# Determination of Statistically Significant Variables Affecting Inflation in The Kenyan Economy

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**Abstract:** The main purpose of this research was to establish the statistically significant factors that determine the rate of inflation in Kenya for duration of 30 years from 1987 up to and including 2017. The research considered data in the areas that included money supply, Central bank rates, currency exchange rates, salaries of employed Kenyans, basket prices of foodstuffs, the price of petroleum products, rates of corruption in the country and Political stability as a dummy variable. The research employed time series analysis that used Ordinary Least Squares estimation covering the mentioned period and regressing the factors affecting inflation to reveal the statistical effect of each of the factors on the inflation rate. It also involved testing significance of parameters and picking the statistically significant factors to create an econometric model. The research revealed that average inflation rate is at 11.908% with a standard deviation of 8.0923 as at 2017. The highest inflation rate was at 45.97% and the minimum at 1.5543%. Food prices have been ranging from 77.8 units to 169.9 units with a mean of 110.14 units and a standard deviation of 23.78. Oil prices have ranged between 69.6 units and 188.1 units with a mean of 102.29 units and a standard deviation of 26.23. The central bank rates range between 8.00% and 36.24% with a mean of 16.68% and a standard deviation of 6.78. The lowest monetary growth is at 0.78% and the maximum at 48.8995% with a mean of 16.73% and a standard deviation of 9.56. According to the respondents, their perception on corruption ranges between 0.03 and 0.33 with a mean of 0.2144 and a standard deviation of 0.063. The regression coefficient showed that there is a negative relationship between food prices and inflation level, oil prices are statistically significant and have a negative relationship with the level of inflation. Central Bank Rates, Monetary Growth and Wage Rate Coefficient have a positive relationship with inflation level while GDP rate and corruption perception index have negative relationship with inflation. Exchange rates are statistically significant and have a positive relationship with inflation level. In addition, presence of political instability increases inflation level by 5.572%. This research output will be useful to policy makers, the Kenyan government, businesspersons, academicians and any other interested people.

**KEYWORDS**: Seigniorage, Nominal Output, CPI

## INTRODUCTION

Inflation rate is “an annual increase in the price of a basket of goods and services that are purchased by consumers in an economy” according to World Bank (2007), Inflation rate, therefore, measures the changes over time of the consumer prices or the GDP deflator which takes into account prices of goods and services produced in the country. This percentage cost of living is calculated using the consumer price index in Kenya.The highest inflation rate ever recorded in Kenya was in 1993 at 46%. This high inflation rate was attributed to excessive money supply, low aggregate demand, and depreciation of the Kenyan shilling with a low investor confidence due to tumult surrounding transition to plural politics. The devaluation of the Kenya shilling was seen as one of the causes of inflationary pressures, coupled with excessive money supply in 1992 and decontrol of prices and poor weather conditions in 1993. A prolonged drought further made the government divert large amounts of funds to famine relief imports to attain food security. The year 2002 registered the lowest inflation rate of 2% in the decade of the 2000’s. According to Economic Survey (2003), this was due to implementation of monetary policy, stability of the Kenyan currency, low prices of foodstuffs and stable petroleum prices. There are three main methods of measuring inflation: The GDP deflator, The Consumer Price Index (CPI), and,The Wholesale price index (WPI).

The choice of the method to measure inflation is influenced by information available. Kenya adopted the use of CPI in 1961, and it has continued to be accepted as the most practical measure. According to Mburu (2002), the CPI method has weaknesses such as not taking into account the change in the quality of goods and new products entering the market as well as the failure to capture the fact that relative prices change at different rates. Inflation imposes a real cost on society thereby distorting the incentives to save and invest. High inflation rates, a sign of economic imbalances, could reduce economic growth and lead to a reduction of the implementation of sustainable development goals. This research will study the statistically significant determinants of inflation and therefore make it easier to control it.

## LITERATURE REVIEW

### Monetarism

Friedman (1982) explained this theory. It focused on the demand for money during hyperinflation and explained that expectations of future inflation rates depended on past inflation rates. It explained that inflation is as a result of an increase in money supply in the economy. He concludes that inflation occurs if money supply in the economy exceeds the economic growth. The monetarist theory explained demand-pull inflation as being caused by excess demand, which inturn, businesses respond by raising prices of commodities to increase profits. This is explained by increases in money supply, depreciation of currency exchange rates and reducing tax rates. Any monetary policy sought to stabilize the exchange rates and prices, raise the level of employment, stable economic growth and interest rate smoothing.

**Structural Perception of Inflation**

According to Ndebbio (1993), Inflation is brought about by structural rigidities in the economy as a natural consequence, these rigidities results mainly from imbalances in public finance, where, the government is unable to raise enough revenue to match with the increased expenditures.

**Cost Push View**

This explained that the pressure on wages and monopoly pricing cause inflation. It argues that with strong trade unions, nominal wages go up once the price levels go up. The altering of wages should match up the price index so as to check inflation levels; however, the commodity shortages and crop failures coupled with high oil prices also cause inflation. Cost-push inflation is brought about by factors that make costs to go up. These costs are hence passed on to the consumers through higher prices. This is also referred to as wage-push inflation because wages are the largest part of the total production cost. (Zahoo & Shama, 2010). An interaction of forces cause inflation, with a number of factors such as exchange rates, money supply, wages, food price, oil prices, political instability and corruption perception leading to a rise in the general price level. However, it is important to note that, research on inflation in many aspects has been done but to determine the statistically significant factors in the Kenyan economy that affect the inflationary process in Kenya are rarely done. This research, therefore, will fill this gap.

## METHODOLOGY

**Data Type and Source**

This research made use of secondary time series data extracted from the Kenya National Bureau of Statistics and CBK for a period of 30 years. This is due to the fact that no other empirical analysis has been done in the past and because of the consistency of the variables.

**Specification of the Model.**

This study adopted a model used to analyze inflation in Tanzania in 2001 by Laryea and Sumalia where it was observed that in the short run, output and monetary factors influence inflation while in the long run, exchange rates, output, and monetary factors do affect inflation. Then the model is given as:

$$Y_t = f(M_t, N_t, E_t, P_{t-1}, M_t, P_t^f)$$

Where;
$Y_t$ is the inflation rate.
$M_t$ is money supply/monetary growth.
$N_t$ is Food price.
$E_t$ is nominal exchange rate.
$P_{t-1}$ oil price.
$P_t^f$ – GDP rate.
In order to determine inflation in Kenya, the following variables were added to the model:
Central Bank Rates – $R_t$
Wages –$W_t$
Political instability – $I_t$
Corruption Perception – $C_t$
Error term - $\varepsilon_t$
Therefore, the model will take the following functional form:

$$Y_t = f(M_t, N_t, E_t, P_{t-1}, M_t, P_t^f, B_t, W_t, I_t, C_t, \varepsilon_t)$$

The model is then given as:

$$Y_t = B_0 + B_1 M_t + B_2 N_t + B_3 E_t + B_4 P_{t-1} + B_5 P_t^f + B_6 R_t + B_7 W_t + B_8 I_t + B_9 C_t + \varepsilon_t$$

Political instability is a dummy variable, which takes zero ( 0 ) if true and 1 if not true and corruption perception as an index.

## RESULTS AND DISCUSSION

From the pre-estimation tests, it was concluded that inflation, monetary growth, wage rates and exchange rates are not stationary in trend. Most of the variable show very weak correlation with the other variables except for Food price and Oil price, which show

positive correlation of 0.705. Exchange rates and CBR also show moderate correlation of 0.671. From the Breusch-Pagan tests, the $p\ value > 0.05$ and therefore we conclude that all the variables had a constant variance. The Durbin Watson test statistic is 1.304. This indicates that there is positive autocorrelation between the variables. The test for normality showed that food prices, CBR rates, corruption index, wage rate, political instability, are not normally distributed.

**Endogeneity test**

The following is the R output for the Wu-Hausman test for Endogeneity.

```
> summary(fm, vcov. = sandwich, df = Inf, diagnostics = TRUE)

Call:
ivreg(formula = inflation ~ Food + Oil + cbr2 + monetary + wage +
    corruption + political + exchange + gdp | Food + Oil + cbr +
    monetary + corruption + wage + gdp + exchange + political)

Residuals:
     Min       1Q   Median       3Q      Max
-16.1473  -3.9561  -0.2845   3.2444  25.4615

Coefficients:
             Estimate Std. Error z value Pr(>|z|)
(Intercept)  6.676977  15.543747   0.430    0.668
Food        -0.042135   0.054367  -0.775    0.438
Oil         -0.039471   0.055838  -0.707    0.480
cbr2         0.004743   0.005321   0.891    0.373
monetary     0.158568   0.138271   1.147    0.251
wage         0.005459   0.004489   1.216    0.224
corruption -15.558543  33.674299  -0.462    0.644
political   -5.645087   4.606239  -1.226    0.220
exchange     0.051025   0.125449   0.407    0.684
gdp         -0.378866   0.267321  -1.417    0.156

Diagnostic tests:
                 df1 df2 statistic p-value
Weak instruments   1  38   585.239  <2e-16 ***
Wu-Hausman         1  37     2.194   0.147
Sargan             0  NA        NA      NA
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 7.94 on Inf degrees of freedom
Multiple R-Squared: 0.2216,     Adjusted R-squared: 0.03723
Wald test: 23.09 on 9 DF,  p-value: 0.005998
```

*Figure 4.18: Endogeneity test*

From the R output, under the diagnostic tests, the p-value of weak instruments is < 2e-16. This p-value is far much less than 0.05, level of significance, and therefore we conclude that there is very weak correlation between the instrumental variables and the endogenous variables. We can also conclude that instrumental variables are sufficiently strong. Looking at the Wu-Hausman test, the p-value is 0.147, which is greater than 0.05 and therefore we conclude that the instrumental variables are consistent.

**Overall Regression**

The following is the R output of overall regression

```
> model

Call:
lm(formula = inflation ~ Food + Oil + cbr + monetary + corruption +
    wage + gdp + exchange + political)

Coefficients:
(Intercept)         Food          Oil          cbr     monetary   corruption         wage
   6.114694    -0.046921    -0.038159     0.216272     0.163350   -16.560055     0.005302
        gdp     exchange    political
  -0.367564     0.044115    -5.572382
```

*Figure 4.19: Overall Regression*

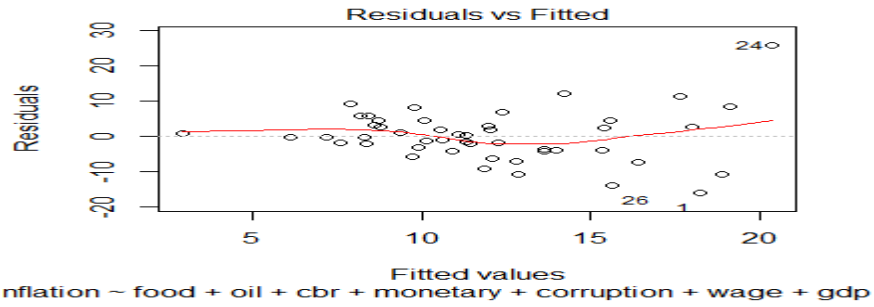
From the output, the regression equation will be

Inflation = 6.115 – 0.0469 Food – 0.0382 Oil + 0.216 CBR + 0.163 Monetary – 16.56 Corruption + 0.0053 Wage – 0.368 GDP + 0.0441 Exchange – 5.572 Political.

From this model, we can make the following inferences:

- When all the factors are held constant, the rate of inflation will be constant at 6.115.
- Any unit change in food price reduces inflation by 0.0469.
- Any unit change in oil price reduces inflation by 0.0382.
- A unit change in the central bank rates increases inflation by 0.216
- A unit increase in the monetary growth increases inflation by 0.163.
- A unit increase in the corruption perception will reduce inflation by 16.56.
- A unit increase in the wage rate causes an increase of 0.0053 in inflation.
- A unit increase in the GDP rate will cause a decrease of 0.368 in inflation.
- Any unit increase in currency exchange rate cause inflation to increase by 0.0441.
- When there is political stability, the rate of inflation is reduced by 5.572.

**Regression Plots**



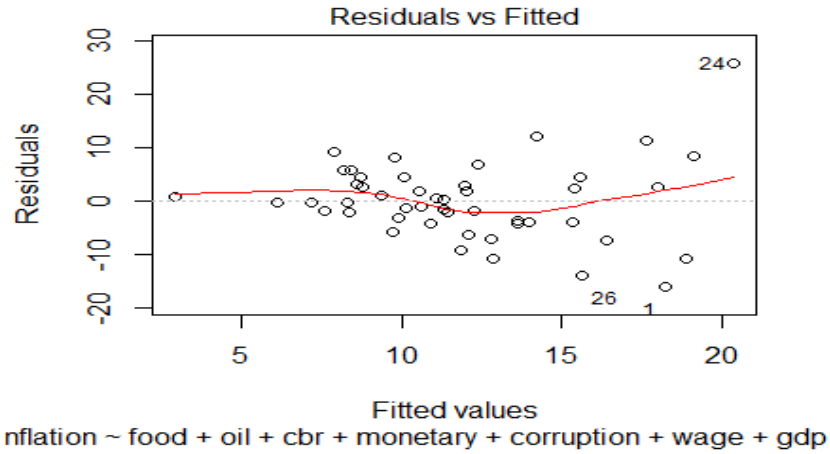




*Figure 4.20: Residuals vs. Fitted values plot.*

The plot of residuals vs. fitted values indicated an almost linear relationship between the predictor and outcome variables of the regression model. This proves the assumption of using a linear model.

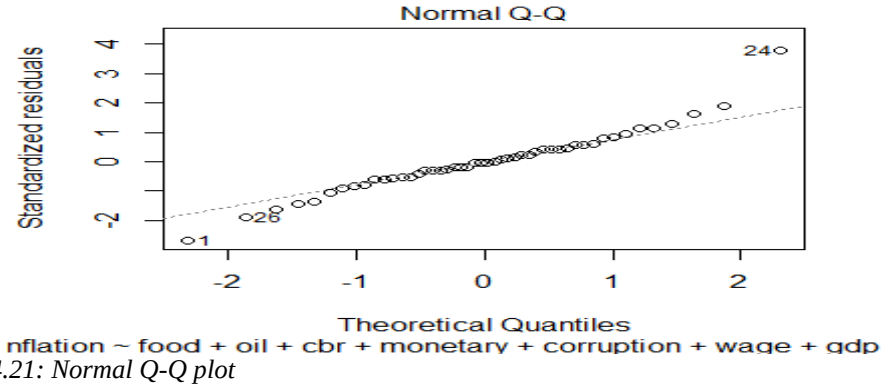



*Figure 4.21: Normal Q-Q plot*

Most of the plotted points in the Normal Q-Q plot are in a straight line except for points 1, 24 and 26, which are outliers. This shows that the residuals of this model are normally distributed.

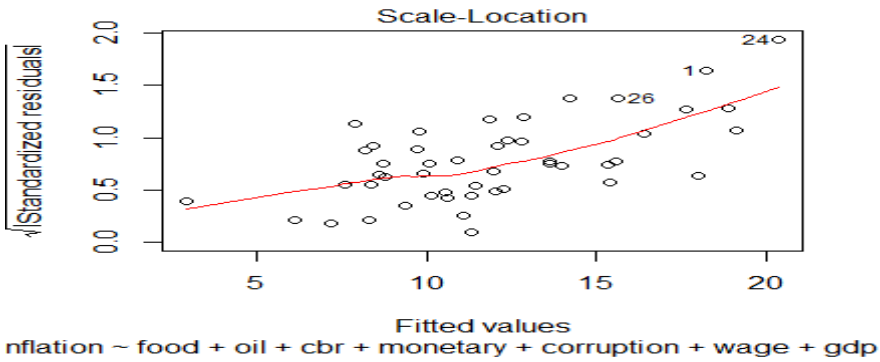



*Figure 4.22: Scale-Location plot.*

From this plot, the residuals are spread equally along the ranges of predictors. This indicates the presence of homoscedasticity.

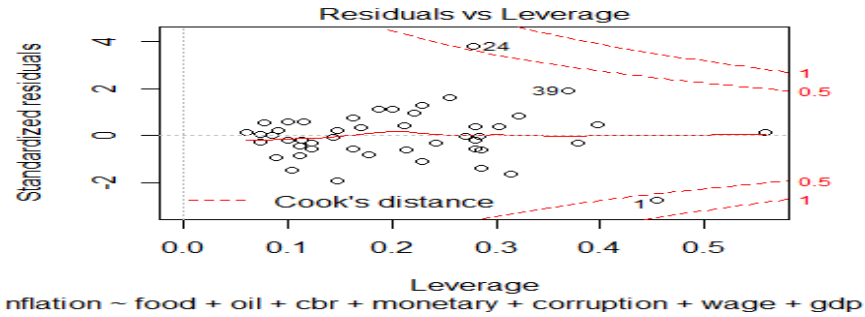



*Figure 4.22: Residuals vs. Leverage plot*

From the Residuals vs. Leverage regression plot above, points 1 and 24 have a higher Cook's distance greater than 0.5 but less than 1. Most of the points are close to Cook's distance of 0. From this plot, we conclude that only two data points of 1 and 24 are the influential to the regression results.

### 1.1 Testing Significance of Parameters

To test the significance of parameters, we use the following hypothesis,

$H_0: \beta_i = 0$ vs. $H_a: \beta_i \neq 0$

```
Call:
lm(formula = inflation ~ Food + Oil + cbr + monetary + corruption +
    wage + gdp + exchange + political)

Residuals:
     Min       1Q   Median       3Q      Max
-15.9946  -3.9925  -0.2666   3.3138  25.6237

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.114694  23.100152   0.265    0.793
Food        -0.046921   0.077449  -0.606    0.548
oil         -0.038159   0.086630  -0.440    0.662
cbr          0.216272   0.259287   0.834    0.409
monetary     0.163350   0.128485   1.271    0.211
corruption -16.560055  27.055695  -0.612    0.544
wage         0.005302   0.008323   0.637    0.528
gdp         -0.367564   0.316888  -1.160    0.253
exchange     0.044115   0.095757   0.461    0.648
political   -5.572382   4.902191  -1.137    0.263

Residual standard error: 7.986 on 38 degrees of freedom
Multiple R-squared:  0.2126,    Adjusted R-squared:  0.02609
F-statistic:  1.14 on 9 and 38 DF,  p-value: 0.36
```

*Figure 4.24: Testing Significance*

From the results above, we look at the p-values of each coefficient. At 5% level of significance, i.e. $\alpha = 0.05$, I compared the p-value with $\alpha = 0.05$ value. All the p-values in the figure above are greater than $\alpha = 0.05$. Therefore, we fail to reject the null hypothesis at 0.05 level of significance and conclude that the coefficients of all explanatory variables are insignificant at 0.05 level of significance. The coefficient of determination, $R^2$, is 0.2126. This indicates that this model has 21.26% effect on the total variation of inflation. From this, we can conclude that all the factors explained used in this model have 21.26% effect on the total rate of inflation.
The figure below shows the confidence intervals of each the coefficients of explanatory variables.

```
> confint(fit)
                                    2.5 %      97.5 %
(Intercept)                   -40.64911825 52.87850710
Data$`Food Price`              -0.20370907  0.10986742
Data$`Oil Price`               -0.21353217  0.13721389
Data$CBR                       -0.30862655  0.74117042
Data$`Monetary Growth`         -0.09675313  0.42345386
Data$`Corruption Index`       -71.33144606 38.21133632
Data$`Wage Rate`               -0.01154732  0.02215113
Data$`GDP Rate`                -1.00907016  0.27394178
Data$`Exchange Rate`           -0.14973422  0.23796425
Data$`Political Instability`1 -15.49634932  4.35158568
```

*Figure 4.25: Confidence Intervals.*

Confidence intervals show the range that the coefficients of the explanatory variables lie. From these results of confidence intervals, we note all the intervals range from negative value to a positive value. This implies that zero is part of the interval and therefore, this proves failing to reject the null hypothesis and concluding that the coefficients of explanatory variables are insignificant.

**Prediction Using the Model**

I used the inflation of data to test my model as shown below.

Inflation = 6.115 – 0.0469 (94.66) – 0.0382(110.85) + 0.216 (16.4) + 0.163 (25.76022) – 16.56 (0.28) + 0.0053 (2990) – 0.368 (5.028794) + 0.0441 (96.36) – 5.572 (0).

Inflation level at 2017 is 11.91477 according to my model. The actual inflation level is 8.042507. There is a difference of 3.872263 and this margin is attributed to other random factors affecting inflation that are not accounted for by the model. Therefore, this model can predict inflation with a margin for error.

## SUMMARY, CONCLUSION AND RECOMMENDATIONS

The study aimed at determining the statistical significant determinants of inflation in Kenya for a period of 30 years while the specific objective was to develop a regression model that can be used to determine inflation rate in Kenya at any time and to draw lessons for future and further suggest policy recommendations. From this study, findings indicate that average inflation rate is at 11.908% for year 2017 after putting the factors in the regression model developed. Food prices have been ranging from 77.8 units to 169.9 units with a mean of 110.14 units and a standard deviation of 23.78. Oil prices have ranged between 69.6 units and 188.1 units with a mean of 102.29 units and a standard deviation of 26.23. The central bank rates range between 8.00% and 36.24% with a mean of 16.68% and a standard deviation of 6.78. The lowest monetary growth is at 0.78% and the maximum at 48.8995% with a mean of 16.73% and a standard deviation of 9.56. According to the respondents, their perception on corruption ranges between 0.03 and 0.33 with a mean of 0.2144 and a standard deviation of 0.063. Wage rates range between 2250 and 3134 with a mean of 2740.42 and a standard deviation of 177.73. The gross domestic product rate ranges in between -4.655% and 22.17% having a mean of 4.46% and a standard deviation of 4.127. The currency exchange rates have a minimum at 56.17 and a maximum at 147.41 with a mean of 97.3 and a standard deviation of 21.028.

The regression coefficient showed that there is a negative relationship between food prices and inflation level, oil prices are statistically significant and have a negative relationship with the level of inflation. Central Bank Rates, Monetary Growth and Wage Rate Coefficient have a positive relationship with inflation level while GDP rate and corruption perception index have negative relationship with inflation. Exchange rates are statistically significant and have a positive relationship with inflation level. In addition, presence of political instability increases inflation level by 5.572%.

### Conclusions and Policy Recommendations

From the results of my study, Central Bank Rates, Monetary growth, Wage rate coefficient and exchange rates are the main variables that policy makes should aim at in controlling inflation in Kenya. The four variables have positive relationship with inflation and therefore an increase in them causes a corresponding increase in Inflation level. Oil price and Exchange rates are the only statistically significant factors that affect inflation in the study period. Interest policy is effective in reducing money supply which in-turn reduces monetary growth thereby reducing inflation rate. GDP rate has a negative effect on inflation and therefore increasing the GDP rate reduces inflation rate. This implies that policy makes should embrace fiscal policies that spur GDP growth in order to contain an increase in inflation.

### Recommendations for further research

This study used time series data and applied Ordinary Least Squares estimation to estimate a regression model for inflation in Kenya. A similar study may be conducted using panel data or any other data type and compare the results. Another study may also be done comparing inflation in different regions of Kenya or yet another may utilize data from black market and compare the findings.

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