Price and Income Elasticities of Oil Demand in Tanzania: An Autoregressive Approach
Benedict Baraka Stambuli

Abstract
Oil is playing a fundamental role in day-to-day economic activities in Tanzania. The demand for oil in the country has been increasing rapidly. Tanzania has been importing oil for almost all her oil needs. Over the years, this oil importation has been accompanied with imported inflation and persistent balance of trade deficit in the country. So, it is the purpose of this study to investigate on how oil demand in Tanzania responds to change in international oil prices and national income so as to control this oil importation without debilitating the appropriate functioning of the economy in the long run. Nerlove’s Partial Adjustment Model (PAM) was adopted to estimate price and income elasticities of oil demand in Tanzania with the use of annual time series data (1972-2010). Also, this paper employed Chow test to examined structural break in the oil demand function. The empirical findings insinuated no structural break in the estimated oil demand equation. Moreover, the paper found out that in the short-run the demand for oil was both price and income inelastic while in the long-run demand for oil was income elastic and price inelastic. This implied that oil demand in Tanzania was more sensitive to income changes relative to oil price changes. There is a need for Tanzania to opt for bio-fuels and speed up the exploration and later extraction of the discovered oil and gas fields. This will enable the country to save more foreign currencies which are spent on oil importation.

Key words: Oil Demand, Demand Elasticity, Autoregressive, Import, Tanzania.

JEL Classification Codes: C13, O13, Q31, Q32.

INTRODUCTION
Every country in this world depends on the use of oil to perform day to day economic activities. Oil plays a significant role in economic development of less developed and developed countries (Xiong and Wu, 2009). It has been the prerequisite for economic development and consequently, the demand for oil has rapidly increased over time.

According to the International Energy Agency (IEA, 2010), the rapid increase in the oil demands has been the global challenge over the past three decades. This is due to the fact that income and population have increased in the world. Rapid urbanization and improved living standard in developing economies have made oil to be essential in supporting day-to-day activities, and so, it is consumed at a high rate. Vehicles have also influenced much in the increase of demand for oil.

It was estimated that global oil consumption grew by 2.7 million barrels per day (b/d) or 3.2% from 84.7 million barrels per day to 87.4 million barrels per day in the year 2009 and 2010 respectively (BP, 2011). In 2010, global oil production increased by 1.8 million barrels per day or 2.2% but it did not match the level of rapid increase in global oil demand of 2.7 million barrels per day or 3.2%. Currently, China and USA form the world’s largest oil consumers.

Tanzania is among the developing countries which have been endowed with mineral and energy resources nevertheless some of them are inefficiently utilized. So, far the country has discovered some on-shore and off-shore oil fields. The initial results of petroleum exploration are promising though the actual extraction has not yet been initiated. The country used to import crude oil and refine it within the country. However, currently the country imports refined oil. So, the country is still depending heavily on the imported oil and it imports oil for almost all of its oil fuel needs.

The Bank of Tanzania (BOT) reported that oil imports in January to March 2011 were USD 1,928.4 million, which is a 24% increase compared to the year 2009. The imported oil fuel is consumed mainly in the transport sector followed by other sectors like industry, household, agriculture and commercial activities. The Ministry of Energy and Minerals also reported that the system of bulk oil procurement took effect since January 2012. For the period of January to June, 2012, imported oil was 1,808, 958 tonnes out of

1 Dar Es Salaam, Tanzania
Email: bennystam@yahoo.com

©Society for Business and Management Dynamics
which 1,191,780 tonnes were for the local market while 617,178 tonnes were for the neighboring countries (MEM, 2012).

The demand for oil is highly affected by the volatility of oil prices in the world market. The adverse consequences are highly borne by the import-dependent countries like Tanzania. The world market price for the crude oil was increased by 43% from USD 60 per barrel in year 2009 to USD 86 per barrel in year 2010 (URT, 2011). This increase in oil prices tends to increase the running costs in various sectors of the economy. This increased cost of production is then passed into higher commodity prices which in turn raises the cost of living to the final consumers. So, the imported oil in Tanzania has been linked with imported inflation, currency depreciation, and persistent deficits in the balance of trade (URT, 2011). Thus, this great challenge has been the rationale of pursuing this study.

Through the Energy and Water Utilities Regulatory Authority (EWURA), the government has introduced the system of the bulk oil procurement so as to tame fluctuations in oil prices which have been associated with increased inflation in the country. The government also expects that this system will stabilize the local currency by lessening the demand for foreign currencies by the oil importers.

The main objective of this paper is to ascertain price and income elasticities of oil demand in Tanzania by using annual time series data for 1972-2010. This will help the researcher and energy policy makers to understand how does oil demand in Tanzania responds to change in oil prices and income so as to control excessive oil importation without hampering the proper functioning of the economy in the long run.

For simplicity, this paper used the words oil demand and oil consumption interchangeably. The remaining part of this paper has been systematized as follows: section two provides the literature review, section three presents the methodology, section four provides data analysis and the discussion of empirical results while section five finalized the paper with conclusion and policy recommendations.

**LITERATURE REVIEW**

This section presents the critical revision of the relevant empirical literatures and identified the research gap. There are few studies that have been conducted basically on demand for oil. Most of the studies examined the relationship between total energy consumption and economic growth. However, every kind of energy has its own impact in the economy. So, this paper focuses on the relationship between economic growth, oil demand and oil prices.

Cooper (2003) used Nerlove's Partial Adjustment Model to estimate short run and long run price elasticities for 23 countries for the period 1979-2000. Oil demand was used as the dependent variable while income, oil prices and the lag of oil consumption were the explanatory variables. He found that demand for oil was price inelastic for both short run and long run.

Narayan and Smyth (2007) used panel data for the Middle East for the period 1971-2002, and estimated the panel cointegration. They found that demand for oil in the Middle East is price inelastic and income elastic.

Ghosh (2007) found inelastic price demand in the long run. He employed Autoregressive Distributed Lag (ARDL) bound testing approach of cointegration for the annual time series data of India covering the period 1970-1971 and 2005-2006. The results suggested that the demand for oil is income elastic in the long run.

Ziramba (2010) used time series data for South Africa covering the period 1980-2006. He employed a multivariate approach in estimating the long run relationship between the variables. He found that demand for oil was price inelastic in the long run and also demand for oil was income inelastic in the long run.

Gately and Huntington (2001) assessed the factors influencing demand for oil in Organization for Economic Co-operation and Development (OECD) and non-OECD countries. They found that for both OECD and non-OECD countries, demand for oil is both income and price inelastic.

Krichene (2002) found that the world demand for crude oil was price inelastic in the short run. He used error correction model and found that the long run price elasticity was low and inelastic.
Altinay (2007) used time series data (1980-2005) for Turkey and used ARDL bound testing approach of cointegration to estimate for the long run relationship. He found significant long run and short run price elasticities. Demand for oil is income inelastic.

Xiong and Wu (2009) analyzed the demand for crude oil in China for the period 1979-2004. They employed Johansen cointegration test and error correction model and found out that the demand for oil was both income and price inelastic.

Dees et al (2007) examined the risks and development of oil market. They applied the error correction model to estimate the short run dynamics. They found that both long run and short run income elasticities were less than unity. The short run price elasticity was very low.

Ghouri (2001) used oil demand data for USA, Mexico and Canada for the period 1980-1999. He found that in the long run demand for oil is price inelastic. Tsirimokos (2011) examined the short run and long run price and income elasticities of crude oil demand in ten IEA countries. The study expressed crude oil consumption as a function of real oil prices, per capita real GDP, one year lagged value of oil consumption and a time trend. So, the study adopted Nerlove’s partial adjustment model and obtained that both price and income are more inelastic in the short run. In the long run, the study found that price was inelastic while income was elastic.

Semboja (1994) applied static computable general equilibrium model to examine the impact of oil prices in Kenya. The results indicated that the deterioration of terms of trade and decreased output has been caused by an increase in oil prices.

In the literature of energy economics, most of previous studies have examined the relationship between economic growth and energy consumption under a bivariate framework and ignored some important variables in the framework. In addition, the relationship between oil demand and economic growth has received less attention to many researchers in the country. To the best of author’s knowledge, there is no past study that has been conducted in Tanzania to analyze oil demand elasticities. Thus, this study will tend to fill that gap in the literature of energy economics in Tanzania by incorporating oil demand, economic growth and oil prices under the same framework.

METHODOLOGY
This section presents the methodology which has been employed in this paper. The section provides a brief description of an econometric model and defines the data and variables used with their sources.

Data Description and Sources
This paper considered the oil sector in Tanzania. For the purpose of estimating price and income elasticities of oil demand in Tanzania, this paper employed annual time series data covering the period 1972-2010. The variables used were the per capita oil consumption (in metric tonnes), international oil prices (in U.S dollars) and per capita real GDP (in Tanzania Shillings). The sources for these data were the Bank of Tanzania (BOT), Ministry of Energy and Minerals and British Petroleum (BP). Oil prices were based on Arabian light in the period 1980-1983. However, from 1984 until today oil prices are based on Brent oil (BP, 2010).

Econometric Model
This paper employed a multiple log-linear regression model to determine the relationship between oil consumption, oil prices and economic growth. The Nerlove’s Partial Adjustment model (PAM), named after Marc Leon Nerlove (1956) was adopted, so as to capture the short-run and long-run price and income elasticities of demand for oil in Tanzania.

Consider a hypothetical assumption that Tanzania needs to reduce consumption of oil to a certain unobservable equilibrium level given the level of per capita income and oil prices. Since Tanzania is still developing then the process of cutting down its oil consumption cannot succeed instantaneously but only partial adjustment can be made in each period due to technical rigidities. So, the adoption of Nerlove’s Partial Adjustment Model will facilitate to capture the situation. The model included the lagged value of oil consumption so as to capture the short-run mechanism (Gujarati, 2009).

The dependent variable for our model was oil (Petrol) consumption and the explanatory variables were economic growth (Per Capita real GDP) and international oil prices. The model to illuminate oil-growth nexus has been extended to incorporate oil prices as per Cooper (2003).

Consider the Partial Adjustment Model (PAM) below:
\[ \text{LnOIL}_t = \lambda_0 + \lambda_1 \text{LnP}_t + \lambda_2 \text{LnY}_{t} + (1 - \theta) \text{LnOIL}_{t-1} + \xi_t \] ………………. (1)

In this case, \( \theta \) represents a coefficient (speed) of adjustment i.e. \( 0 < \theta < 1 \). This means that oil consumption adjusts only partially toward the desired level. In addition, \( \lambda_1 \) denotes the short run price elasticity of oil demand and \( \lambda_2 \) denotes the short run income elasticity of oil demand. The long run price elasticity and income elasticity of oil demand will be given by \( \beta_1 = \frac{\lambda_1}{[1-(1-\theta)]} = \frac{\lambda_1}{\theta} \) and \( \beta_2 = \frac{\lambda_2}{[1-(1-\theta)]} = \frac{\lambda_2}{\theta} \) respectively.

The regression model (1) is Autoregressive in nature and it has been adopted because its error term (\( \xi_t \)) is not correlated with the \( \text{OIL}_{t-1} \). The Ordinary Least Square (OLS) estimates of the Partial Adjustment Model are consistent although they tend to be biased in small samples (Gujarati, 2009). Thus, the nature of our research problem to be addressed in this study motivated the researcher to adopt Nerlove’s Partial Adjustment Regression Model. The model was estimated in logarithmic form in the sense that the coefficients will be directly interpreted as elasticities. Log-linear functional form tends to produce more efficient results than a simple linear functional form. The theoretical bedrock of the Partial Adjustment Model that has been adopted in this paper can be referred to (Gujarati, 2009).

This paper anticipated that the higher levels of output will increase demand for oil. Also high levels of oil prices are expected to reduce oil consumption. So, the expected signs from the model are \( \lambda_1 < 0, \lambda_2 > 0 \).

**EMPIRICAL FINDINGS AND DISCUSSION**

This section provides the estimated results corresponding with their interpretation based on the OLS estimates of the Nerlove’s Partial Adjustment Regression Model in equation 1. Since we are dealing with the time series data, more attention has been paid on the serial correlation problem and spurious regression problem that might occur during estimation. This paper has also tested for the existence of serial correlation, spurious regression, multicollinearity and heteroscedasticity problem. The results were promising. The more details regarding OLS regression results and the corresponding diagnostic tests can be referred from the Appendix of this paper. The econometric packages, EVIEWS 6.0 and STATA 12.0 have supported data analysis in this paper.

Consider the estimated short-run oil demand equation below:

\[ \text{LnOIL}_t = -5.827717 - 0.005132 \text{LnP}_t + 0.747229 \text{LnY}_{t} + 0.573175 \text{LnOIL}_{t-1} \] ……… (2)

<table>
<thead>
<tr>
<th>P-values</th>
<th>Adjusted-R²</th>
<th>D-Watson</th>
<th>F-Statistic</th>
<th>Prob (F-Statistic)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0436</td>
<td>0.9138</td>
<td>0.0096</td>
<td>19.99947</td>
<td>0.0034</td>
</tr>
</tbody>
</table>

From our estimated model, the adjusted-\( R^2 \) indicates the goodness of fit of the model. It shows that about 61 percent of the total variation in oil demand has been explained by the oil prices, per capita real GDP and the lagged value of per capita oil consumption. So, our model fits the data well.

Since the adjusted-\( R^2 \) is less than Durbin-Watson statistic, then our regression model is not spurious. The Durbin-Watson statistic i.e. 1.64 which is closer to 2.0 (perfect absence of serial correlation) indicates no serial correlation. However, this will be confirmed by the Breusch-Godfrey Lagrange Multiplier (LM) test of serial correlation as it has been shown in the Appendix. Also, the F-statistic indicates the joint significance of all independent variables in the model. It shows that at least one independent variable was not zero in explaining the dependent variable. The model in general seems to be statistically significant.

Furthermore, the estimated demand equation indicated that all variables have the correct sign as anticipated by the demand theory. In the short-run, the results indicated that the demand for oil is price inelastic. However, oil prices do not have a significant impact on oil consumption as it has been shown by the regression results. On the other hand, demand for oil seems to be income inelastic in the short-run.

Per capita income significantly has a positive impact on oil consumption since a percent increase in per capita real GDP leads to 0.75 percent increase in per capita oil consumption.

The speed of adjustment of per capita oil consumption towards its desired level in the long run is given by \( \theta = 1 - 0.573 = 0.427 \). The results indicated that actual per capita oil consumption seems to adjust
towards its long run desired level by 42.7% in each year. This coefficient of adjustment can also help us to determine the long-run elasticities from the short-run elasticities.

$$\beta_1 = \frac{\lambda_1}{1 - (1 - \theta)}$$ and $$\beta_2 = \frac{\lambda_2}{1 - (1 - \theta)}$$ represent the long-run price and income elasticities respectively, therefore, the long-run price elasticity is -0.012 while the long-run income elasticity is 1.750. A percent increase in income will increase per capita oil consumption by 1.750%.

From the analysis, it seems that short-run income elasticity is lower than the long-run income elasticity as it was expected. Also, short-run price elasticity (in absolute term) is lower than the long-run price elasticity (in absolute term). This indicates that a country is more sensitive in the long run than in the short run. Thus, the results show that, in the long run, demand is income elastic and price inelastic. Since the results indicated a higher level of price inelasticity, then the country will find it difficult to adjust to alternative energy sources. This makes the country to be more susceptible to oil price shocks.

Some of the past studies whose results are quite similar to the results of this study include Altinay (2007), Ghouri (2001) and Cooper (2003). Ghouri (2001) examined the price and income elasticities for USA and found that the long income elasticity is 0.98 while the short run and long run price elasticities were -0.029 and -0.045 respectively. Altinay (2007) also did the same study for Turkey and found that the short run and long run income elasticities were 0.64 and 0.61 respectively. On the other hand, the short run and long run price elasticities found to be -0.10 and -0.18 respectively. Cooper (2003) used the same Partial adjustment Model with annual time series data for 1971-2000. He examined the short run and long run price elasticities for Sweden and Denmark. For the case of Sweden results showed that the short run and long run price elasticities were -0.043 and -0.289 respectively. For the case of Denmark the results indicated that the short run and long run price elasticities were -0.026 and -0.191. All these results from the past studies seem to be nearly consistent with the results of this study.

On the other hand, the estimated demand equation was also tested for structural break by using Chow test and parameter stability by using Cumulative Sum (CUSUM) test. The Chow test aims to investigate whether our estimated oil demand function was the same before and after the second oil shock in Tanzania that occurred in year 1979. It tests whether there is a structural change in all of the equation parameters. All explanatory variables and the intercept were taken into account. The null hypothesis for this test is no structural change in the demand function before and after the oil shock. It can be seen from table VII in the Appendix that there is no a structural change in our demand function and parameters before and after 1979 since all test statistic are not significant at all levels of significance. So, our estimated relation was stable.

Moreover, the CUSUM test is based on the cumulative sum of recursive residuals which are plotted with 5% critical lines (Brown et al., 1975). Whenever the cumulative sum goes outside the region between two critical lines then the test indicates parameter instability. So, the null hypothesis for this test is parameter constancy. Figure I in the Appendix has indicated parameter stability in our estimated demand equation during the sample period since the cumulative sum lies within the region between the two 5% critical lines.

CONCLUSION AND POLICY RECOMMENDATION

The demand for oil in Tanzania has been increasing swiftly over time. The country has been experiencing bulky oil importation so as to cater for the expanding day-to-day economic activities. This circumstance has raised the need to quest for the relationship between oil demand and economic growth in Tanzania. For the purpose of capturing this relationship, this paper has adopted Nerlove’s Partial Adjustment Model to estimate price and income elasticities of oil demand in Tanzania. Since Tanzania depends much in importation of petroleum products so as to support her domestic, transport, industrial and commercial activities, the empirical findings from this study will have significant policy implications for the energy policy makers. This is due to the fact that this oil importation has contributed much in bringing in imported inflation and persistent deficits in balance of trade. Imported inflation has been associated with increased cost of living and the cost of producing domestic goods.
From the empirical findings, it has been signposted that in the short run, oil demand is both price and income inelastic. However, in the long run, demand for oil is price inelastic and income elastic. The country will be more vulnerable to oil price shocks since the results indicated higher levels of price inelasticity both in the short run and long run.

The oil prices have a negative impact on oil consumption despite that this impact is not significant in the short run. Per capita income has a significant positive impact on oil demand in both short run and long run. So, the estimated demand function indicated that in Tanzania oil is not only a necessity but also a normal good. Since the short run income elasticity is lower than the long run income elasticity, the response seems to be high in the long run than in the short run. Thus, in the long run, it is at least possible for Tanzania to adjust her demand for oil. The results of this study are comparable to those of Cooper (2003), Altinay (2007) and Ghouri (2001). The Chow test for structural break was also performed and the results indicated that oil demand function was stable before and after the oil shock in year 1979.

Based on the above empirical findings, this paper insinuates that it is very essential for Tanzania to start adjusting her energy policy and begin utilizing her oil fields. Despite that some of the efforts have been undertaken to explore and extract oil within the country; these efforts do not keep pace with increasing oil demand in the economy. The increase in importation of oil and continuous rise in oil prices are heavy burden for the country. However, Tanzania has a potential of replacing a large percentage of this imported fuels with bio-fuels i.e. ethanol and biodiesel that could be produced within the country and this can be possible if the government will adopt the right energy policy, regulations and incentives. There is also a need for Tanzania Petroleum Development Corporation (TPDC) to accelerate the process of oil exploration and then extraction so that the country can adjust her oil importation as soon as possible. Since the initial oil exploration results are promising, there is a need for the government to devote more financial resources to support the research and development on the oil sector.

On the other hand, the use of natural gas which has been found recently in Mnazi Bay in Mtwara region, Songo Songo in Lindi region and Mkuranga gas fields can be used to supplement oil consumption in Tanzania for power generation in the industries and for domestic purposes. This will reduce heavy dependence of oil in power generation and save the resources that could be invested elsewhere within the economy. Also, the development of this sector requires substantial financial support from the government and other development partners.

REFERENCES


### APPENDIX

#### Table I: Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>OIL</th>
<th>LnOIL</th>
<th>P</th>
<th>LnP</th>
<th>Y</th>
<th>LnY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>3813.19</td>
<td>8.22</td>
<td>28.66</td>
<td>3.11</td>
<td>280797.10</td>
<td>12.54</td>
</tr>
<tr>
<td>Median</td>
<td>3524.80</td>
<td>8.17</td>
<td>20.67</td>
<td>3.03</td>
<td>264911.10</td>
<td>12.49</td>
</tr>
<tr>
<td>Maximum</td>
<td>8914.70</td>
<td>9.10</td>
<td>97.26</td>
<td>4.58</td>
<td>401636.30</td>
<td>12.90</td>
</tr>
<tr>
<td>Minimum</td>
<td>2753.71</td>
<td>7.92</td>
<td>2.48</td>
<td>0.91</td>
<td>241985.10</td>
<td>12.40</td>
</tr>
<tr>
<td>Std. Dev.</td>
<td>1074.28</td>
<td>0.22</td>
<td>21.10</td>
<td>0.74</td>
<td>41163.4</td>
<td>1.48</td>
</tr>
<tr>
<td>Skewness</td>
<td>3.21</td>
<td>2.14</td>
<td>1.61</td>
<td>-0.60</td>
<td>1.66</td>
<td>1.48</td>
</tr>
<tr>
<td>Kurtosis</td>
<td>14.83</td>
<td>8.88</td>
<td>5.10</td>
<td>4.56</td>
<td>4.66</td>
<td>4.10</td>
</tr>
</tbody>
</table>

Jarque-Bera 294.62 85.9 23.91 6.32 22.31 16.15

<table>
<thead>
<tr>
<th></th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>39</td>
</tr>
</tbody>
</table>

#### Table II: Regression Analysis Results

Dependent Variable: LnOIL_t
Method: Ordinary Least Squares
Sample (adjusted): 1973-2010
Included observations: 38 after adjustments

<table>
<thead>
<tr>
<th></th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnP</td>
<td>-0.005132</td>
<td>0.047042</td>
<td>-0.109094</td>
<td>0.9138</td>
</tr>
<tr>
<td>LnY</td>
<td>0.747229</td>
<td>0.272244</td>
<td>2.74702</td>
<td>0.0096</td>
</tr>
<tr>
<td>LnOIL_{t-1}</td>
<td>0.573175</td>
<td>0.181759</td>
<td>3.153481</td>
<td>0.0034</td>
</tr>
<tr>
<td>C</td>
<td>-5.827717</td>
<td>2.780087</td>
<td>-2.096235</td>
<td>0.0436</td>
</tr>
</tbody>
</table>

R-squared 0.638292  Mean dependent var 8.221740
Adjusted R-squared 0.606376  S.D. dependent var 0.218832
S.E. of regression 0.137294  Akaike info criterion -1.034084
Sum squared resid 0.640888  Schwarz criterion -0.861706
Log likelihood 23.6476   Hannan-Quinn criter. -0.972753
F-statistic 19.99947 Durbin-Watson stat 1.635501
Table III: Normality Test of Regression Residuals

<table>
<thead>
<tr>
<th>Variable</th>
<th>Obs</th>
<th>Pr(Skewness)</th>
<th>Pr(Kurtosis)</th>
<th>adj chi2(2)</th>
<th>Prob&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>ehat</td>
<td>38</td>
<td>0.7820</td>
<td>0.3188</td>
<td>1.13</td>
<td>0.5688</td>
</tr>
</tbody>
</table>

Table IV: Multicollinearity Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>LnY</td>
<td>2.64</td>
<td>0.378272</td>
</tr>
<tr>
<td>LnP</td>
<td>1.85</td>
<td>0.540664</td>
</tr>
<tr>
<td>lagLnOil</td>
<td>1.74</td>
<td>0.574917</td>
</tr>
<tr>
<td>Mean VIF</td>
<td>2.08</td>
<td></td>
</tr>
</tbody>
</table>

Table V: White's Heteroskedasticity Test Results

<table>
<thead>
<tr>
<th>Test Statistic</th>
<th>Value</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>1.357275</td>
<td>0.2538</td>
</tr>
<tr>
<td>Obs*R-squared</td>
<td>11.54252</td>
<td>0.2403</td>
</tr>
<tr>
<td>Scaled explained SS</td>
<td>11.10778</td>
<td>0.2684</td>
</tr>
</tbody>
</table>

Table VI: Serial Correlation LM Test Results

<table>
<thead>
<tr>
<th>lags (p)</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2.305</td>
<td>1</td>
<td>0.1290</td>
</tr>
<tr>
<td>2</td>
<td>2.482</td>
<td>2</td>
<td>0.2892</td>
</tr>
<tr>
<td>3</td>
<td>2.495</td>
<td>3</td>
<td>0.4762</td>
</tr>
</tbody>
</table>

H0: no serial correlation
Table VII: Chow Breakpoint Test Results

Chow Breakpoint Test: 1980
Null Hypothesis: No breaks at specified breakpoints
Varying Regressors: All equation variables
Equation Sample: 1973-2010

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Value</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>F-statistic</td>
<td>0.707604</td>
<td>Prob. F(4,30) 0.5931</td>
</tr>
<tr>
<td>Log likelihood ratio</td>
<td>3.426006</td>
<td>Prob. Chi-Square(4) 0.4892</td>
</tr>
<tr>
<td>Wald Statistic</td>
<td>2.830417</td>
<td>Prob. Chi-Square(4) 0.5866</td>
</tr>
</tbody>
</table>

Figure I: CUSUM Test