most countries having a per capita income less than 1,000 US $. Figure 1 show the scatter plots of key variables (CPI inflation, GDP deflator, GDP growth rate and money supply growth rate). The graphs show that volatility in all of the variables was declining since 2000 due to improved peace and security and macroeconomic management.

The plots show that SSA is a diverse region with countries showing different levels of inflation, money and real GDP growth. During 1990-2016, the both consumer price index and GDP deflator were showing a declining trend. This is due to reduced volatility since 2000. Before 2000, there are countries with CPI and GDP deflator higher than 50% while since 2000 most countries are in the range plus-minus 50%. Similarly, broad money supply growth rate is

showing a declining trend. GDP growth rate is on average increasing by 9 percentage points each year. This is due to improved peace and security, macroeconomic management and growth in G7 countries and China. In addition, favorable oil and commodity prices played a role (Brookings Global: Africa Growth Initiative, 2016) .

Figure 1: Trend of key variables



Note: data cut at -50:100 for inflation and GDP growth, -100 to 100 money

3.3 Model

3.3.1 Effect of Inflation on Economic Growth

Based on the theoretical and empirical reviews, a fixed effects regression model is employed on 5 year average data from 1991 – 2015. This has two advantages. First, it smooths the data and take out business cycle fluctuations. This allows for the estimation of medium-long run relationships. Finally, it allows for the use of fixed effects estimation. Without averaging fixed effects, estimation on 25 years data will not give consistent estimates, as it

does not account for the time series properties of the data. Table 5 provides estimates using annual data using different estimation methods. The following equations are used to estimate the effect of inflation on economic growth.

$$\text{gdppc\_gr}_{\text{it}} = \alpha_i + \lambda_t + \beta_l(\pi_{it}) + \beta_3' X_{it} + \epsilon_{it} \quad (3.1)$$

$$\text{gdppc\_gr}_{\text{it}} = \alpha_i + \lambda_t + \beta_l ln(\pi_{it}) + \beta_3' X_{it} + \epsilon_{it} \quad (3.2)$$

where gdppc_gr is real GDP per-capita growth rate; i is index for country, t index for year, α_i is country fixed effect, λ_t is year effects, π is inflation measured as changes in consumer price index. X includes controls that affect economic growth including share of investment in GDP, share of trade in GDP, and share of government expenditure in GDP and a growth convergence variable computed as ratio of GDP per-capita of South Africa to the GDP per-capita of the countries. Few explanatory variables are included because by including country and year fixed effects the estimation controls for factors not included in the model. Equation 3.1 and 3.2 are assume that inflation has linear effect on economic growth. The second equation, 3.2, will serve two additional purposes. Using log of inflation dampens the effect of outliers and allows for multiplicative interpretation of the effects of inflation. The expected sign of β_1 in both 3.1 and 3.2 is negative. Both equations 3.1 and 3.2 implemented fixed effects and fixed effects instrumental variable regression to control for possible endogeneity of inflation. Lagged, L(1), money supply growth rate is used as an instrument for inflation.

In addition to the base estimation using five-year averaged data; estimation is done using three-year averaged data and annual data. Mean groups estimation is applied to the annual data in addition to fixed effects. Mean group (MG) allows for heterogeneous slope coefficients, fixed effects and time trends for each country. The mean group estimator is implemented using robust regression, which controls for outliers.

3.3.2 Cointegration between logs of price, real GDP and money supply

From equilibrium between money supply and demand long run relationship between money, prices, output and interest rates can be deduced. This study tested for the existence of cointegration between logs of money supply, consumer price index and real GDP using panel cointegration tests. The tests use the following regression model:

$$LGDP = \gamma_i + \beta_1 LM + \beta_2 LP + e_{it} \quad (3.3)$$

where LGDP is log of real GDP, LM is log of broad money supply, LP is log of consumer price index and γ_i is country fixed effects. Two tests Kao and Pedroni are used to test for cointegration (Stata Corp., 2017). Kao test assumes the co-integrating vectors (β_1 and β_2) to be the same across panels. The test applies five test statistics based on dickey fuller (DF) and augmented dickey fuller (ADF) tests. Pedroni test on the other hand allows the co-integrating vectors (β_1 and β_2) to differ across countries and uses ADF tests to test for the stationary of the residuals estimated in 3.3. (Stata Corp., 2017)

After co-integration test, a vector error correction model is estimated since the variables are found to be integrated of order 1 (results section). Estimation uses dynamic fixed effects estimators suggested by (Frank & Blackburne III, 2007). The estimator restricts the co-integrating vector coefficients to be the same across countries while it allows country specific intercepts. VECM estimation will follow 2 steps, in the first step optimal lag selection will be done by estimating a VAR(p) model of the variables where p is the lag length using information criterion. In the second stage error correction model shown below will be estimated by takin p-

1 lags where p is the optimal lag selected. The estimated equation is like equation 3.5 with the p-1 being the maximum lag used.

3.3.3 Granger causality between logs of prices, real GDP and money supply

The study tested for granger causality between logs of consumer price index, real GDP and money supply based on the results of vector error correction (VECM). Panel unit root tests are applied and test for co-integration is conducted since the series were found to be I(1). The following VECM equation is used to test for co-integration.

$$\mathrm{DLGDP} = \alpha + \beta_1(LGDP_{t-1} - \rho_\pi LP_{t-1} - \rho_m LM_{t-1}) + \sum_{i=0} \gamma_i \mathrm{DLM_{t-i}} + \sum_{i=0} \theta_i \mathrm{DLP_{t-i}} + \sum_{i=1} \eta_i \mathrm{DLGDP_{t-i}} \quad (3.5^3)$$

where LGDP is log of real GDP (local currency unit), LM is log of money supply (local currency unit) and LP is log of consumer price index. VECM lag length (i) is selected by first estimating VAR model and taking (k-1) lags assuming k is the lag that minimizes the information criterion for the VAR model.

VECM or VAR estimation follows three steps. First, test for stationary is conducted. If the variables are not stationary test for cointegration is done and decision is made whether to implement VAR or VECM estimation. In the second step, optimal lag selection is done for the selected model. This is done by selecting the lag length that gives the minimum lag length

[3] Only one equation is provided for simplification. There will be separate equations for DLM and DLP similar to DLGDP

selection using AIC criteria. Finally, granger causality tests is conducted using the estimation results from the selected VAR or VECM model.

3.3.4 Granger causality between inflation, and growth rates of money and output

Granger causality between growth rates of prices (inflation), money and output is conducted based on the results of vector error correction (VECM) or VAR models. VECM will be applied if the series are co-integrated. Panel unit root tests are applied on the growth rates output, broad money supply and consumer price indexes. Estimation of VAR or VECM followed three steps as discussed in the previous section, 3.3.2.

4 Results

4.1 Baseline Results

Table 3 shows inflation negatively and significantly affects economic growth. Equations 1 to 3 provide results where inflation in levels is the explanatory variable while equations 4 to 6 use log inflation. Equations 3 and 6 show instrumental variable regression results using lagged (L1) money supply growth as instrument for inflation. Discussions here after use the equation in logs (4-6, results from equation 5 are discussed). A[4] percentage point increase in inflation reduces economic growth rate on average by 0.013 percentage points. The negative impact of inflation on economic growth is consistent with other studies in SSA countries (Nodricimpa, 2017; Khan & Senhadji, 2000; Sepehri & Moshiri, 2004).

The negative effect of inflation on economic growth comes from two channels. First in the domestic sector higher inflation makes investment planning difficult as investors will not be certain about their returns. In addition, since most SSA countries are low income countries, higher inflation will induce people to save less. The second channel is through exports. Higher inflation reduces export competitiveness as it causes real exchange rate appreciation. IV regression results (columns 3 and 6) using lagged values, L(1), of money growth as instrument for inflation show similar results with the other results (columns 1, 2, 4 and 5).

[4] All discussions are based on ceteris paribus assumption (holding other things constant)

Table 3: Baseline Estimation Results[5] (using 5-year averaged data)

	Inflation in levels[6]			Inflation in log		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Dlgdp_pc	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**
inf_cpi	-0.00072***	-0.00075***	-0.01010*	-1.20430***	-1.28783***	-2.20907***
	(0.00026)	(0.00020)	(0.00597)	(0.19669)	(0.14956)	(0.46289)
inv	0.22782***	0.18180***	0.09620	0.22729***	0.16622***	0.15429***
	(0.03148)	(0.03523)	(0.07689)	(0.02905)	(0.02495)	(0.03092)
gov	-0.15631*	-0.16213*	-0.83073**	-0.15198*	-0.15887**	-0.29376*
	(0.09162)	(0.08954)	(0.35659)	(0.07569)	(0.07141)	(0.15700)
trade_pct		0.02393	0.07079*		0.03184**	0.04036***
		(0.01885)	(0.03861)		(0.01459)	(0.01407)
converge		0.08155	1.26427***		0.09423	0.31476*
		(0.10943)	(0.47883)		(0.08570)	(0.16684)
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	197	197	156	196	196	155
r2	0.59286	0.60386		0.64578	0.66414	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3 and 6 use IV estimation using lagged money growth as instrument for inflation

Investment has a significant and positive impact on economic growth. A percentage point increase in investment as share of GDP leads to a 0.17 increase in economic growth. As investment is highly volatile component of GDP (Romer, 2012), getting a strong impact of investment on economic growth is consistent with expectation. Growth in government expenditure has a significant negative impact on economic growth with a coefficient of -0.16. This is evident of crowding out in SSA economies where increased government expenditure crowds out private investment. In addition, the negative impact of government expenditure is

[5] All results in section 4 use cluster standard errors

[6] Indicates inflation is entered in levels as explanatory variable in 1-3 while 4-6 it enters as log of inflation

also due to the inefficiencies of SSA governments. The World Bank governance effectiveness index[7] ranks SSA 27 out of 100 in 2006 and 2011 and the rank declined to 26 in 2016. Similarly, for control of corruption the region scores 32 in 2006 and 2011 and 31 in 2016. This shows that governments in SSA are not effective in efficiently using resources.

Share of trade in GDP does not have significant effect on growth in the model with inflation in levels but it has a significant positive effect on growth in the log model (columns 3-6). The positive effect of trade on growth is similar to results in (Nodricimpa, 2017). The positive effect arises because trade increases investment, allows countries to diversify their markets, and increases competitiveness. The lack of significance in the levels model arises mainly due to the difference in the growth rates of imports and exports in the region. Import growth have been relatively stable than exports. Exports show a high volatility due to the impact of global commodity prices. As a result, most of the increase in trade share is due to increase in imports that reduced the impact on GDP growth.

Growth convergence variable, measured as the ratio of GDP per-capita of South Africa to GDP per-capita of each country, has a positive but insignificant effect on growth (but the effect is significant when money growth instruments inflation). The insignificant effect is due to the instability in the countries, which have lower GDP per-capita (higher convergence value). These countries include Central African Republic, Democratic Republic of Congo, Niger, Mozambique, Sierra Leone and others, which are in the top list of fragile states index[8].

[7] Data is available here: http://info.worldbank.org/governance/wgi/#reports
[8] https://en.wikipedia.org/wiki/List_of_countries_by_Fragile_States_Index

4.2 Hausman Tests: Fixed Effects vs. Random Effects

I conducted Hausman tests for the six equations (columns) in Table 3 to check for the consistency of random effects. The results, in the appendix in Table 12, show that all of the models except for equation 3 reject the null of no systematic difference between RE and FE which implies that the null of RE is consistent is rejected. As a result, I used fixed effects.

4.3 Robustness checks

4.3.1 Estimation using 3 year averaged data

Estimation using 3 year averaged data give similar results as the results using 5 year averaged data. Similar to previous results inflation, investment and government expenditure has significant influence on economic growth. The other variables in the model have similar results as earlier, except trade, which is insignificant now.

Table 4: fixed effects estimation using 3 year averaged data

	Inflation in level			**Inflation in log**		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Dlgdp_pc	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**
inf_cpi	-0.00097***	-0.00099***	-0.00167**	-1.02932**	-1.08043**	-1.31944*
	(0.00007)	(0.00011)	(0.00074)	(0.42424)	(0.42481)	(0.71329)
inv	0.22818***	0.21159***	0.21298***	0.23075***	0.19562***	0.20036***
	(0.03471)	(0.03517)	(0.03755)	(0.03288)	(0.03587)	(0.04347)
gov	-0.20403**	-0.21277**	-0.20446**	-0.21924***	-0.23219***	-0.16497*
	(0.07827)	(0.08195)	(0.09933)	(0.07329)	(0.07773)	(0.08437)
trade_pct		0.00939	0.01327		0.02045	0.02130
		(0.01873)	(0.02137)		(0.02188)	(0.02398)
converge		0.07157	-0.13093		0.00145	-0.15262
		(0.10942)	(0.18348)		(0.12017)	(0.21358)
Year	Yes	Yes	Yes	Yes	Yes	Yes
N	353	352	304	339	338	300
r2	0.41848	0.42100		0.43458	0.44006	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

3 and 6 use IV estimation using lagged, L (1), money growth as instrument for inflation

4.3.2 Estimation using annual data

Fixed effects and mean groups estimations are implemented using annual data to see for the robustness of the results using 5-year and 3-year averaged data. Mean group estimator estimates separate equations for each country including fixed effects and linear trend. The MG slope estimates are the averages of the estimates for the individual countries. (Eberhardt, 2011)

FE estimation using annual data (1-2, in Table 5) give similar results as the fixed effects results using 5-year averaged data. Inflation and government expenditure has a significant and negative impact on growth while investment has a significant positive effect. Results using MG show two points. First, they show that the direction (sign) of the effects obtained using averaged data is consistent using annual data also. Second, now inflation is significant only on logs (column 6) while it has a negative and insignificant impact on the levels (column 5).

Table 5: Estimation results using annual data

	FE (1-2 inflation in level, 3-4 inflation in log)				**MG (5 inflation in level, 6 inflation in log)**	
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
	Dlgdp_pc	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**
inf_cpi	-0.00038***	-0.00155***	-0.89754**	-1.58849**	-0.00104	-0.45564
	(0.00007)	(0.00043)	(0.34426)	(0.74830)	(0.03136)	(0.33133)
inv	0.13517***	0.14389***	0.12764***	0.12790***	0.10507	0.08498
	(0.02442)	(0.02465)	(0.02209)	(0.02191)	(0.06599)	(0.05982)
gov	-0.18201**	-0.18431**	-0.20131***	-0.20292**	-0.18969**	-0.16748
	(0.07191)	(0.08346)	(0.07325)	(0.09729)	(0.08500)	(0.10239)
trade_pct	0.03183**	0.03045**	0.03754***	0.03909***	0.04459*	0.03752
	(0.01265)	(0.01236)	(0.01282)	(0.01192)	(0.02696)	(0.02363)
converge	-0.10795	-0.19327	-0.09123	-0.15799	-2.93809***	-2.85713***
	(0.15526)	(0.17553)	(0.14983)	(0.17494)	(0.65258)	(0.66439)
Year	Yes	Yes	Yes	Yes	No	No
N	989	913	910	843	975	889

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

2 and 4 are IV estimation using lagged money supply growth as instrument

4.3.3 Robustness to outliers

In addition the robustness checks using 3-year averaged and annual estimates, I conducted robustness check using inflation between 1 and 99 percentiles and between 5 and 95 percentiles to see the effect of outliers on the estimation results. Results in Table 6 which uses inflation between 1 and 99 percentile show that the results are similar to the base estimation results except for government expenditure which is insignificant now. IV estimation in columns 2 and 4 also give results that are similar to base estimation results but now government expenditure is not significant but properly signed.

Table 6: 5 year averaged data estimation using inflation from 1-99 percentile

	(1)	**(2)**	**(3)**	**(4)**
	inf_cpi	**inf_cpi**	**linf_cpi**	**linf_cpi**
inf_cpi	-0.00921**	-0.02894***	-1.49942***	-2.35519***
	(0.00385)	(0.00419)	(0.31325)	(0.48227)
inv	0.18080***	0.18336***	0.16780***	0.16121***
	(0.03473)	(0.03414)	(0.02290)	(0.02922)
gov	-0.02220	-0.11335	-0.13348*	-0.23329
	(0.12060)	(0.14225)	(0.07808)	(0.15637)
trade_pct	0.02383	0.02625*	0.03097**	0.03677***
	(0.01903)	(0.01494)	(0.01377)	(0.01333)
converge	0.02284	0.14545	0.05779	0.21254
	(0.09512)	(0.21770)	(0.08504)	(0.17775)
Year	Yes	Yes	Yes	Yes
N	194	154	194	154

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
2 and 4 are IV estimation using lagged L(1) money as instrument for inflation

Estimation results in Table 7 using inflation between 5 and 95 percentile also give similar results. The results in FE estimation without IV are similar to base estimation except for government expenditure which is insignificant while IV estimation results give similar

signs but both inflation and government expenditure are not significant. This mainly arises because the instrument used is weak for the data taking only 5-9 percentile inflation.

Table 7: 5 year averaged data estimation using inflation from 5-95 percentile

	FE			
	(1)	(2)	(3)	(4)
	inf_cpi	inf_cpi	linf_cpi	linf_cpi
inf_cpi	-0.09693***	-0.12955	-1.28508***	-4.64984
	(0.02909)	(0.17503)	(0.43084)	(6.31972)
inv	0.17548***	0.16933***	0.17094***	0.14329**
	(0.02752)	(0.03867)	(0.02537)	(0.06235)
gov	-0.14613	-0.18623	-0.13741	-0.38055
	(0.12493)	(0.18209)	(0.12232)	(0.42294)
trade_pct	0.02679*	0.03282**	0.02892*	0.04607
	(0.01545)	(0.01627)	(0.01439)	(0.02928)
converge	0.03528	0.18924	0.01369	0.22282
	(0.10802)	(0.21535)	(0.09311)	(0.21449)
Year	Yes	No	Yes	Yes
N	180	145	180	145

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
2 and 4 are IV estimation using lagged (L(1) money as instruments

Additional robustness check for the possibility of endogeneity of investment in addition to inflation is done using lagged money supply growth and lagged investment as instruments. The results in the appendix, Table 13, show similar results with major difference being now trade and growth convergence variable are significant (and positive).

4.4 Co-integration between logs of price, money supply and real GDP

Table 8, provides results of error correction model estimation. VECM using lags 1 and 2 are estimated. Lag 1 is selected using Schwarz Information Criterion (SIC, also called Bayesian Information Criterion) and Hannan–Quinn information criterion (QIC) while lag 2 is selected by AIC (Akaike Information Criterion). The results selected using SIC and QIC are preferred for discussion because the VAR (2) estimation selected using AIC is not stable while VAR (1) is stable. The results show that in the short-run there is a significant relationship between real GDP growth rate and growth rates of money supply and consumer price index. Money supply growth significantly and positively influences growth. This happens because increase in money supply results in mismatch between money demand and supply. The excess supply of money leads to reduction of interest rates as a rightward shift of the money supply results in a lower interest rate and increases investment. (Romer, 2012)

Inflation affects growth negatively in the short-run. It leads to reduced real balances and higher nominal interest rates. This in turn reduces investments and household spending on durables and reduces output. All the long run effects are consistent with the short run effects in sign, price affects GDP negatively, while money supply affects GDP positively. The error correction term is properly signed and shows that each year 7.6% of the deviation in the long-run equilibrium is closed. This indicates that the adjustment is slower. This happens mainly because the model estimated is simple (does not include interest rate and other exogenous variables).

Table 8: Co-integration Estimation Results

Dependent: DLGDP	**(1)**		**(2)**	
Co-integrating equation				
L.LGDP	1		1	
L.LM	0.379***	(0.0816)	0.152	(0.220)
L.LP	-0.195*	(0.118)	0.245	(0.327)
Short run				
Error correction	-0.0758***	(0.00927)	-0.0447***	(0.0102)
D.LM	0.0766***	(0.0161)	0.109***	(0.0244)
D2.LM			-0.0501**	(0.0208)
D.LP	-0.0338**	(0.0140)	-0.0544***	(0.0197)
D2.LP			0.0139	(0.0134)
D2.LGDP			0.456***	(0.0158)
_cons	1.421***	(0.191)	1.027***	(0.294)

Cluster standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

4.5 Granger Causality

4.5.1 Granger causality between Logs of price, money and real GDP

4.5.1.1 Unit root tests

To test for granger causality between the logs of the variables, unit root tests are conducted and the variables are found to be integrated of order 1. Unit root tests by Maddala and Wu (MW) and Pesaran (CIPS) (Eberhardt, 2011) are used and results are shown in Table 9. Both tests have a null of nonstationarity. MW test used dickey fuller test ignores cross section dependence but allows the autoregressive term to differ across countries. Similarly the CIPS test allows for heterogeneous AR coefficients and includes unobserved common factor. (Eberhardt, 2011)

Table 9: Unit root tests for log of variables

	Lags	LGDP	p-value	LM	p-value	LP	p-value
MW	0.00	30.52	1.00	275.77	0.00	535.41	0.00
MW	1.00	36.18	1.00	108.68	0.07	174.35	0.00
MW_trend	0.00	162.73	0.00	122.14	0.01	154.22	0.00
MW_trend	1.00	190.14	0.00	179.86	0.00	243.92	0.00
CIPS	0.00	4.66	1.00	-1.10	0.13	-1.70	0.04
CIPS	1.00	5.32	1.00	-0.55	0.29	-6.28	0.00
CIPS_trend	0.00	2.53	0.99	0.11	0.54	-0.33	0.37
CIPS_trend	1.00	-0.23	0.41	0.59	0.72	-7.82	0.00

Note: MW tests use Chi-square statistics while CIPS uses Z-statistics

As shown in Table 9 except log of consumer price index, the other variables are not stationary; they are integrated of order 1. This is seen in section 4.5.2 where the first difference (growth rates) of the variables are found to be stationary. Since the variables are I(1), granger causality requires testing for co-integration and conducting proper causality test. This is because if the variables are co-integrated, the Wald test does not follow chi-square distribution (Toda & Yamamoto, 1995) .

4.5.1.2 Granger causality test

Kao and Pedroni co-integration test results,

Table 16 in the appendix, reject the null of no-cointegration. Following the suggestion by (Toda & Yamamoto, 1995), granger causality test is applied by running a VAR model of order p + m, where p is the selected VAR length using information criterion while m is the highest order of integration.

$$LGDP = \sum_{i=1}^{p+m} \beta_i LGDP_{t-i} + \sum_{i=1}^{p+m} \beta_i LM_{t-i} + \sum_{i=1}^{p+m} \beta_i LP_{t-i} + \epsilon_t$$

As an example, granger causality from money (LM) to output (LGDP) uses the null of $H_o = \sum_{i=1}^{p} \beta_i = 0$ against the alternative that they are different from zero. Estimation results from VAR (2) in

Table 17 in the appendix show that the variables do not granger cause each other.

4.5.2 Granger causality between growth rates of price, money and real GDP

4.5.2.1 Unit root tests

Two types of unit root tests are applied; Maddala and Wu (MW) and Pesaran (CIPS) tests (Eberhardt, 2011). The MW test uses Dickey-Fuller regression and allows for heterogeneity in the autoregressive (AR) coefficient. The CIPS uses Augmented Dickey-Fuller regression and allows for a single unobserved common factor in addition to heterogeneity in the AR coefficient. Both unit root tests are applied with and without trend. The results in Table 10 show that all of the growth rate variables are stationary.

Table 10: Unit root test for growth rates

	Lags	**DLGDP**	**p**	**DLM**	**p**	**DLP**	**p**
MW	0.00	695.27	0.00	745.68	0.00	439.62	0.00
MW	1.00	392.36	0.00	356.93	0.00	429.64	0.00
MW_trend	0.00	597.77	0.00	706.70	0.00	393.46	0.00
MW_trend	1.00	321.90	0.00	310.02	0.00	423.21	0.00
CIPS	0.00	-14.50	0.00	-15.34	0.00	-8.87	0.00
CIPS	1.00	-8.08	0.00	-7.68	0.00	-8.20	0.00
CIPS_trend	0.00	-13.63	0.00	-13.55	0.00	-7.48	0.00
CIPS_trend	1.00	-6.40	0.00	-7.18	0.00	-4.51	0.00

4.5.2.2 Granger causality and impulse responses

This study tested for granger causality among the growth rates of the three variables using VAR estimation. Minimizing SIC criteria selected VAR (1) as the optimal model, and the results in Table 11 show that inflation negatively granger causes GDP growth and positively money supply growth. Money supply growth positively granger causes inflation. GDP growth

is not found to granger cause any of the variables. The estimated results are robust to different lag (VAR specification) selection as seen in the appendix in Table 19.

The positive granger causality from money supply to inflation is consistent with the ideas that increased money supply leads to more money chasing fewer goods. This in turn results in increased inflation. Inflation is found to positively granger cause money supply growth. Though this is unexpected, since mostly causality is expected from money to inflation, it shows that inflation arises also from other shocks and this can result in increased money supply.

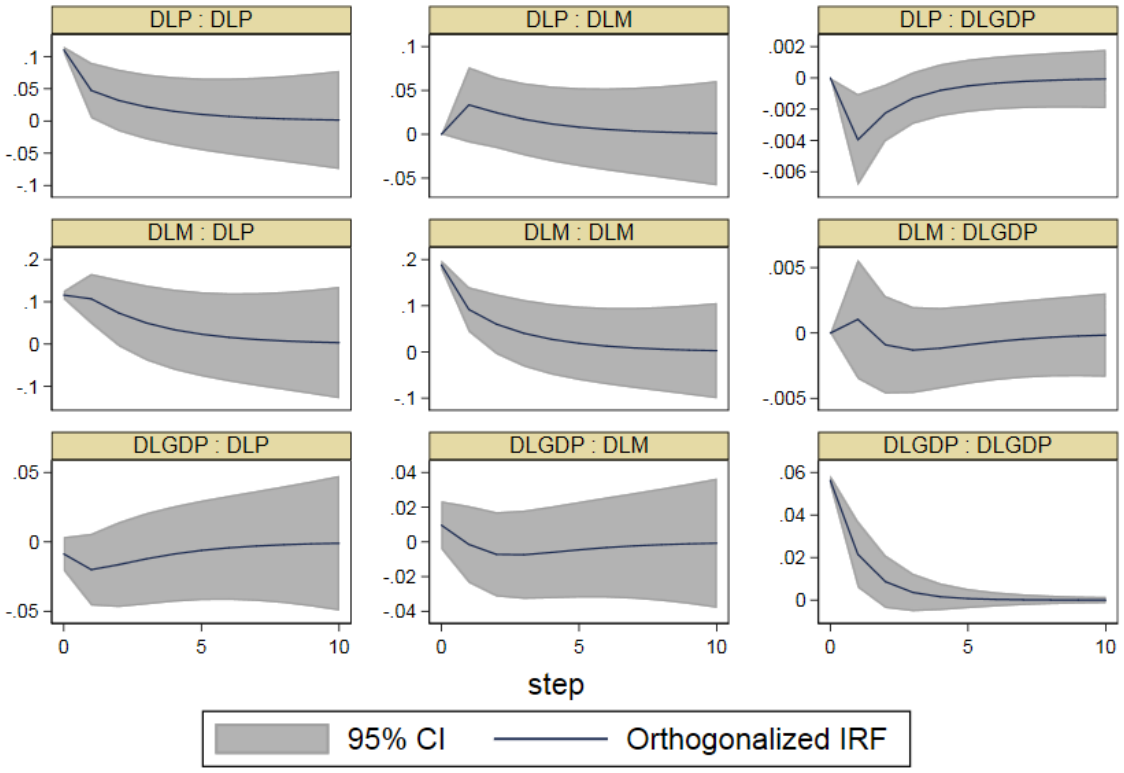
Table 11: Granger causality test based on VAR (1)

	chi2	**df**	**Prob > chi2**
DLGDP			
DLM	2.614	1.000	0.106
DLP	6.165	1.000	**0.013**
ALL	6.510	2.000	0.039
DLM			
DLGDP	0.024	1.000	0.876
DLP	3.034	1.000	**0.082**
ALL	3.046	2.000	0.218
DLP			
DLGDP	2.185	1.000	0.139
DLM	4.001	1.000	**0.045**
ALL	4.061	2.000	0.131

Impulse Responses computed from the VAR (1) estimation are in Figure 2. Inflation responds positively to shocks in money supply growth and inflation itself, and negatively to output growth. Higher inflation in previous year increase expectations and increase inflation. Similarly, growth in money supply leads to outward shift of the short run aggregate demand curve and results in higher prices as more money is chasing the same output.

Money supply growth show a positive response to shocks in money, inflation and real output. This is consistent with results in other studies, (Gillman, Harris, & Mátyás, 2004). Output growth rate responds negatively to increase in inflation and positively to increases in money supply and output growth. The negative shocks to output growth from growth in inflation is due to the impact of uncertainty on investment. Increased in money supply growth rate is followed by a temporary increase in output growth.

Figure 2: Impulse responses



5 Conclusion

This study analyzed the impact of inflation on economic growth and granger causality between inflation, money and economic growth using unbalanced panel data on Sub Saharan African countries from 1990 – 2016. Results using fixed effects regression on 5-year averaged data show inflation significantly and negatively affects economic growth. The result is consistent with results in (Gillman & Harris, 2010; Gillman & Nakov, 2004; Kasidi & Mwakanemela, 2013; Khan & Senhadji, 2000) and others. In addition, investment has a significant positive effect on growth while government expenditure has an insignificant effect. Robustness checks using 3-year averaged and annual data also show similar results. The paper finds that the estimation results are robust to outliers as estimates using inflation between 5 and 95 percentile, and between 1 and 99 gave similar results as the base estimation using 5-year average data.

The study finds a co-integrating relationship between the logs of consumer price index, broad money supply and real GDP. The long and short run dynamics and error correction term show that the system converges back to equilibrium. Granger causality tests show the logs of real output, consumer price index and money supply do not granger-cause each other. This paper finds significant positive granger causality from inflation to money and vice versa. Similarly inflation negatively granger causes economic growth.

This study shows that that inflation is hurtful to economic growth in Sub Saharan Africa. This shows the importance of following macroeconomic policies that favor stable price outlooks. Governments need to focus on improving central bank independence. In addition central banks in the region need to think about inflation targeting as only 2 countries out of 47

(Heintz & Ndikumana, 2010) formally implement inflation targeting in SSA in 2010. Inflation targeting is being considered as a successful tool to achieve lower inflation without hurting economic growth (Mishkin & Posen, 1998) and considering the ways to adapt the approach to each country's context should be considered. The findings in the study show investment plays a positive role in economic growth while government expenditure reduces growth. Countries should focus more on improving the business climate for investment and work towards making government expenditure effective. This requires reducing public expenditure and making procurement procedures transparent and competitive.

Finally, the paper showed further areas of study. One area is the estimation of long-run relationship between logs of price, money supply and real GDP. This paper showed that the variables have a long run relationship with coefficients having expected signs both on the short and long run equations. I believe this work can be further extended in two ways. First the model estimated in this paper is a simple model and further analysis including additional endogenous variables (like interest rates, exchange rates) and exogenous variables can give a better picture of the dynamics of the variables. Second in this study, I assumed no structural break from 1990 – 2016. Future studies including tests of structural breaks within the series can give additional insights.

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7 Appendices

Table 12: Hausman test for fixed effects vs. random effects

	Chi-square	**P value**
model 1	29.20117	.0000557
model 2	36.14097	.0000165
model 3	3.409038	.9061334
model 4	29.20117	.0000557
model 5	36.14097	.0000165
model 6	56.60789	2.15e-09

Note: Null hypothesis: random effects is consistent

Table 13: IV (inflation and investment) estimation using 5-year averaged data

	inf_cpi		**log(inf_cpi)**	
	(1)	**(2)**	**(3)**	**(4)**
	Dlgdp_pc	**Dlgdp_pc**	**Dlgdp_pc**	**Dlgdp_pc**
inf_cpi	-0.00722	-0.00578	-2.61784***	-2.35766***
	(0.00713)	(0.00490)	(0.75921)	(0.47593)
inv	0.24506***	0.13085***	0.23624***	0.14517***
	(0.03448)	(0.05029)	(0.03063)	(0.03136)
gov	-0.59228**	-0.50431***	-0.32432*	-0.30419*
	(0.25659)	(0.18494)	(0.19580)	(0.16105)
trade_pct		0.05349**		0.04428***
		(0.02538)		(0.01501)
converge		0.81249**		0.32408*
		(0.37308)		(0.17251)
Year	Yes	Yes	Yes	Yes
N	153	153	152	152

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$
L1 of money supply growth and investment used as instrument for inflation and investment

Table 14: Lag Selection in levels

Lags	CD	J	J pvalue	MBIC	MAIC	MQIC
1	1.00	63.58	0.00	-176.02	-8.42	-72.89
2	1.00	33.63	0.18	-146.07	-20.37	-68.73
3	1.00	23.37	0.18	-96.43	-12.63	-44.87
4	1.00	9.10	0.43	-50.80	-8.90	-25.02

Table 15: Panel lag length selection in growth rates

Lags	CD	J	J pvalue	MBIC	MAIC	MQIC
1	0.99	65.90	0.00	-171.45	-6.10	-69.89
2	0.99	51.49	0.00	-126.52	-2.51	-50.36
3	0.99	45.79	0.00	-72.89	9.79	-22.11
4	0.75	34.36	0.00	-24.98	16.36	0.41

CD is overall coefficient of determination, J is Hansen's J statistics, MBIC: Bayesian information criteria, AIC; Akaike information criterion and QIC: Hannan and Quinn information criterion

Table 16: Co-integration test[9]

	stat	p-val
Pedroni co-integration test		
Modified variance ratio	-3.110	0.001
Modified Phillips-Perron	-3.295	0.000
Phillips-Perron	-4.345	0.000
Augmented DF (Dickey fuller)	-0.631	0.264
Kao co-integration test		
Modified DF	-2.313	0.010
DF	-3.472	0.000
Augmented DF	-3.903	0.000
Unadjusted modified DF	-1.182	0.119
Unadjusted DF	-2.878	0.002

[9] Though two tests show no co-integration, I chose the result backed by most of the tests because both Pedroni and Kao assume the null of all panels are co-integrated which is a strong assumption.

Table 17: VAR results in logs

	(1) LGDP	(2) LM	(3) LP
L.LGDP	1.280***	0.809	0.678
	(5.98)	(0.99)	(0.83)
L2.LGDP	-0.289*	-0.412	-0.279
	(-2.29)	(-1.06)	(-0.62)
L.LM	0.0281	0.965***	-0.0000160
	(0.74)	(4.57)	(-0.00)
L2.LM	-0.0378	-0.112	-0.121
	(-1.29)	(-1.09)	(-1.40)
L.LP	0.0205	-0.139	0.915***
	(0.65)	(-0.80)	(6.24)
L2.LP	0.00258	0.126	0.0336
	(0.08)	(0.91)	(0.28)
N	920		

t statistics in parentheses, * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 18: List of countries included in the study

Country	**# of data points for inflation (1990-2016)**	**Country**	**# of data points for inflation (1990-2016)**
Angola	26	Madagascar	27
Benin	24	Malawi	27
Botswana	27	Mali	27
Burkina Faso	27	Mauritania	27
Burundi	27	Mauritius	27
Cabo Verde	27	Mozambique	27
Cameroon	27	Namibia	14
Central African Republic	26	Niger	27
Chad	26	Nigeria	27
Comoros	15	Rwanda	25
Congo, Dem. Rep.	24	Sao Tome and Principe	20
Congo, Rep.	24	Senegal	27
Cote d'Ivoire	27	Seychelles	27
Equatorial Guinea	27	Sierra Leone	27
Ethiopia	27	South Africa	27
Gabon	27	Sudan	27
Gambia, The	27	Swaziland	27
Ghana	27	Tanzania	27
Guinea	12	Togo	27
Guinea-Bissau	27	Uganda	27
Kenya	27	Zambia	27
Lesotho	24	Zimbabwe	25
Liberia	15		

Table 19: VAR Estimation in growth rates

	Lags							
	1 (selected model)		**2**		**3**		**4**	
DLGDP								
L.DLGDP	**0.37*** **	**(0.13)**	0.36***	(0.13)	0.40***	(0.15)	0.42***	(0.15)
L2.DLGDP			0.13**	(0.05)	0.08*	(0.05)	0.06	(0.05)
L3.DLGDP					0.14***	(0.06)	0.12*	(0.06)
L4.DLGDP							0.18**	(0.09)
L.DLM	**0.03**	**(0.02)**	0.04*	(0.02)	0.03	(0.02)	0.03	(0.03)
L2.DLM			0.05***	(0.02)	0.07***	(0.02)	0.07***	(0.02)
L3.DLM					0.01	(0.02)	0.01	(0.03)
L4.DLM							-0.01	(0.02)
L.DLP	**-0.04** **	**(0.01)**	-0.05**	(0.02)	-0.05**	(0.02)	-0.07**	(0.03)
L2.DLP			-0.02	(0.02)	-0.03	(0.03)	0.01	(0.04)
L3.DLP					0.01	(0.01)	0.02	(0.03)
L4.DLP							-0.00	(0.02)
DLM								
L.DLGDP	**-0.03**	**(0.20)**	-0.06	(0.17)	0.09	(0.16)	0.25*	(0.14)
L2.DLGDP			0.31**	(0.16)	0.16	(0.16)	0.14	(0.12)
L3.DLGDP					0.37***	(0.14)	0.35**	(0.14)
L4.DLGDP							0.20*	(0.10)
L.DLM	**0.30** **	**(0.14)**	0.35***	(0.12)	0.24***	(0.08)	0.18***	(0.06)
L2.DLM			0.11	(0.07)	0.19***	(0.06)	0.16***	(0.05)
L3.DLM					0.08	(0.05)	0.09*	(0.05)
L4.DLM							0.06	(0.04)
L.DLP	**0.30***	**(0.17)**	0.03	(0.26)	-0.28	(0.20)	-0.07	(0.08)
L2.DLP			0.24	(0.22)	0.45*	(0.24)	0.18**	(0.09)
L3.DLP					0.15*	(0.09)	-0.19***	(0.07)
L4.DLP							0.18***	(0.06)
DLP								
L.DLGDP	**-0.34**	**(0.23)**	-0.34	(0.22)	-0.33	(0.20)	-0.07	(0.06)
L2.DLGDP			-0.06	(0.12)	-0.10	(0.12)	-0.03	(0.05)
L3.DLGDP					-0.03	(0.09)	-0.03	(0.05)
L4.DLGDP							0.04	(0.04)
L.DLM	**0.30** **	**(0.15)**	0.33**	(0.14)	0.23***	(0.09)	0.09***	(0.02)
L2.DLM			0.03	(0.06)	0.06	(0.05)	0.01	(0.02)
L3.DLM					0.05	(0.04)	0.01	(0.02)
L4.DLM							0.01	(0.03)
L.DLP	**0.43** **	**(0.18)**	0.12	(0.27)	-0.11	(0.27)	0.19***	(0.07)
L2.DLP			0.37	(0.24)	0.71*	(0.37)	0.11	(0.08)
L3.DLP					0.02	(0.09)	-0.06	(0.05)
L4.DLP							0.17***	(0.05)
N	**920**		**872**		**824**		**777**	

Standard errors in parentheses, * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$