Determine the Breaking Point of Kenya Debt using the Generalized Extreme Value theorem.

1) KIILU DANLOF MUSYOKI - SCM212-9265/2015
2) KIMATHI LINDA KARIMI -SCM212-8868/2015
3) ANG'AH STACY SEMO - SC281-6558/2014
4) MWANGI MOSES MUTHANJI - SCM212-8894/2015
5) MURIMI GEOFREY KABEU - SC281-7349/2014

Supervised by

PROF. SAMUEL MWALILI

&

DR. JOSEPH MUNG'ATU

This thesis is submitted to the Department of Statistics and Actuarial Science in the School of Mathematical Sciences for the award of Degree in Actuarial Science at Jomo Kenyatta University of Agriculture and Technology.

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DECLARATION

This thesis is our original work and has not been presented in any other institution in award of degree

NAME / REG NO:

1.ANG'AH STACY SEMO /SC281-6558/2014 -

2.KIILU DANLOF MUSYOKI / SCM212-9265/2015-

3.KIMATHI LINDA KARIMI / SCM212-8868/2015 -

4.MWANGI MOSES MUTHANJI / SCM212-8894/2015-

5.MURIMI GEOFREY KABEU / SC281-7349/2014-

Date : ____________________

APPROVAL

This thesis below has been submitted for examination with my approval as the University supervisor.

Name : Prof. Samuel Mwalili   Sign: ________________________

Date : ____________________

Name :Dr. Joseph Mung'atu   Sign : ________________________

Date : ____________________

DEDICATION

We would want to dedicate this thesis to our parents ,brothers and sisters and also our fellow students.

ACKNOWLEDGEMENT

We would like to acknowledge God for giving us unrelenting zeal to work on this project till the end . We would also like to thank our supervisors Pro .Samuel Mwalili and Dr. Joseph Mung'atu for their inspiration, positive criticism and guidance.Without them we could have not completed this dissertation. We would also like to acknowledge our parents for both financial support and encouragement though out the year. Finally , we would like to acknowledge our fellow coursemates for all the support.

ABBREVIATIONS

Ksh	Kenya Shillings
GEV	Generalized Extreme Value
GDP	Gross Domestic Product
BPS	Budget policy statement
SGR	Standard Gauge Railway
MDA	Maximum domain of attraction
IID	independent and identically distributed
w.r.t	with respect to
POT	peak over threshold
EVT	Extreme value theorem
GPD	Generalised pareto distribution

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ABSTRACT

There has been a rapid increase in borrowing to fund new infrastructure since 2008. We saw that revenue collected was not enough, hence experiencing budget deficits. This resulted to more borrowing from domestic and external markets from 2008 to 2020.

As the adage goes, too much of everything is poisonous. Sovereign debt in great proportions caused stalling of both foreign and domestic investments. For example, these loans taken were used to repay creditors and the first Eurobond that had just matured, instead of funding development projects and infrastructure.

In our study we used the Generalized Pareto model to determine the sustainable debt levels. Where we found a threshold of 3.5 on projecting the data to 2025 we found the total debt to reach heights of 10 trillion. We recommended a change of the fiscal structure to curb this aggressive trend in borrowing.

Chapter 1: Introduction

1 .1: Background of the study

Government needs resources for public expenditure while taxes generally provide the bulk of the revenue, public borrowing bridge the resource gap between receipt and expenditure .High rate of borrowing may lead to adverse effect called the debt overhang effect which occurs when debt is greater than the ability of a country to repay ,and the anticipated servicing cost on debt being high hence depressing further domestic and foreign investment (Karagol ,2002).Economic theory suggests that reasonable levels of borrowing by a developing country are likely to enhance its economic growth (Patillo,Ricci,Poirson,2002).

Kenya debt levels have been on a rapid increase over the years. Ochieng (2013) noted that Kenyan debts levels are governed by the treasury under the external loans and credit Act of the laws of Kenya which limits the total indebtedness in respect of the principle set. In October 2019 the parliament approved to raise borrowing ceiling to Ksh 9.1 trillion ($85.7 billion) .The recently released treasury figures by then painted a very frightening picture .The government of Kenya was not only broke but also struggling with declining revenues, as a result they were now spending an equivalent of 90 percent on the wage bill on interest repayment causing less allocation of money on counties (David Ndii, 2018). Interest payments on debt were eating into recurrent expenditure ,threatening to grind daily government operations to a halt .At end of June 2018,kenya's total public debt was ksh5.2 trillion up from ksh1.8 trillion five years before , an increase of ksh3.3 trillion .

Recently the government of Kenya borrowed a syndicated loan of ksh 77.2 billion from four international commercial lender to repay another syndicated loan that fell due October 2018 .If a country uses the money it has borrowed to repay another debt ,no new wealth is created and it might struggle to repay debt in future. This is likely to cause its credit rating to fall .Lenders and investors would then demand a higher interest rate to compensate for the risk that they will lose their money .This makes it costly to repay the new debt.

A statement by the national treasury on revenues and exchequer issues published in September 2019 Gazette notice showed that the country incurred KSH 975.8 billion loans in the 2018/2019 financial year. Half of these loans were issued to repay creditors, including the holders of Kenya's first Eurobond that matured during this period, while the rest went into development projects which included President Kenyatta's Big 4 agenda.

1.2: Statement of the problem

The rate of borrowing in Kenya needs a lot of attention more so due to the recent borrowings trends .Unsustainable debt levels can be harmful. They can crowd out development and social programs because huge portions of revenues are taken away from essential services and used to service debt .It also forces the citizens of a country to pay more tax than normal .Our study used data for a period of 20years. It is important to find the breaking point of the debts so that the government will be able to plan on how to deal with speculated effects.

1.3: Justification of the study

Increase in sovereign debt can lead to political instability where the government does not take care of its military funds, leading to terrorists and a state of anarchy.Since most of the revenue collected is used to service debt with very high interest rates.

Increase in taxes e.g. the sportpesa saga, may force potential and current investors to go away due to unfavorable investing grounds.

Currency exchange rates drop with additional debt since the country is borrowing more money, it must sell more of its bonds and there is an increased risk if it can't pay them back. The country's credit rating may drop on extreme cases (Eric Norinson)

In Sri Lanka, they forfeited paying their debts to the Chinese and their port was taken to cater for this debt .No one wants to lose Kilindini harbor.

1.4: Research questions

1.4.1: Primary Research question

Can “generalized extreme value theorem” be used to determine the unsustainable levels of debt?

1.4.2:Secondary Research questions

1. What is the relationship between various variables?

2. What is the return level of total debt?

3. Which is the debt threshold to be used as a starting point of our analysis?

1.5: Objectives

1.5.1: General objective

To determine the Breaking Point of Kenya’s debt using the Generalized Extreme Value theorem.

1.5.2: Specific objectives

1. To determine the threshold of debt given predictor variables from historical data.

2. To fit the Generalized Extreme Value distribution to the Kenya’s foreign debt.

3. To determine the Breaking Point of Kenya’s debt using the Generalized Extreme Value theorem.

1.6: Scope of the Study

Our study focused on the trend on which the country has been borrowing over the years and we tried to forecast where our debt level will be in future if we continue with the current trend.The sample we are going to use consists of historical data from 2000-2020.We used the generalized extreme value distribution to fit the data we collected,where we ended basing our results using the outcome from generalized pareto distribution since we used the POT. Our geographical focus will be in our country Kenya.

1.7: Significance of the study

Despite the worries and effects being raised by countries and international organizations, the debt cap in place is not concrete. The purpose of this project was to prevent a crisis by applying GEV so that we can be able to find Kenya's debt global threshold.

Autor (2012) stated that the inability of national government in European countries to tighten fiscal policies during the booming period; companies in the private sector kept increasing their risks .Revenues went up in terms of taxes, assets prices rising and increased investments during the booming season. Most of the increased revenue collection by government was used to cater for tax cut and extra public spending and the low amounts actually went to fiscal improvements.

Reinhard (2011) found that the failure to monitor the debt levels, especially the debt in a country can lead to external debt crisis. Autor (2012) defines external debt crisis as the default on debt payments obligations incurred under foreign legal jurisdiction. Rejection of the debt and restructuring of the debt are the two main actions that countries that fail to pay debt are forced into .Restructuring have less favorable terms than original terms thus it is the last resort.

CHAPTER 2: LITERATURE REVIEW

2.1:Theoretical review of generalized extreme value distribution

The Generalized Extreme Value distribution is a family of continuous probability distribution developed within extreme value theory .The GEV distribution is often used to model the smallest or largest value among a large set of iid random values representing measurements or observations .

The three cases covered by the GEV distribution are often referred to as Type I, Type II and Type III. Distribution whose tails decrease exponentially ,such as Normal lead to the type I. Distribution whose tails decrease as a Polynomial ,such as Student's t ,lead to type II . Distributions whose tails are finite ,such as the Beta ,leads to type III.

Type I,II and III are sometimes also referred to as The Gumbel ,Fretchet and Weibull respectively, when a shape parameter is equal to 0 ,greater than 0 and lower than 0 .Among these three families of distribution , the Type I is the most commonly referred in discussions of extreme values.

Type I which is the Gumbel distribution, named after one of the pioneer scientists in practical applications of the EVT , has been extensively used in various fields including hydrology for modelling extreme events .Gumbel applied EVT on real world problems in engineering and in meteorological phenomena such as annual flood flows .

Type II which is the Fretchet distribution, was named after Maurice Frechet , a french mathematician , who devised one possible limiting distribution for a sequence of maxima , provided convinient scale normalization . In application to finance , the Frechet distribution has been of great use apropos to the adequate modelling of market-returns which are often heavy-tailed.

Type III which is the Weibull distribution was named after Woladdi Weibull , a swedish engineer ,well known for his work on strength of materials and fatigue analysis.Even though the Weibull distribution was originally developed to address the problems for minima arising in materials science , it is widely used in many other areas , thanks to its flexibility.

2.2: Empirical study

Medford(2015), wrote that the application of extreme value statistics allows us to investigate the behavior of a statistical process at very high or very low levels.EVT has been used in the field of modern science and engineering to model rare events that have significant consequences(Gilli and kellezi,2003).EVT has also found a place in finance by being used to model risk financial sector(Embrecghts,renick and samoodnisky,1999).

According to (Mung'atu, 2016), he established a debt threshold of 1.263 which implied that that year's borrowing should not occasion public debt to rise beyond 26.3 per cent of the previous year's level. Unconditional value-at-risk has been determined as 1.263 α=0.05 .This implies that the public debt VaR is 1.263, which means that the maximum tolerable public debt limits. In say, the current year is 1.263 times that of the previous year.

Conditional value at risk has been established as α =0.05, implying that the public debt VaR is 0.957, which is a maximum tolerable public debt limit in the prevailing year compared the previous. In other words the current year borrowing should occasion a public debt reduction by 4.27 per cent from the previous one.

From previous research shows that Gumbel model is the best candidate for the Total Debts ξ = 0.03 which tends to zero. At a 95% threshold.The extreme debt level sustainable is KES 5 trillion. (Mathenge 2017).

From (Manmohan ,2010), he explores the impact of high public debt on long run economic growth. The analysis is based on a panel of advanced and emerging economies over almost four decade, took into account a broad range of growth as well as various estimation issues including reverse causality and endogeneity. In addition non linearity and differences between advanced and emerging market economies were examined. They found that there is an inverse relationship between initial debt and subsequent growth controlling for other determinant of growth: on average a 10% increase in the initial debt to GDP ratio is associated with a slowdown in annual real per capita GDP growth of around 2% points per year, with the impact being smaller in advanced economy. There is some evidence of non-linearity with higher levels of initial debt having a proportionately larger negative effect on subsequent growth. Analysis of the component of growth suggests that the adverse effect largely reflects a slowdown in labor productivity growth mainly due to reduced investment and slower growth of capital stock.

Chapter 3: Research Methodology

3.1: Introduction

In this section, we present an overview of the research model that was used in our study, the research designs, data collection methods, target population, theoretical review of GEV and the data analysis.

3.2: Research Design

We used quantitative design using the secondary data. Whereby the design helped us to, quantify the problem by way of generating numerical data that was transformed into usable statistic. Also, in our study, the quantitative design helped us generalize results from a larger sample population.

3.3: Data collection method

The study used secondary data collected which was extracted from the following sources ; Central Bank of Kenya, websites, publications, International Monetary Fund, The National Treasury, Kenya National Bureau of Standards, Kenya Revenue Authority

The study used time series data from the period of 2000-2020.

3.4: Target Population

The study focused on various variables such as government expenditure,government imports,government revenue, external debt and domestic debt.

3.5: Theoretical review of generalized extreme value distribution

3.5.1: Fishers-Tippet theorem, limit laws for maxima

Let x_n be a sequence of iid random variables. If there exist norming constants $c_n>0$ $d_n \in \mathbb{R}$ and 0some non-degenerating distribution function H such that

$$c_n^{-1}(m_{n-}d_n) \xrightarrow{d} H \qquad 1$$

Then H belongs to the type of one of the following three dfs:

Fréchet: $\Phi_\alpha(x) = f(x) = \begin{cases} o & ,x\leq 0 \\ \exp\ \{-x^{-\alpha}\} & ,x>0 \end{cases} \quad \alpha > 0 \qquad 2$

Weibull: $\psi_\alpha(x) = \begin{cases} \exp\ \{-(-x^{\alpha}\} & x\leq 0 \\ 1 & x>0 \end{cases} \quad \alpha > 0 \qquad 3$

Gumbel: $\Lambda(x)=\exp\{-e^{-x}\}$, $x \in$ R $\qquad 4$

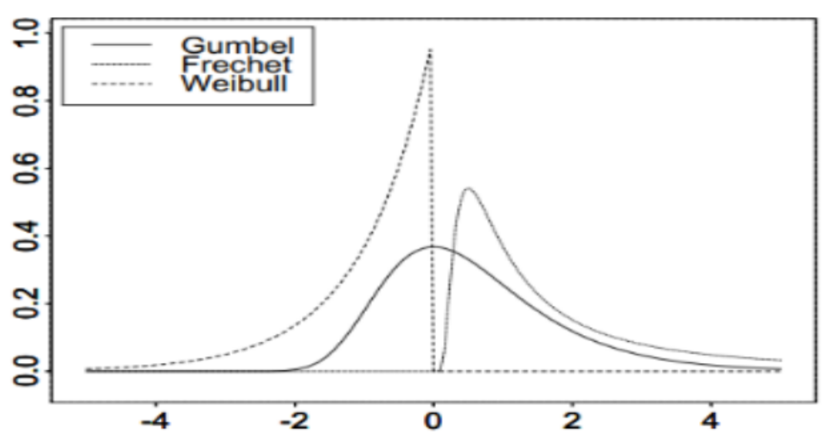

Figure 1: Densities of the standard extreme value distributions. We chose α=1 for the Frechet and the Weibull distribution.

3.5.2: Maximum domain of attraction

We say that the random variable X (the degrees of freedom F of X ,the distribution of X) belongs to the maximum domain of attraction of the extreme value distribution H if there exists $c_n>0$, $d_n \in \mathbb{R}$ such that $c_n^{-1}(M_n - d_n) \xrightarrow{d} H$ holds

3.5.2.1: Jenkinson-Von Mises representation of extreme value distribution

A one-parameter representation of the 3 standard cases in one family of distribution functions will turn to be useful. They can be represented by introducing a parameter ξ so that

$\xi = \alpha^{-1} > 0$ correspond to the Frechet distribution

$\xi = 0$ correspond to the gumbel distribution

$\xi = -\alpha^{-1} < 0$ corresponds to the weibull distribution

The Jenkinson-Von Mises representation of the extreme value distributions is as follows:

Define the distribution of functions H_ξ by

$$H_\xi(x) = \begin{cases} \exp\left\{-(1+\xi x)^{-\frac{1}{\xi}}\right\} & \text{if } \xi \neq 0 \\ \exp\{-\exp(-x)\} & \text{if } \xi = 0 \end{cases} \qquad 5$$

Where $1+\xi x > 0$

Hence the support of H_ξ corresponds to:

$x > -\xi^{-1}$ for $\xi > 0$

$x < -\xi^{-1}$ for $\xi < 0$

$x \in \mathbb{R}$ for $\xi = 0$

H_ξ is called a standard generalized extreme value distribution GEV. One can introduce the related location-scale family $H_{\xi;\mu;\psi}$ by replacing the argument x above by (x-μ)/ψfor ;$\mu \in R$, $\psi > 0$ The support has to be adjusted accordingly.We also refer to $H_{\xi;\mu;\psi}$ as GEV.

We consider the df H_0as the limit of $H\varepsilon$for $\varepsilon \to 0$ With this interpretation

$$H\varepsilon(x)=\exp\{-(1+\varepsilon x)^{-\frac{1}{\xi}}\} \quad ;1+\xi>0 \qquad 6$$

serves as a presentation for all $\xi \in R$.

3.5.2.2: Characterization of the MDA of H_ξ

For $\xi \in \mathbb{R}$ the following assertions are equivalent

a) $F \in$ MDA (H_ξ)

b) There exists a positive, measurable function a(.) such that for $1 + \xi x>0$

$$\lim_{u \uparrow xF.0} \frac{\bar{F}(u+xa(u))}{\bar{F}(u)} = \begin{cases} (1+\xi x)^{-1/\xi} & \text{if } \xi \neq 0 \\ e^{-x} & \text{if } \xi = 0 \end{cases} \qquad 7$$

c) X,y,>0;y≠1

$$\lim_{s \to \infty} \frac{U(sx)-U(s)}{U(sy)-U(s)} \begin{cases} \dfrac{x^{\xi}-1}{y^{\xi}-1} & \text{if } \xi \neq 0 \\ \dfrac{\ln x}{\ln y} & \text{if } \xi = 0 \end{cases} \qquad 8$$

3.6: Approach to Extreme value theorem

In EVT there are two fundamental approaches ,both widely used; the block maxima and peak over threshold .In block maxima approach in EVT ,consist of dividing the observation period into non overlapping periods of equal size and restrict attention to the maximum observations in each period (Gumbel ,1958). The new observations thus created follow under domain of attraction conditions. Parametric statistical methods for the extreme values are then applied to those observations.

In the peak over threshold approach in EVT one selects those of the initial observations that exceed a certain high threshold. The probability distribution of these selected observations is approximately a generalized Pareto distribution.

The peak over threshold method picks up all relevant high observations. The block maximum method on the other hand misses some of these high observations and, on the other hand, might retain some lower observations. Hence the POT seems to make better use of the available information.

3.6.1: Peak-over threshold method

The Peak over Threshold-method (POT-method) is one way to model extreme values. The main concept of the method is to use a threshold to seclude values considered extreme to the rest of the data and create a model for the extreme values by modeling the tail of all the values that exceeds this threshold. This is done in practice by setting a threshold u to be some value defined on R that exceeds most but not all values defined in some time series or some other vector of collected values. Furthermore it can be shown that for some sufficiently large threshold u the distribution of the values exceeding the threshold approximate to a General Pareto Distribution with some Shape and Scale parameter.

3.6.1.1: Setting a threshold

The main difficulty of modeling with the POT-method is setting an appropriate threshold. If it’s too large there will be too few values to model the tail of the distribution correctly as the variance is likely to be large due to only very extreme observations remaining. On the other hand a low threshold will include too many values giving a high bias. It is thus of importance of finding a good balance in setting the threshold to find a suitable balance between the variance and the bias of the model.

3.6.1.1.1: Rule of thumb

One way to approach setting a threshold is by using a rule of thumb to choose the k largest observations and modeling. Commonly used is the 90th percentile, but others have also been proposed, such as $k = \sqrt{n}$ and $k = n^{(2/3)} / \log(\log(n))$ all of which are practical but to some level theoretically improper.

3.6.1.1.2: Graphical method

Another way to approach the problem is by using graphical tools to perform diagnostics and draw conclusion based on the results. Scarrot and MacDonald (2012) speaks of how a graphical approach hold some benefits in that it requires more involvement with the data set when setting a threshold and analyzing the final model. The threshold level set will be more dependent on the data itself and allows for more parameters when deciding relative to using a predetermined rule. These methods are however far more time-consuming than using a rule of thumb and when working with multiple data sets it may be more effective to use a rule of thumb at the cost of accuracy.

3.7: Data Analysis.

We used RStudio to analyze our data since it contains some inbuilt functions which helped us in fitting the models.

In our study, we considered Generalized extreme value and Generalized pareto distribution. Due to the nature of the data we had we ended up basing our results using the outcome from Generalized pareto distribution since the data converged to GPD.

CHAPTER 4: RESULTS

4.1: exploratory data analysis

This approach helps in visualizing the given data to be able to have an insight.

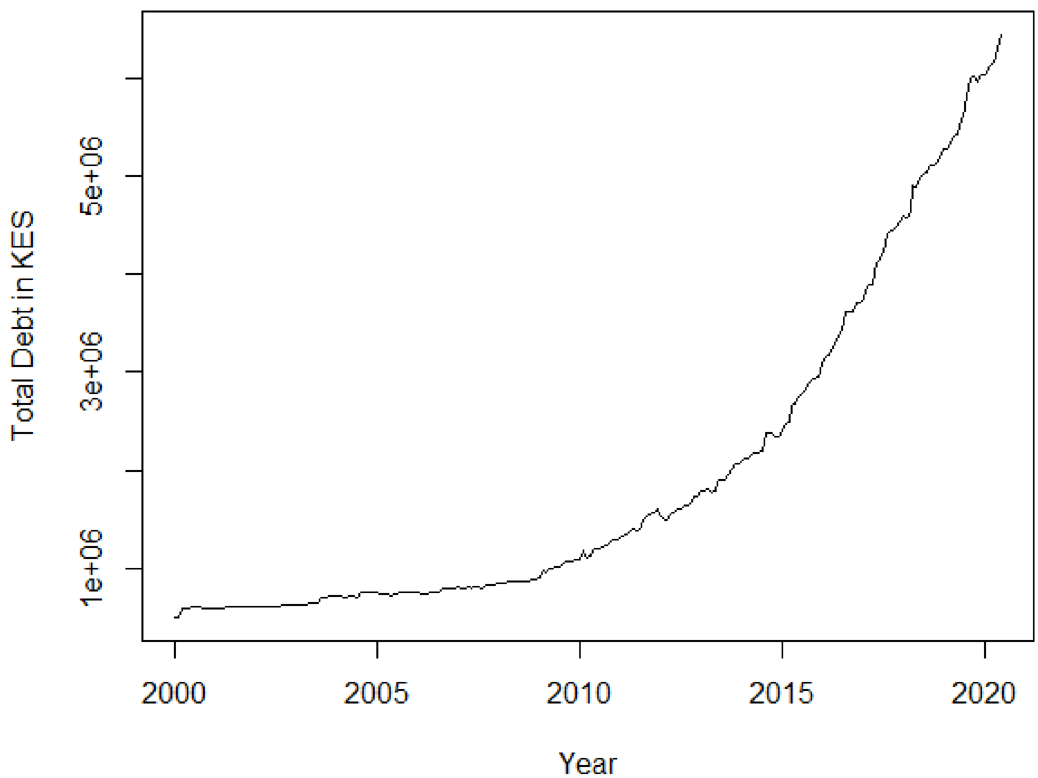

Fig.4.1: A time series plot of total public debt in Kenya

Figure 4.1 shows the total public debt from 2000 to 2020. There has been an exponential increase of the debt from 2010 which was due to implementation of the new Constitution which devolved the governance criterion.Many projects I.e the Thika super high way , LAPPSET Project, Sgr and military funding to Somalia have been some of the key reasons for the exponential growth.

Furthermore, we can have have a clearer look at the debt structure by having distinctively the external and internal debt as show below;

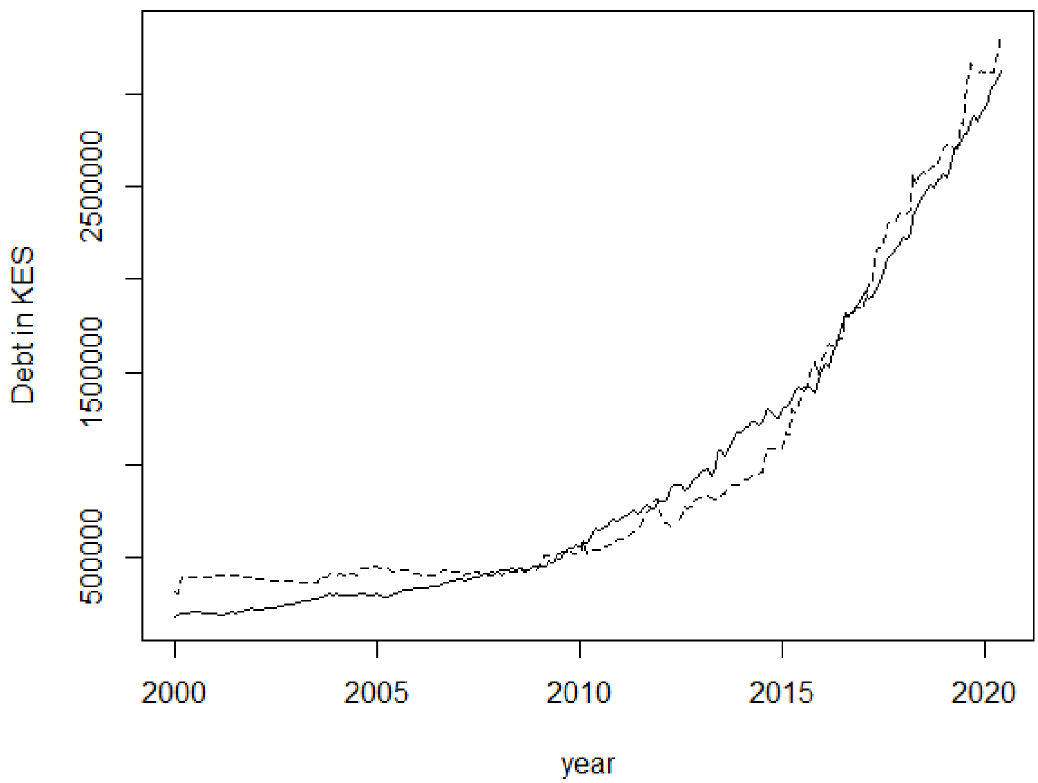

Fig.4.2:Time series plot of the external(dotted line) and domestic(continuous line) debt

Figure 4.2, shows both the domestic and external debts exhibit the exponential tendency from 2010 due to reasons stated above. From 2014 we can see an increased borrowing from the foreign market to service the budget deficits, which rises steadily despite still borrowing more from the domestic market. The reliance on domestic debt at this point is mainly due to the fact the principle was not paid up on expiration but rather, the debt is restructured to a new interest rate upon maturity. In 2018 we see a radical increase of the foreign debt due to the issue of the second euro-bond.

4.2: Fitting the Generalized Pareto distribution

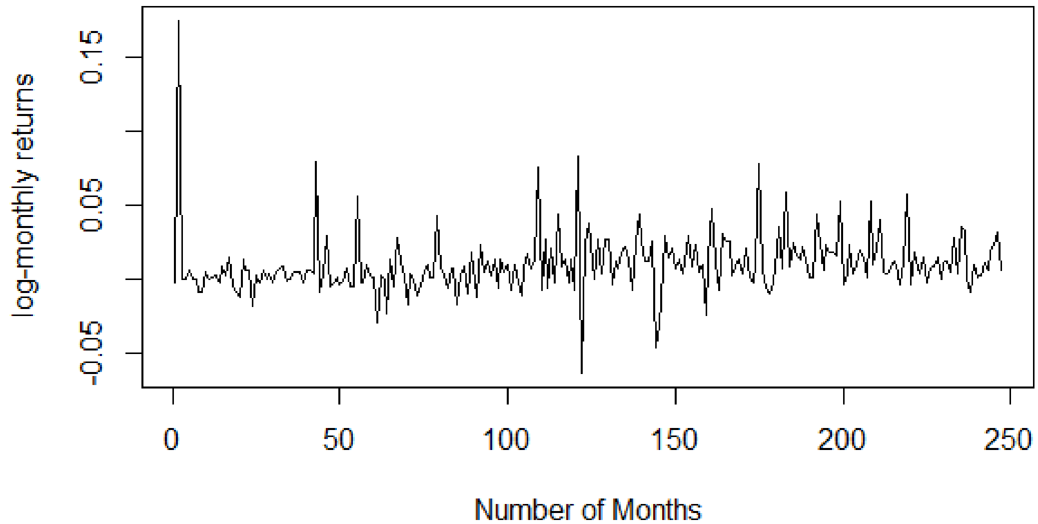

Fig .4.3: log monthly returns of total debt

Figure 4.3 shows the transformed data is close to stationarity, for further understanding of the data and better our forecasting. Since the total debt had trend in it.

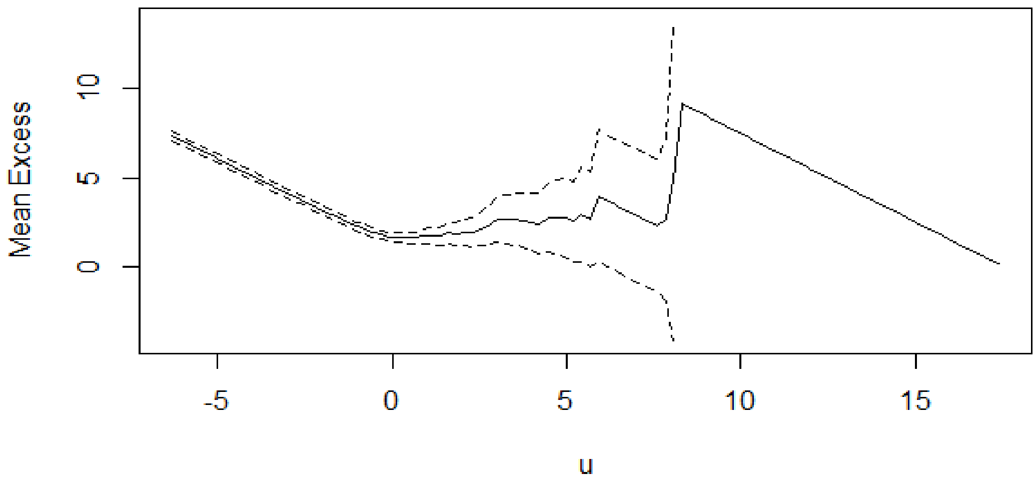

Fig 4.4: Mean residual life plot for total debt monthly log returns

Figure 4.4 show a mean residual life with a 95% confidence interval. Above a threshold say u_0 at which the generalized Pareto distribution provides a valid approximation of the excess distribution, the mean residual life plot should be approximately be linear in u Due to linearity , we took u_0 =3.5,and information on the right hand side of u_0 was unreliable due to great variability since there was limited observations accounted for.

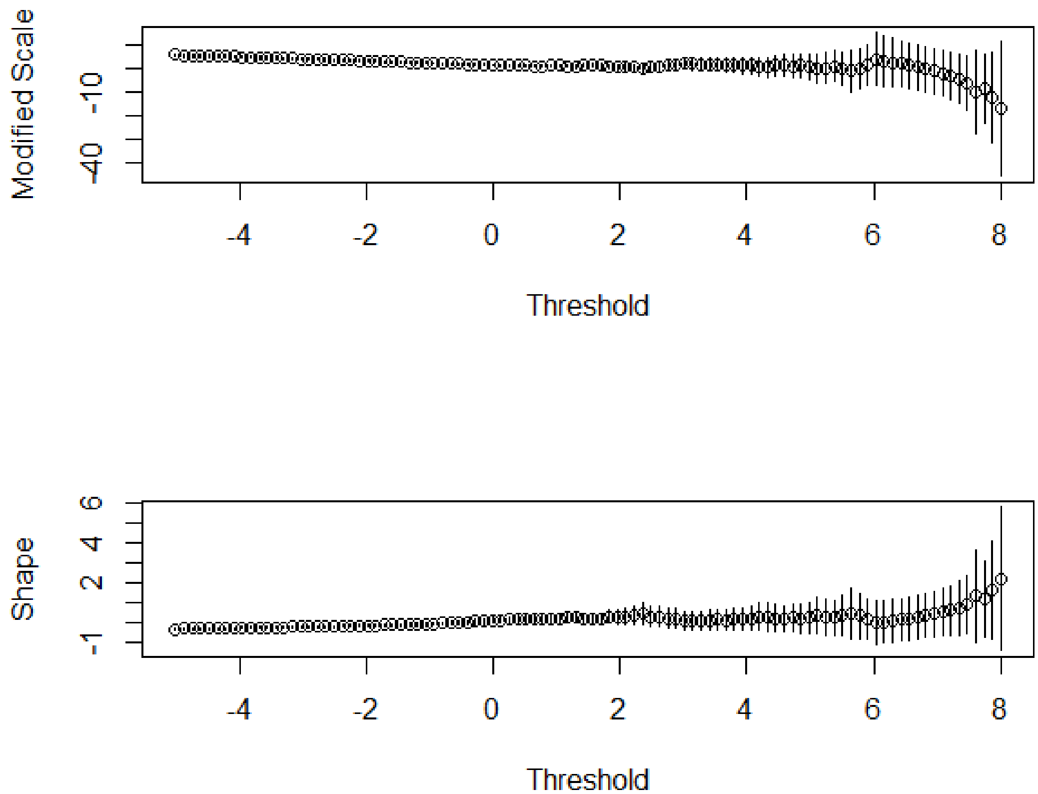

Fig .4.5:MLE of the reparameterized generalized Pareto model as a function of threshold for total public debt log monthly returns,(95% confidence interval).

Figure 4.5 shows the plots of the modified scale and shape parameters against the threshold, and these plots further tries to validate our choice of the threshold at u=3.5,by checking the stability with respect to u of the MLEs for the reparameterized model. The change of pattern for very high thresholds is also apparent as in the mean residual life plot, but the perturbations appear small relative to sampling errors hence sticking with our u=3.5.

4.2.1:Maximum likelihood estimates of the GPD parameters

		Estimate of scale parameter	*Estimate of the shape parameter*
Threshold	3.5		
Number of excesses	19		
Conv	0		
Negative log likelihood	36.33972		
Mle		2.0779504	0.1813505
Rate	0.07692308		
Standard error		0.7164204	0.2607790

Table 4.1:The fitted GPD model results

4.2.2:Model diagnostics

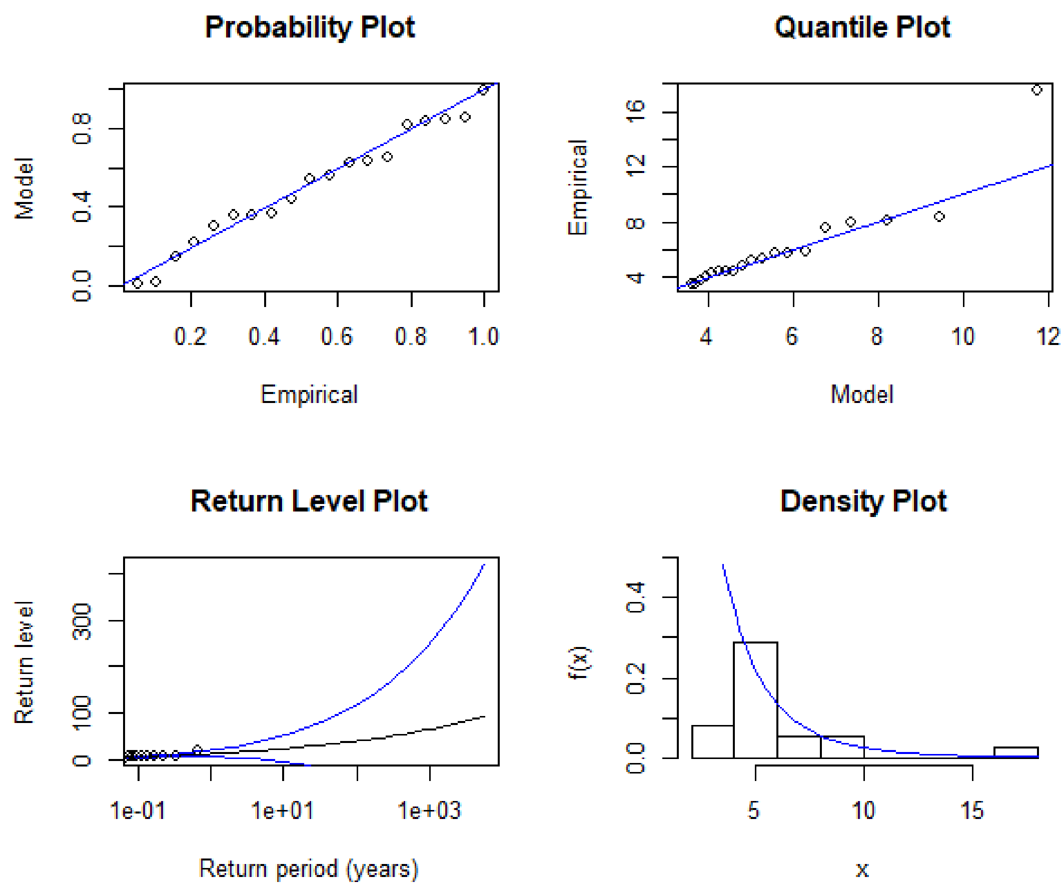

Fig4.6:Diagnostic plots indicating the goodness of fit of the GPD to the total public debt extremes.

In Figure 4.6, the quantile plot was convincing since most of the plotted points are almost on or near the line of best fit. The return level plot shows the risks that accumulate if the model is extrapolated to higher level.The return levels here are the value at risk against risk, which the generalized Pareto threshold model enables us to estimate the value at risk. Hence figure 4.6 gives little doubt that the model converges to the GPD model.

4.2.3:Profile Likelihood

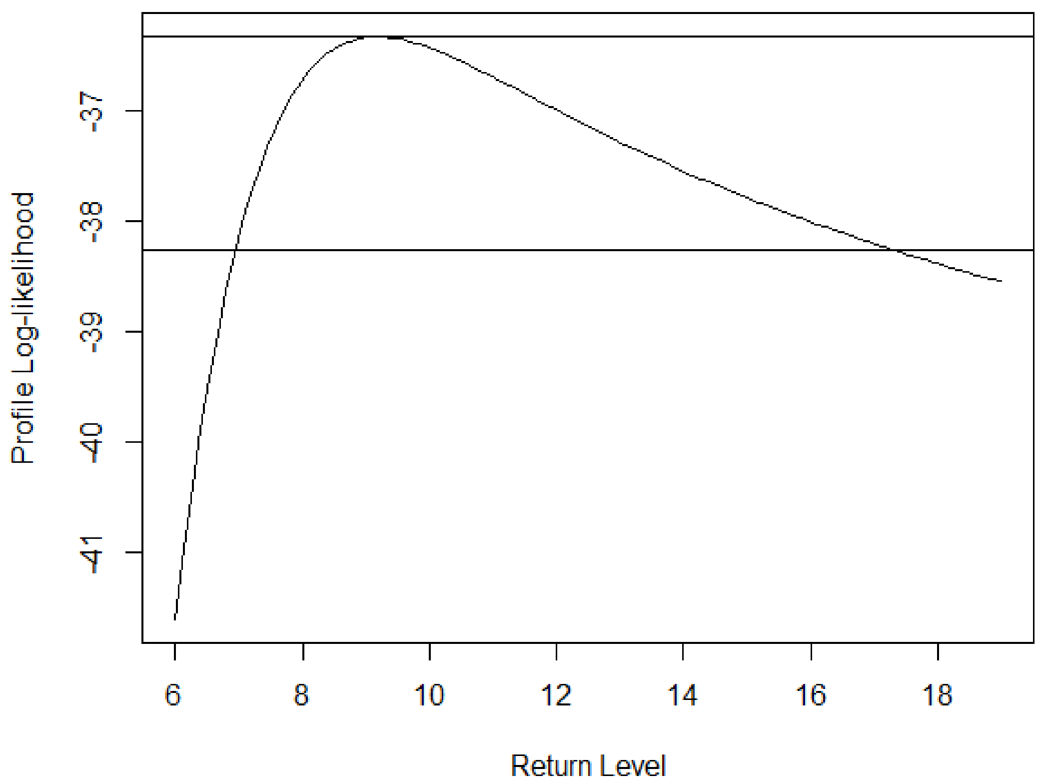

Fig 4.7:Profile likelihood of l0-year return level in threshold exceedance analysis of the total public debt log-monthly returns.

Figure 4.7 shows the profile log likelihood of total debt , with a 95% confidence interval. The return plot in figure 4.6 showed there is slight concern that the model appears to underestimate at the top end, so that the largest observed value is on the bound of the corresponding confidence interval. Where we can say, based on profiling the log likelihood of about [7,17.5] gives a better accuracy for the total debt return for 10 years.

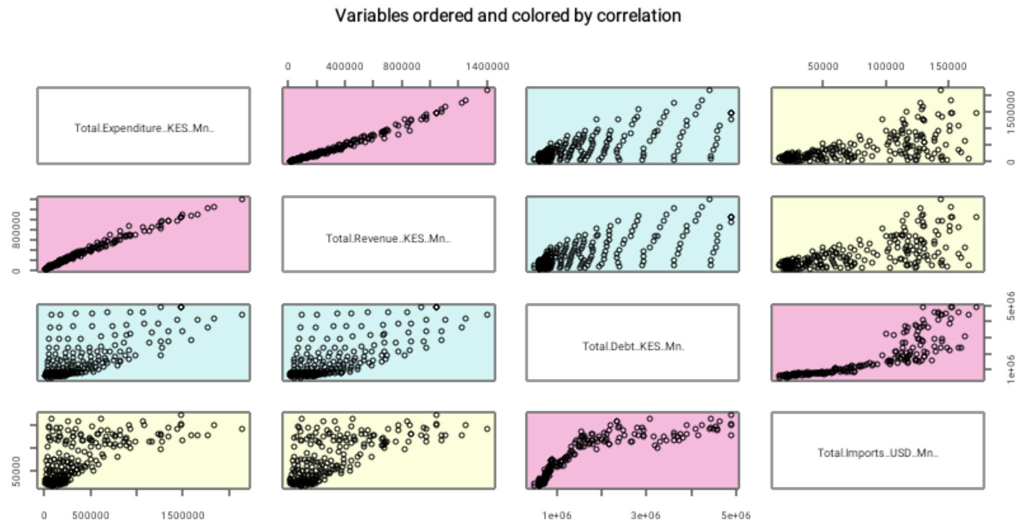

Fig:4.8 shows a scatter plot matrix of the variables and their correlations

variables	Correlation coefficients with respect to total debt
Total debt	1.0000
Total expenditure	0.7064469
Total imports	0.8522446
Total revenue	0.7158794

Table4.2:correlation coefficients of the different variables with respect to total debt

From the scatter plot matrix, fig 4.8, we see that the variables nearer to the diagonal spaces have a higher correlation than those far from it. There was a positive correlation of total debt with respect to total expenditure , total revenue and total imports. Which implies that an increase in any of the variables causes a corresponding increase in total debt, which we expected. Since the government tries to balance the books of revenue collected and the expenditure incurred, leading to borrowing if the money is not enough.

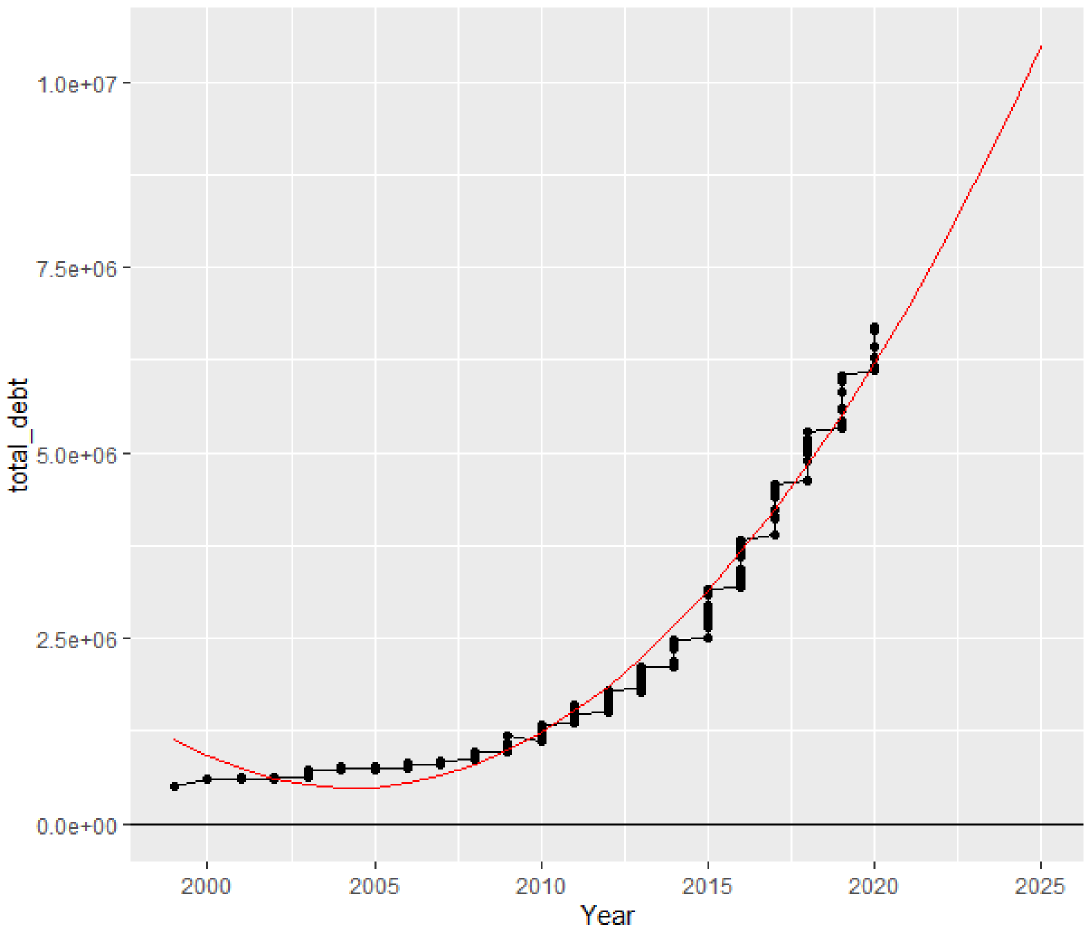

Fig4.9: shows the extrapolated total debt till 2025

Figure 4.9 shows a very alarming rate at which the government is borrowing money both internally and externally. If using the same fiscal policies then by 2025 Kenya would have a debt of about 10trillion Kenyan shillings. Which calls for new policies to be implemented to curb this trend. Since the effects of unsustainable debt level are slowly catching with us via inflation and an ever increasing unemployed youths. Moreover, debt should only be taken for development projects since these add value and provide ways to sustainably repay creditors.

Chapter 5:Conclusion and recommendations

5.1:Conclusion

We saw an aggressive borrowing trend in both domestic markets and foreign markets.Over the past 10 years we saw the introduction of a devolved government, which created more political positions which caused a great strain on the budget .This was echoed by the positive correlation between total debt and and total expenditure , where this total expenditure included wages and salaries of civil servants. To take care of these budget deficits , it resulted in increasing the sovereign debt through borrowing. We saw also at the same time increase in government projects that were mismanaged by corrupt deals.

As of May 2020 the debt levels were at 6 trillion Kenya shillings, and if this trend goes on by 2025 they will have hit heights of 10trillion Kenya shillings and that may not be sustainable given the current fiscal policies.Previously the debt ceiling has been pegged at 50 per cent of the GDP but the recently approved 9 trillion has already violated the PFM act by exceeding the current limit. This calls for a review of the current policy. A more robust fiscal policy was needed on the government spending levels , revenue collection and generation and how to efficiently use debt to act as an economic stimulus.

In view of the above we recommend that the government should show prudence when managing taxes collected from its citizens and debt finance from its creditors. This was to be implemented by having tough measures against public officers who misuse public funds.

The government should also heed to the international centre for policy and conflict which has urged the MPs to stop approval of the debt ceilings until forensic audit for Kenya public debt is done

Secondly, the government needed to cut on its budgets aggressively. This was to be implemented by having a reduction of salaries of over paid government officials and also reducing the numbers of politicians since we are already over represented people.

Thirdly, the government needed to do a background check on any project they embark on.Money borrowed should be used to finance projects that are identifiable or that can be shown to the public to see if it has a financial benefit to the economy. Since this projects financed by debt should sustainably be repaying the invested amount.

In conclusion, addressing sovereign debt crisis in Kenya should be a longstanding approach. Adherence to these policies will cause significant positive changes over the cause of their implementation. A government think tank should be put in place to forge a way forward, since the current fiscal policy has been failing since the 2008 financial crises it is time to have a change.

5.2 Recommendations

Insert here…..

References

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APPENDIX

The appendix contains the R-codes used to come up with the output in Chapter 4.

6.1: R-codes

```
#RStudio version 1.3.1073 was used for this codes,
library(ismev)
data<-read.csv("E:/Debtdata2.csv", header=TRUE,stringsAsFactors = FALSE)
domestic_debt=data $Domestic.Debt..KES..Mn.
external_debt=data$ External.Debt..KES..Mn.
total_debt=(data $Total.Debt..KES..Mn.)
total_debt
length(total_debt)
length(external_debt)
length(domestic_debt)

#Explolatory data analysis
#storing data in R as time series objects
require(graphics)
#total debt
total_ts<-ts(total_debt,start=c(2000,1),end=c(2020,6),frequency=12)

domestic_ts<-ts(domestic_debt,start=c(2000,1),end=c(2020,6),frequency=12)
external_ts<-ts(external_debt,start=c(2000,1),end=c(2020,6),frequency=12)
```

```
#plotting the time series data
#Total debt plot
ts.plot(total_ts,gpars=list(xlab="Year",ylab="Total Debt in KES"))

#domestic and external debt plot
ts.plot(domestic_ts,external_ts,gpars=list(xlab="year",ylab="Debt in KES",lty=c(1:2)))
#checking if the data is stationary
library(tseries)
adf.test(total_debt)#if p-value<0.05 indicates the time series data is stationary
#Transformation to log monthly returns to remove trend
Debt.data<-log(total_debt[2:248])-log(total_debt[1:247])
#plotting the monthly log returns
plot(Debt.data,type="l",xlab="Number of Months",ylab="log-monthly returns")

#Rescalling the data
Debt.data<-100*Debt.data
#mrl plot with 95% confidence interval
mrl.plot(Debt.data)
#at u=3.5,checking how many threshold exceedances this may have
length(Debt.data[Debt.data>3.5])
#Checking stability with respect to u of the mle for the reparameterized model
gpd.fitrange(Debt.data,-5,8,nint=100)
#fitting the modell at u=3.5
Debtdata.gpd<-gpd.fit(Debt.data,3.5)
 #Model adequacy
```

```
gpd.diag(Debtdata.gpd)


#profile likihood

#the 10 year return

gpd.prof(Debtdata.gpd,m=10,npy=12,6,19)


#scatter plot

library(gclus)

#picking the rows where the variables in the columns have values

dta<-data[c(1:223),c(6,8,14,15)]# get data

dta.r<-abs(cor(dta))#getting the correlations

dta.r

dta.col<-dmat.color(dta.r)#getting colors

#reordering the variables so that those with the highest correlation are clossest to the diagonal

dta.o<-order.single(dta.r)

cpairs(dta,dta.o,panel.colors=dta.col,gap=2,main="Variables ordered and colored by correlation ")

#extrapolation

#model developing

data$pred1<-predict(lm(total_debt~poly(Year,2),data=data))

##checking the data

p1<-ggplot(data,aes(x=Year,y=total_debt))+geom_line()+

  geom_point()+

  geom_hline(aes(yintercept=0))

print(p1)
```

```
##checking the model
p1+
  geom_line(aes(y=pred1),color="blue")
##extrapolating based on the model
pred<-data.frame(Year=1999:2025)
pred
pred$total_debt<-predict(lm(total_debt~poly(Year,2),data=data),newdata = pred)
p1+
  geom_line(color="red",data=pred)
```