MACROECONOMIC UNCERTAINTY AND GROWTH: EMPIRICAL EVIDENCE FROM SUDAN ECONOMY

(1956 –2006)

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Abstract

The objective of this paper is to assess the role of macroeconomic uncertainty on growth via estimating volatility as a system composed of six macroeconomic variables i.e. real GDP per capita, money supply growth rate, government aggregate expenditure ratio to GDP, real exchange rate, and terms of trade. Estimated volatility by multivariate GARCH is used as proxy for uncertainty. Results indicate that uncertainty has been caused by volatility of macroeconomic variables, distortionary economic policies, government failures, and weak social institutions.

Key Words: macroeconomic variables, institutions, policies, uncertainty, MGARCH,

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1. Introduction

The relation between uncertainty and recession as driving force to business cycle has been empirically investigated by many scholars (Bachmann and Moscarini 2012; Bloom etal 2013; Henzel and Rengel 2013; Leduc and Liu 2012; and Bachmann, Elstner and Sims 2011). Uncertainty results from all macroeconomic fluctuation in addition to discretionary macroeconomic policies, social conflicts, and financial development. Uncertainty has an adverse effect on output through investment and effectiveness of economic policy (Darin etal 2002; Alberto & Gradstein 2006, and Sengupta 2011, Aastveit 2013). Estimated volatility can be taken as a proxy for Uncertainty.

Sudan has been facing high macroeconomic uncertainty since its independence in 1956. It witnessed frequent recession and booms during the independence period verified by Baxter-King filter (Figure 1); an apparent business cycle whereas GDP growth averaged 3.6 oscillating between -7.7 percent and 14 percent; high inflation averaged 26.4 percent; and a negative relationship between unemployment and GDP i.e. Okun's law.

Motivation for the study is that no one to my knowledge has empirically studied macroeconomic volatility via MGARCH for Sudan economy. Since many macroeconomic variables fluctuate together, of course by different amounts this paper will estimate volatility (uncertainty) as a system of GARCH.

The structure paper as follows: Section 2 reviews empirical literature on the impact of macroeconomic variables volatility on growth; Sections 3 reviews theoretical background on effects of volatility of macroeconomic variables on economic growth; Section 4 is devoted to methodology and data, Section 5 reveals empirical results and discusses their implication; Section 6 conclusion and recommendations.

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2. Literature Review

The nexus between volatility and economic growth have been empirically studied on different economies. Rabah and Markus (2010) and Alessandra & Fabrizio (2013) studied the process of foreign assets accumulation. They showed the association between macroeconomic volatility and accumulation of net foreign assets in a panel 145 countries during the period 1970-2007 and OECD respectively. Windfalls from international commodity price booms lead to a significant increase in net foreign assets, but only in countries that are homogeneous. In polarized countries, net foreign assets significantly decreased due large increased government spending, political corruption, and the risk of expropriation, with no overall effect on GDP per capita growth. Samimi, Somaye, and Soraya(2011) indicated that economic growth depends positively on the current level of the terms of trade, while volatility in the terms of trade has a negative impact on growth for oil exporting countries.

Tafirenyika (2013) established   relationship between financial development and economic growth in Namibia, and found a unidirectional relationship between them. Bianchi etal (2013) verified that an increase in uncertainty about financial conditions leads firms to substitute away from debt to reduce shareholder payout in times when risk perimia are high.

Rexford (2012) asserted the role of internal macroeconomic volatility parameters on performance indicators in the sub-region than external macroeconomic. Sebastian Edwards (1986) investigated the potential role of monetary and real factors in explaining real exchange rate variability in developing countries. He found that more unstable nominal exchange rate policies were reflected in higher real exchange rate instability in the short-run; more unstable domestic credit policies resulted in higher short-term real exchange rate variability; and more unstable external terms of trade also affected positively the degree of real exchange

rate instability. Ogunmuyiwa and Ekone (2010) investigated the impact of money supply on economic growth in Nigeria between 1980 and 2006 revealing that although money supply was positively related to growth. Meng and cheng (2003) and Asmat etal (2013) verified the impact of fluctuation in money supply, budget deficit, and domestic capital formation and inflation on economic growth as measured by the mean of real GDP in Malaysia and in Pakistan respectively.

Daron etal (2002) stated countries that have pursued distortionary macroeconomic policies, including high inflation, large budget deficits and misaligned exchange rates, appear to have suffered more macroeconomic volatility and also grown more slowly during the postwar period. Countries pursuing poor macroeconomic policies also have weak "institutions," including political institutions that do not constrain politicians and political elites, ineffective enforcement of property rights for investors, widespread corruption, and a high degree of political instability. Acemoglu, Johnson and Robinson (2001) and Acemoglu etal (2002) documented a strong and robust relationship between the historically-determined component of postwar institutions and volatility as well as severity of economic crises and economic growth. Distortionary macroeconomic policies reflect institutional problems i.e. lack of law enforcement; transfer of resource from agriculture to urban interests through overvalued exchange rate; influence interest groups on political decisions in institutionally weak society; and corruption. Dani (1998) empirically verified that social conflicts diminish the productivity with which society resources are utilized in number of ways: by delaying needed adjustments in fiscal and key relative prices (such as real exchange rate and real wages) and diverting activities from productive and entrepreneurial spheres to political sphere. Economic performance of countries with internal social conflicts, such as in Latin America, has suffered much more from the turbulence than countries with a stronger social structure, such as in East Asia. Jonardan, Akshay and Avinash

(2012) reveal that most of the economic indicators have played a significant role for the reduction of death rate (Social Development Indicator) in the various states in India in 16 for the period spanning 1981 to 2009.

Alberto & Gradstein (2006) empirically supported that policy volatility has an adverse effect on firms' entry into productive industries, thereby affecting economic growth. Additional evidence is provided on the channels through which volatility affects firm growth, showing that institutional obstacles magnify the effect. Fatas & Mihov (2006) presented evidence that policy volatility exerts a strong and direct negative impact on growth using data for 93 countries.

The cited papers has focused almost on the nexus between variability and economic growth utilizing cross section data, measuring volatility by simple standard deviation or rolling variance of output. This paper differs from the cited papers in size and number of variables included and the way of measuring volatility i.e. MGARCH.

3. Theoretical Background

According to Keynes the chronically unstable economy that subject to fluctuations delivers equilibrium less than full employment due to inadequate investment over saving both rooted in psychology of uncertainty (Daniel and Stanislaw 1998). The stoppage of the normal functioning of economy of circular flow of income by recession should be resumed either by increasing money supply or government spending - buying things itself to reestablish circular flow of money - as proposed by the Keynesian theory. Loss of consumer confidence is triggered by visible events as stock market crash; and natural disaster may lead to hoarding. Quantity of money is one of the major determinants of aggregate demand which pushes back economy to its full employment if it is enhanced. Monetarists view that changes in the money supply are primary determinants of changes in total spending and

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should be major emphasis in economic stabilization (Leonal and Keith (1970)). Monetarists advocate good policy is to control money supply, and disagree with Keynes on the usefulness of fiscal policy and on the stability of the economy – vertical against flat aggregate supply curve – and the stability of velocity of circulation. They agree on the influence of money supply variation on output. With fully anticipated increase in money supply in the short-run, aggregate demand increases and output increases with labor supply unchanged. The price level increases cause labor demand curve to shift upward. If labor supply curve is unchanged then level of employment rises. Since expected price is unrelated to current policy variables in the Keynesian and monetarist framework, therefore the positions of labor supply and aggregate supply remains unchanged.

Financial stability entails efficient allocation of resources, assessment and management of financial risks, maintaining employment levels close to the economy's natural rate, and eliminating relative price movements of real and financial assets. Stable financial systems absorb shocks and a necessity to economic growth as medium for most real transactions. Stability is measured by z-score and distance to default i.e. probability of observing one default among a number of institutions; contribution to systemic risk by individual institution; distribution of systematic loss.

Real Exchange Rate: The RER between two countries is defined as the relative cost of a common basket of goods measured in terms of a common numeraire. The Law of One Price implies that the same basket of goods in two different countries must have the same price. Overvaluation or appreciation the episodes of PPP are the departure in the short or medium run. Overvalued RER generates unsustainable current account deficits through the loss of competitiveness. The latter also leads to possible recession and losses of reserves (Goldfajn and Vald6s 1996). Positive and permanent shock of Terms of trade TOT increases the demand for nontradable

raises their relative price, at temporary shocks the demand will not increase provided the constancy of supply of nontradable and the cost of transfer of resources from tradable to nontradable, and decrease in the supple of tradable otherwise they affect real exchange in the medium and the long-run through supply. An expansion in government spending will appreciate the RER if it increases the overall demand for nontradables if the government propensity to consume is larger than the private sector's (Philip etal 2004).

Prebish-Singer hypothesis state that primary product specializing country's terms of trade will weaken over time compare to the countries that produce manufactured goods. An increase in terms of trade induces a nation to divert resources from inefficient sector to efficient sector, which result in an increase in world output that could be shared by trading nations. Because of the volatility of primary product prices, exporters of these products experience greater instability of export revenue (Samimi, Somaye, and Soraya 2011).

Inflation Variability: higher inflation rate leads to higher volatility in inflation which causes greater uncertainty in production and investment decisions. The most influential economist of the twenties century Milton Friedman hypothesized that an increase in inflation may induce an erratic policy response by monetary authority leading to more uncertainty about the future of inflation rate; the increasing uncertainty distorts the effectiveness of price mechanism in allocation resources (Friedman 1977). Arabi (2010) research presented supportive evidence for the positive and significant relationship between the level and variability of inflation in the Sudan, using annual data for the period 1960 – 2005. The estimated the conditional variance of inflation with possibility of a simultaneous feedback relationship between inflation and uncertainty

Social Conflicts: Institutionally weak societies inherited from the colonial period lack the power to constrain interest groups from exploiting their position

employing various instruments to pass (distortionary) economic policies that prevent the government from achieving the general interest. These societies are incapable of dealing with global crises. They are characterized by wide spread of corruption, ineffective enforcement of property rights for investors, state failures i.e. inability to manage conflicts – civil war, revolutions, and severe fighting. Thus the interactive term of volatility and institutional quality have an effect on growth (Rodrik 1999, Goudzwaard 2007, Antonio Fatás 2008).

4. Methodology

Secondary data consists of six macroeconomic variables were selected according to theoretical and empirical evidence c covering the independence period up to the signing of Comprehensive Peace Accord to end the war between North and South Sudan i.e. 1957 -2006.

Variable	Symbol	Source
Real Per Capita Income	Q	Central Bureau of Statistic
Inflation Rate	INF	Central Bureau of Statistic
Money Supply Growth Rate	MSDOT	Central Bank of Sudan
Real Exchange Rate	RER	Computed Variable
Government Expenditure ratio to GDP	GX/GDP	Central Bureau of Statistic
Terms of Trade	TERMS	Central Bureau of Statistic

The VEC-GARCH model of Bollerslev, Engle, and Wooldridge (1988) is a generalization of the univariate GARCH model. Every conditional variance and covariance is a function of all lagged conditional variances and covariances, as well as lagged squared dependent variable and cross-products of dependent variables (Silvennoinen and Ter¨asvirta2007). The model may be written as follows:

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$$vec(H_t) = c + \sum_{j=1}^{q} A_j\, vec(y_{t-j} - y'_{t-j}) + \sum_{j=1}^{P} B_j\, vec(H_{t-j})$$

Where vech ($\cdot$) is an operator that stacks the columns of the lower triangular part of its argument square matrix, c is $N(N+1)/2 \times 1$ vector, and Aj and Bj are $N(N+1)/2 \times N(N+1)/2$ parameter matrices. A restricted version of the VEC model is the Baba-Engle-Kraft-Kroner (BEKK) defined in Engle and Kroner (1995). It has the attractive property that the conditional covariance matrices are positive definite by construction. The model has the form

$$H_t = CC' + \sum_{j=1}^{q}\sum_{j=1}^{K} A'_j r_{t-j} r'_{t-j} A_j + \sum_{j=1}^{p}\sum_{k=1}^{K} B'_{kj} H_{t-j} B_{kj}$$

Where A_{kj}, B_{kj}, and C are N × N parameter matrices and C is the lower triangular, the decomposition of the constant term into a product of two triangular matrices is to ensure positive definiteness of H_t (Andersen etal 2007).

5. Results and Discussion

5.1 Results

5.1.1 Descriptive Statistics

The statistical features of the six macroeconomic variables indicate that real exchange rate is the only negatively skewed; all variables have excess kurtosis with money supply growth rate, ratio of government expenditure to GDP and terms of trade being the highest at 13.2, 12.5 and 10.3. Only real exchange rate and the ratio government expenditure to GDP are normally distributed at 5% according to Jarque-Bera normality test this may indicate the presence of conditional heteroskedasticity (Hai etal 2009). Results of unit root tests (Levin, Lin & Chu and Lm, Pesaran, and Shin-W) accepted the null hypotheses of common unit root process and individual unit root process. Augmented Dickey Fuller and Phillips –

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Perron rejected the hypothesis of individual unit root process at 5% level (Annex 2). The long –run relationship among macroeconomic variables under study has been presented in Annex (3).

5.1.2 Multivariate GARCH Estimation Results

Estimation Method: ARCH Maximum Likelihood (Marquardt)

Covariance specification: Diagonal BEKK

Date: 01/17/15   Time: 10:39

Sample: 1957 2006

Included observations: 50

Total system (balanced) observations 300

Bollerslev-Wooldridge robust standard errors & covariance

Presample covariance: backcast (parameter =0.1)

Convergence achieved after 333 iterations

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	0.354579	0.002998	118.2534	0.0000
C(2)	29.04937	1.337445	21.72005	0.0000
C(3)	60.32291	2.185847	27.59704	0.0000
C(4)	1.508431	0.008792	171.5706	0.0000
C(5)	0.102538	0.004550	22.53806	0.0000
C(6)	0.956484	0.012392	77.18462	0.0000
Variance Equation Coefficients				
C(7)	0.000882	0.000190	4.650820	0.0000
C(8)	1.720103	0.205619	8.365471	0.0000
C(9)	1.859862	0.282440	6.584988	0.0000
C(10)	0.587587	0.078646	7.471244	0.0000
C(11)	0.856496	0.090363	9.478376	0.0000
C(12)	1.040783	0.104219	9.986515	0.0000
C(13)	0.503424	0.088145	5.711322	0.0000
C(14)	0.220894	0.059476	3.713998	0.0002
C(15)	0.129918	0.061478	2.113236	0.0346
C(16)	0.908827	0.020224	44.93847	0.0000
C(17)	0.880255	0.015777	55.79476	0.0000
C(18)	0.760635	0.028205	26.96827	0.0000
C(19)	0.941862	0.011312	83.26088	0.0000
Log likelihood	-321.7641	Schwarz criterion		14.35713

Avg. log likelihood	-1.072547	Hannan-Quinn criter.	13.90725
Akaike info criterion	13.63056		

Equation: Q = C(1)

R-squared	-0.728802	Mean dependent var	0.413207
Adjusted R-squared	-0.728802	S.D. dependent var	0.069373
S.E. of regression	0.091214	Sum squared resid	0.407683
Durbin-Watson stat	0.058278		

Equation: INF = C(2)

R-squared	-0.000568	Mean dependent var	28.21520
Adjusted R-squared	-0.000568	S.D. dependent var	35.35525
S.E. of regression	35.36529	Sum squared resid	61284.48
Durbin-Watson stat	0.341803		

Equation: MSDOT = C(3)

R-squared	-1.028109	Mean dependent var	32.62653
Adjusted R-squared	-1.028109	S.D. dependent var	27.59246
S.E. of regression	39.29489	Sum squared resid	75660.34
Durbin-Watson stat	0.359522		

Equation: RER=C(4)

R-squared	-0.135682	Mean dependent var	1.342644
Adjusted R-squared	-0.135682	S.D. dependent var	0.454649
S.E. of regression	0.484512	Sum squared resid	11.50286
Durbin-Watson stat	0.434172		

Equation: GX/GDP=C(5)

R-squared	-1.185572	Mean dependent var	0.160362
Adjusted R-squared	-1.185572	S.D. dependent var	0.053645
S.E. of regression	0.079307	Sum squared resid	0.308194
Durbin-Watson stat	0.183379		

Equation: TERMS=C(6)

R-squared	-0.130699	Mean dependent var	1.091984
Adjusted R-squared	-0.130699	S.D. dependent var	0.378609
S.E. of regression	0.402591	Sum squared resid	7.941893
Durbin-Watson stat	0.772790		

Covariance specification: Diagonal BEKK

GARCH = M + A1*RESID(-1)*RESID(-1)'*A1 + B1*GARCH(-1)*B1

M is a scalar

A1 is a diagonal matrix

B1 is a diagonal matrix

	Transformed Variance Coefficients			
	Coefficient	Std. Error	z-Statistic	Prob.
M	0.000882	0.000190	4.650820	0.0000
A1(1,1)	1.720103	0.205619	8.365471	0.0000
A1(2,2)	1.859862	0.282440	6.584988	0.0000
A1(3,3)	0.587587	0.078646	7.471244	0.0000
A1(4,4)	0.856496	0.090363	9.478376	0.0000
A1(5,5)	1.040783	0.104219	9.986515	0.0000
A1(6,6)	0.503424	0.088145	5.711322	0.0000
B1(1,1)	0.220894	0.059476	3.713998	0.0002
B1(2,2)	0.129918	0.061478	2.113236	0.0346
B1(3,3)	0.908827	0.020224	44.93847	0.0000
B1(4,4)	0.880255	0.015777	55.79476	0.0000
B1(5,5)	0.760635	0.028205	26.96827	0.0000
B1(6,6)	0.941862	0.011312	83.26088	0.0000

The estimated Multivariate GARCH revealed the volatility and co-volatility of six macroeconomic variables indicating that the volatility of one variable leads to volatility of other variables. Conditional volatility serves as a proxy for uncertainty. The volatilities are transmitted directly and indirectly through conditional variance and covariance respectively. The impact of negative and positive shocks is not the same and the correlation between variables does change over time. Terms of trade, government expenditure and inflation have the most impact on the volatility of economic growth. The estimated variance equation and transformed coefficients via explicit modeling of the constant conditional correlation are not statistically different from zero. The correlation could be higher at some periods of business cycle (Longin and Solnik 1995). The estimated model

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is invariant with respect to linear transformations since that it stays in the same class after a linear transformation.

5.2 Discussion

Fiscal and monetary policy: the governments in their request for development devoted considerable resources –mostly available through external debt- to implement development project but the outcome was far away beyond aspirations. Fiscal policy resulted in continuous budget deficits even when there were windfalls from the rise of some commodities' prices. The government resort always to deficit finance due to the continuous budget deficit caused by lavish spending on the ruling activities, the costly civil war, security – development tradeoff i.e. priority is given to get a strong grip of power, corruption and lack of law enforcement. Government relies heavily on indirect tax, tolls and departmental charges and privatization 'of public entities as the main sources of revenue. These lead to increased cost of production and distribution. Windfalls from international commodity price booms have been directed to government consumption rather than accumulating foreign assets. Foreign liabilities are always exceeding foreign assets. Demand deposit ratio to GDP has been oscillating between 0.2% and 4.6% during the period 1956-1991. Then in February 1992 the Minister of Finance and National Economy announced new economic policy – Economic Liberation- embodied change of local currency from Sudanese Pound to Sudanese Dinar accompanied with minimum level of withdrawal thus raising demand deposit and M1 ratio to GDP to 23.4% and 34% respectively since then has been declining steeply to reach 5.4% and 11.1% in 1996 the year that showed the highest level of inflation ever in Sudan economy. New economic policies were declared led to steady increase in the ratios to reach 12.7% and 18% at the end of study period in 2006. These results indicate the nexus between inflation and the demand for money

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leads to significant negative covariance between M1 ratio to GDP and real growth rate i.e. -9.82; t=-1.92 with probability (t=0) = 0.06. There is also significant negative covariance between M2 ratio to GDP and real per capita i.e. -33.1; t=-3.38 with probability (t=0) = 0.001

The financial sector is composed of national commercial banks, four specialized banks in agriculture, industry, real estate, and saving. In 1994 Khartoum Stock Exchange (KSE) started functioning. It is of small size listing at most 53 company, five of them dominate 90 per cent of the market capitalization; inefficient, and there is negative relationship between economic growth and volatility of stock prices (Onour 2007, and Arabi 2010).The central started reforming banks in accordance with Basel agreement in 1994. Bank ratings of fair, marginal, satisfactory, strong, and unsatisfactory are 262, 205, 202, 4, and 80 respectively over the period third quarter of 2002 to the fourth quarter of 2009 (Arabi 2013).

Inflation rate in Sudan has been associated with its uncertainty due to the asymmetry of information and greater policy response to negative than to positive shocks (Arabi 2010). Uncertainty led to delay of investment decisions thus reducing output. Inflation uncertainty is linked to output uncertainty. Continuous budget deficit rendered the consecutive government to rest to borrowing from the banking system – Seignorage was used as a proxy showed strong significant positive impact on inflation (Arabi 2002).

Real exchange rate volatility caused by the continuous devaluation of nominal exchange rate affected growth adversely through reduction of aggregate demand in response to redistribution of income and fall in investment as a consequence of increased debt burden, irreversibility, uncertain environment for investment decisions, and increased government expenditure on nonproductive activities; on the supply side the very essential imported inputs have becoming more expensive.

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Fluctuation of real exchange rate exerts negative effects on export demand as a result of allocation of resources by market participants. Another cause of real exchange volatility has been continuous rise in domestic prices mainly in response to money growth. The variability of bilateral real exchange rates has adverse effects on growth .Unstable terms of trade contributed in the fluctuation of the real exchange rate

Terms of trade shocks are a key source of macroeconomic instability in commodity-specialized countries. Sudan is a primary product exporting country. Cotton, groundnuts, sesame, and animal wealth constituted 90 per cent of export of goods till the end of the third quarter of 1999 then oil has becoming the major source of export returns. The estimated cost of extracting oil was 13 $ dollar per barrel, oil prices surged to 100 $ dollar have not been reflected in the wellbeing of the Sudanese society, on the contrary poverty was spreading to cover 80 per cent of the population, and the middle class has been eroding. Agricultural exports are produced mainly in the traditional rain-fed sector and producers are price taker. Thus shocks of terms of trade are the key source of macroeconomic instability. It is worth mentioning that 80 per cent of manufacture sector inputs are imported hence fluctuation in terms of trade affect both export and import which is reflected in fluctuation in output and economic growth GARCH-M estimate showed that expected growth is related to expected risk (volatility) indicating tradeoff between risk and growth (annex 3).

Social conflicts: civil war between north and south Sudan has irrupted few months before the attainment of independence in Jan 1956 and lasted for seventeen years ended with signing of peace accord. It irrupted again ten year later and continued for twenty two years whereas the peace accord gave the south the right to attain independence based on a referendum. And eventually the South attained independence in 2011. Other fronts of war (21 Militia) were opened in the East and

West Sudan due to the marginalization endured. In addition to civil war political turbulence has been the main feature of Sudanese politics a cycle of democratic elected government pursued by military coup. There deep divisions caused by the application of federal system since early 1990's; the political stances to weaken the traditional parties, nepotism; lack of law enforcement led to wide spread of corruption and very low ranking according to Corruption perception index CPI prepared by Transparency International.

6. Conclusion

Sudan economy has been facing periods of recessions and booms since its independence in 1956 creating uncertainty. Fluctuations in output have been proven to be a result of movement of macroeconomic variables, distortionary economic policies, and social conflicts. It is recommended that the government react during a recession by increasing money supply through the increasing or improving infrastructure. The opposite way the government should go during inflation i.e. reduce the supply of money by cutting funding for projects, increasing taxes, etc. The enforcement of laws, fighting corruption and nepotisms should a priority.

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Annex

Figure (1) Baxter-King Filter (Business Cycle)

PERCAPITA
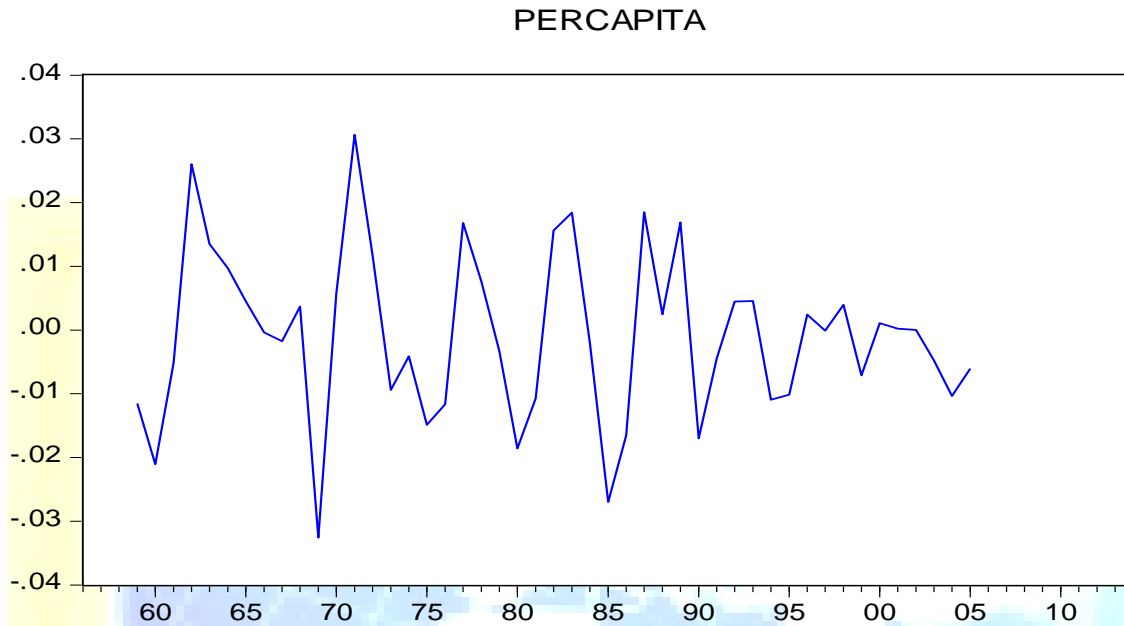
Annex (1) Descriptive Statistics

	Q	INF	MSDOT	RER	GX	TERMS
Mean	0.413207	28.21520	32.62653	1.342644	1426139.	1.091984
Median	0.401954	16.08000	27.88965	1.305000	1181.500	1.042888
Maximum	0.619182	129.2000	168.7016	2.150000	18253000	2.830334
Minimum	0.306321	-7.600000	-5.133203	0.330000	41.50000	0.577593
Std. Dev.	0.069373	35.35525	27.59246	0.454649	3718113.	0.378609
Skewness	0.831156	1.650780	2.639111	-0.121033	3.130892	2.125181
Kurtosis	3.358676	4.721023	13.15329	2.072599	12.47831	10.28376
Jarque-Bera	6.024854	28.87963	272.8103	1.913891	268.8505	148.1639
Probability	0.049172	0.000001	0.000000	0.384064	0.000000	0.000000
Observations	50	50	50	50	50	50

Annex (2) Unit Roots Test

Group unit root test: Summary
Series: Q, INF, MSDOT, RER, GXR, TERMS
Date: 01/24/15   Time: 15:47
Sample: 1956 2014
Exogenous variables: Individual effects
Automatic selection of maximum lags
Automatic lag length selection based on SIC: 0 to 5
Newey-West automatic bandwidth selection and Bartlett kernel

Cross-

Method	Statistic	Prob.**	sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	2.79088	0.9974	6	315
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.02833	0.5113	6	315
ADF - Fisher Chi-square	21.5733	0.0426	6	315
PP - Fisher Chi-square	28.8333	0.0042	6	320

** Probabilities for Fisher tests are computed using an asymptotic Chi
-square distribution. All other tests assume asymptotic normality.

Annex (3) Cointegration Test

Date: 01/17/15   Time: 14:19
Sample (adjusted): 1959 2006
Included observations: 48 after adjustments
Trend assumption: Linear deterministic trend
Series: Q INF MSDOT RER GX TERMS
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.942055	253.4779	95.75366	0.0000
At most 1 *	0.692019	116.7614	69.81889	0.0000
At most 2 *	0.479996	60.23096	47.85613	0.0023
At most 3	0.328044	28.84289	29.79707	0.0641
At most 4	0.142663	9.759919	15.49471	0.2997
At most 5	0.048207	2.371550	3.841466	0.1236

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Annex (4) Vector Error Correction Estimates

Date: 01/12/15   Time: 15:24
Sample (adjusted): 1978 2009
Included observations: 32 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
Y(-1)	1.000000
U(-1)	-52488.45
	(13717.2)
	[-3.82648]
@TREND(56)	5415.216
	(2260.99)
	[2.39506]
C	570298.7

Error Correction:	D(Y)	D(U)
CointEq1	-0.018452	-8.19E-06
	(0.00353)	(3.5E-06)
	[-5.22771]	[-2.34246]
D(Y(-1))	-0.043954	3.47E-05
	(0.17898)	(0.00018)
	[-0.24558]	[0.19548]
D(U(-1))	-1225.455	-1.171807
	(310.111)	(0.30726)
	[-3.95167]	[-3.81375]
C	1025.088	0.523531
	(181.792)	(0.18012)
	[5.63880]	[2.90657]
R-squared	0.740175	0.419029
Adj. R-squared	0.712336	0.356782
Sum sq. resids	3722229.	3.654076
S.E. equation	364.6049	0.361252
F-statistic	26.58823	6.731721
Log likelihood	-232.0316	-10.68775
Akaike AIC	14.75197	0.917984
Schwarz SC	14.93519	1.101201
Mean dependent	674.3632	0.237500
S.D. dependent	679.7981	0.450433
Determinant resid covariance (dof adj.)		17315.89
Determinant resid covariance		13257.48
Log likelihood		-242.6891
Akaike information criterion		15.85557
Schwarz criterion		16.35942

Annex (5) Effects of Terms of Trade Variability on Growth

Dependent Variable: Q
Method: ML - ARCH (Marquardt) - Normal distribution
Date: 01/20/15   Time: 23:17
Sample (adjusted): 1956 2006
Included observations: 51 after adjustments
Convergence achieved after 41 iterations
Bollerslev-Wooldridge robust standard errors & covariance
Presample variance: backcast (parameter = 0.1)
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LOG(GARCH)	0.026912	0.006901	3.899561	0.0001
TERMS	0.115486	0.013248	8.716962	0.0000
C	0.451450	0.058495	7.717699	0.0000
Variance Equation				
C	-3.09E-05	1.41E-06	-21.89780	0.0000

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RESID(-1)^2	0.885771	0.255657	3.464689	0.0005
GARCH(-1)	0.593831	0.057739	10.28478	0.0000

R-squared	0.697138	Mean dependent var	0.413269
Adjusted R-squared	0.684519	S.D. dependent var	0.068677
S.E. of regression	0.038574	Akaike info criterion	-3.660670
Sum squared resid	0.071423	Schwarz criterion	-3.433397
Log likelihood	99.34709	Hannan-Quinn criter.	-3.573822
Durbin-Watson stat	1.464760		