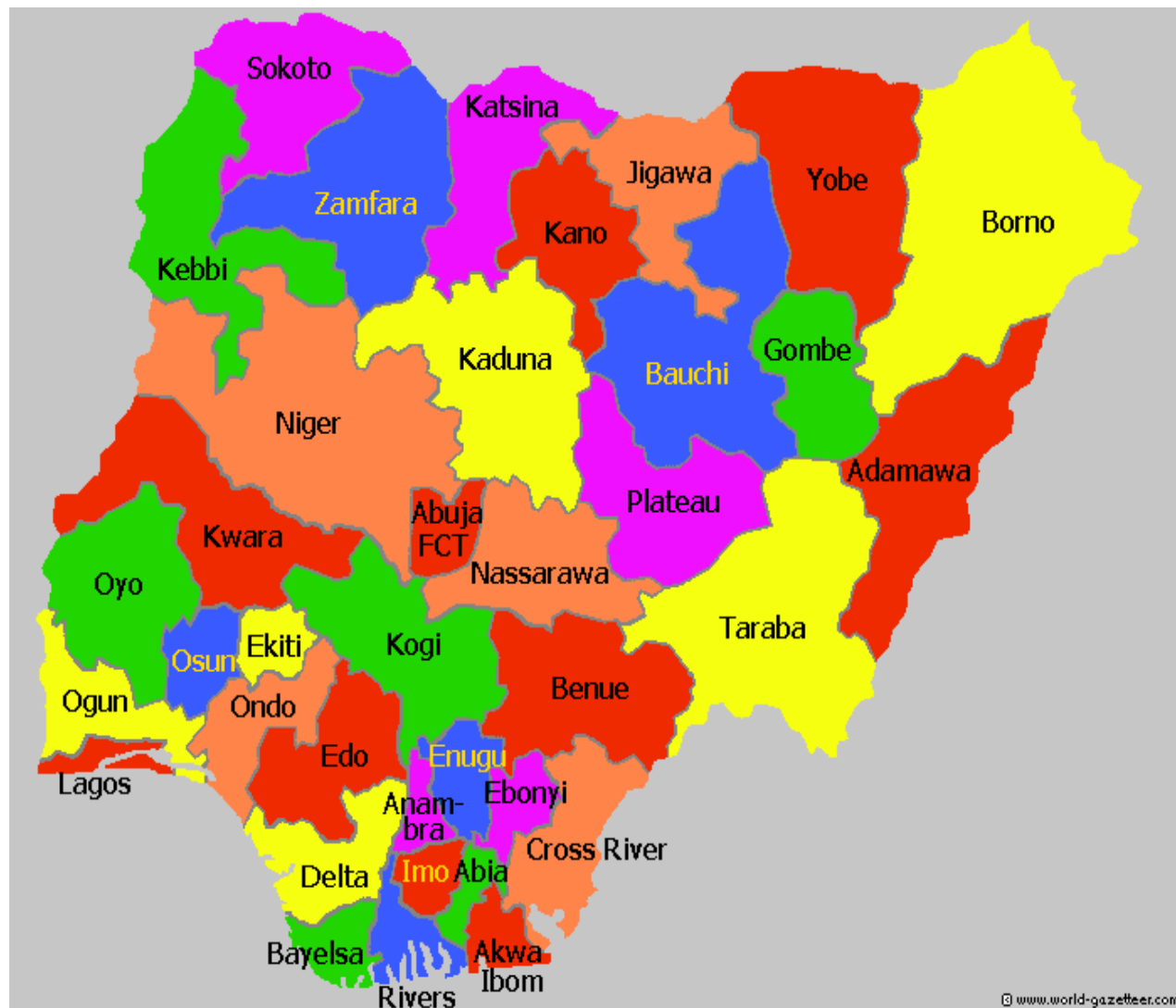# Review of the Nigerian Economy in 2011
&
Economic Outlook for 2012 - 2015

nbs

NATIONAL BUREAU OF STATISTICS

Administrative map of Nigeria showing the 36 States of the Federation and the Federal Capital Territory. Abuja

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PREFACE

In the *Review of the Nigerian Economy in 2011 & Economic Outlook for 2012 -2015*, the National Bureau of Statistics (NBS) aims to provide policy-makers, researchers, investors and the general public of its assessment of the Nigerian economy in the past year, and the likely trends of key macroeconomic indicators in the current year and future years. The objective here is not to contest the assertions in similar reviews and outlooks already in the public domain, but rather to add to the discourse on the direction of economic development as Nigeria aims to become one of the 20 largest economies (as measured by Gross Domestic Product, GDP) by the year 2020. Unlike previous reports therefore, the focus of this report is on key macroeconomic statistics including GDP, inflation, and trade which are quick pointers to the growth and health of the economy by itself, and when compared to the rest of the world.

This short report combines a qualitative review of economic developments in 2011 with quantitative inputs into a Bayesian vector autoregressive model (BVAR) model in order to arrive at reasonable forecasts of the levels and growth of the aforementioned macroeconomic variables. Based on quarterly data from 1996-2011, economic growth is projected to be 6.5% in 2012, a decline from 7.63% recorded in 2011.

As the national statistical office, and the custodian of official statistics in Nigeria, NBS continues to strive for improvements in the delivery of its mandate which includes data production, coordinating the National Statistical System (NSS), advising the Federal, States and Local Governments on matters relating to statistical developments; as well as developing and promoting the use of statistical standards and appropriate methodologies. This review has benefitted from the latest (2011) statistics in order to satisfy at least 2 of these functions, i.e., advocacy and data dissemination. It is my sincere hope that this report will facilitate evidence-based policy at all levels and enhance decision-making by various users.

While hoping that this report will engender a positive discourse on the direction of the economy and macroeconomic policy in 2012, I would like to convey my sincere gratitude to all producers and providers of data all around the country, whose valuable inputs made the publication of this report possible. Finally, the *Review of the Nigerian Economy in 2011 & Economic Outlook for 2012* – 2015 is a product of the hard work and commitment of the management and staff at NBS, all of whom are gratefully appreciated.

Dr. Yemi Kale
Statistician General of the Federation/Chief Executive Officer
National Bureau of Statistics
May 2012.

Executive Summary

In its second year of economic projections, the NBS is also evolving in its approach to forecasting by employing an econometric model to augment results from the traditional methods of surveys and its system of administrative statistics. A Bayesian Vector Autoregressive (BVAR) model is employed to provide a baseline forecast for Gross Domestic Product (GDP), inflation and the value of total trade. Adjustments are made to incorporate the effect of the nationwide strike that occurred in the early part of January 2012, as well as the shock to the economy due to the partial repeal of the subsidy on Premium Motor Spirit (PMS).

In 2012, the Nigerian economy measured by real GDP is projected to grow at 6.50 percent, a decline in the annual growth rate compared to 2011. However, in 2013, the economy is projected to grow at a faster pace as the effects due to the partial repeal of the PMS subsidy are expected to dissipate. The economy is expected to grow at a respectable rate of 7.43 percent in 2014 and 7.25 percent in 2015.

Table 1: Historical and Projected Annual Growth rates for Real GDP, Inflation and value of total trade (%)

Year	2007	2008	2009	2010	2011	2012f	2013f	2014f	2015f
GDP	6.45	5.98	6.96	7.98	7.36	6.5	8.04	7.43	7.25
Trade	5.08	16.88	-3.00	57.49	47.87	-11.03	11.25	20.6	16.44
Inflation	5.57	11.98	11.97	13.59	10.91	13.57	12.21	12.04	11.91

Table 2: Projected Quarterly Growth Rates for the period 2012- 2015

	2012Q1f	2012Q2f	2012Q3f	2012Q4f	2013Q1f	2013Q2f	2013Q3f	2013Q4f
GDP (%)	5.34	6.37	6.85	7.07	9.08	8.12	7.72	7.55
Total Trade (%)	3.76	-12.33	-11.86	-20.24	-2.91	8.29	17.46	21.66
	2014Q1f	2014Q2f	2014Q3f	2014Q4f	2015Q1f	2015Q2f	2015Q3f	2015Q4f
GDP (%)	7.53	7.46	7.4	7.36	7.34	7.29	7.23	7.17
Total Trade (%)	23.67	21.15	19.29	19.02	18.95	16.57	15.01	15.64

In 2012, inflation is projected to rise to 13.57 percent due, to some extent, to the higher price levels in the economy following the partial removal of the PMS subsidy. The BVAR model also indicates inflation rates of 12.21 percent in 2013, 12.04 percent in 2014 and 11.91 percent in 2015. It is important to note that these projected rates also depend on the responses of the Central Bank of Nigeria (CBN) through monetary policy which has set its sights on single digit inflation. In fact, the moderation in price levels in 2011 could be partially attributed to the decisions by the CBN during the period.

The Value of Total Trade for the country is expected to decline in by 11.03 percent in 2012. This is expected to be partly due to the import ban on certain food products that took effect in 2011. The decline could also be due to a decline in crude oil exports possibly due to supply disruptions that occurred during 2011. Further out into the near term, the value of total trade is expected to rebound in 2013 to 11.25 percent, followed by 20.6 percent in 2014 and 16.44 percent in 2015.

In conclusion, while shocks in the early part of 2012 may have marginally slowed economic growth, the economy is expected to rebound in 2013 and grow at respectable trends in 2014 and 2015. The projected growth rates in this report may be further accelerated due to economic reforms expected to kick-in in the near future. As the current Administration is looking to reform key sectors such as agriculture and power, coupled with increased public (capital) expenditure, these are likely to put the economy on a higher growth path.

Introduction

This section provides a review of economic developments in Nigeria and trends in the major macroeconomic variables. The variables discussed in this section include Gross Domestic Product, Inflation and the Value of Total Trade.

A. Gross Domestic Product:

In 2011, the Nigerian economy grew at an estimated real rate of 7.36 percent (see figure 1). This was slightly lower than the 7.98 percent recorded in 2010. In 2011 on a quarterly basis, the economy grew by 6.68% in the first quarter, down by 0.64 percentage points year-on-year. In the second quarter, the economy grew by 7.61% down marginally from the 7.71% posted in the corresponding quarter a year earlier. The economy recorded growth rates of 7.30% and 7.68% in the third and fourth quarters of the year respectively, down by 0.66 percentage points and 0.92 percentage points year-on-year.

Figure 1: Growth Rates 2010-11

Key economic developments that contributed to the marginal decline in GDP in 2011 include lower agricultural output, the lingering effect of the financial sector reforms (involving mainly

the banking sector and the capital market), as well as some significant disruptions witnessed in the oil and gas sector particularly towards the fourth quarter. Despite the marginal decline posted in 2011 however, the growth rate for the year was higher than the five year average recorded over 2005 to 2010 at 6.68 percent.
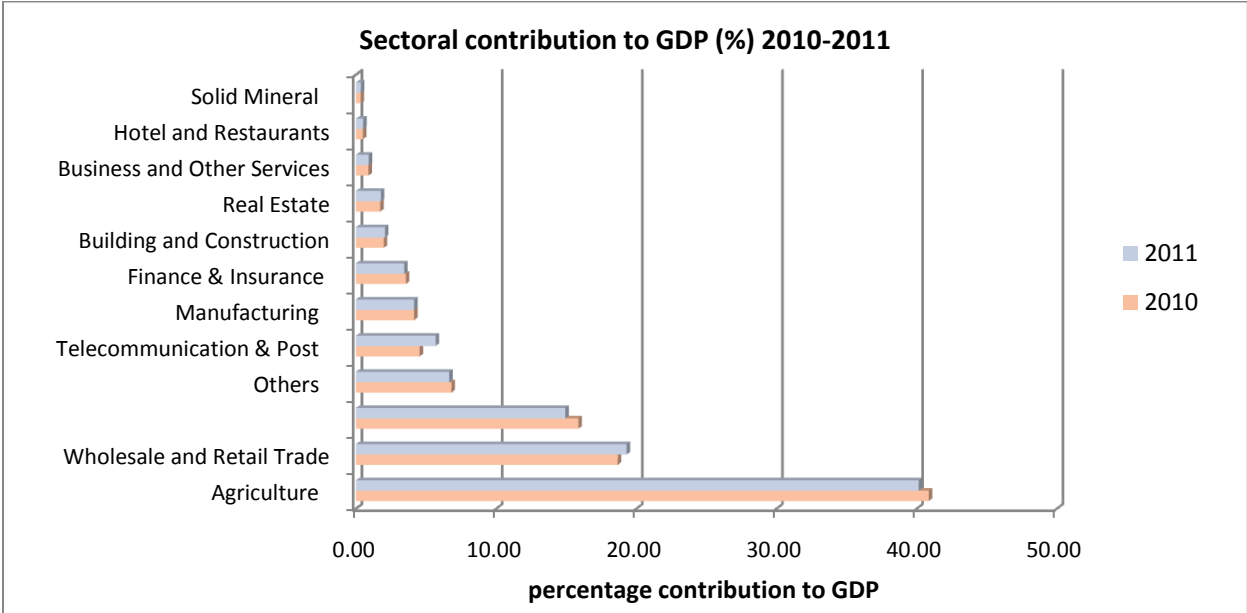

Figure 2: Sectoral Contributions to GDP (2010 – 2011)

Figure 2 above shows the sectoral contributions to GDP in 2010 and 2011. In 2011, the largest sectoral contributors were recorded by agriculture comprising 40.24% to the economy, followed by wholesale & retail trade with 19.38% and crude oil and natural gas contributing 14.71%, the three sectors making up over 70% of the nation's GDP in 2011. The contribution from the crude oil and natural gas sector was down by 1.17 percentage points in 2011 compared with 2010, while the agricultural contribution was down by 0.63 percentage points. In contrast, the wholesale and retail trade contribution to the economy increased by 0.69 percentage points from 2010 to 19.38 percent in 2011. Another notable sector with higher contributions in 2011 compared to 2010 was the Telecommunications & Post sector. Other sectors including Manufacturing, Solid minerals, Hotels & Restaurants, Building and Construction, Real Estate, as well as Business & other services also recorded marginal increases in sectoral contributions to GDP in 2011. Nevertheless, these increases were not sufficient to offset the declines in

agriculture, crude petroleum & natural gas, and finance & insurance sectors, hence the marginal decline in real GDP growth in 2011.
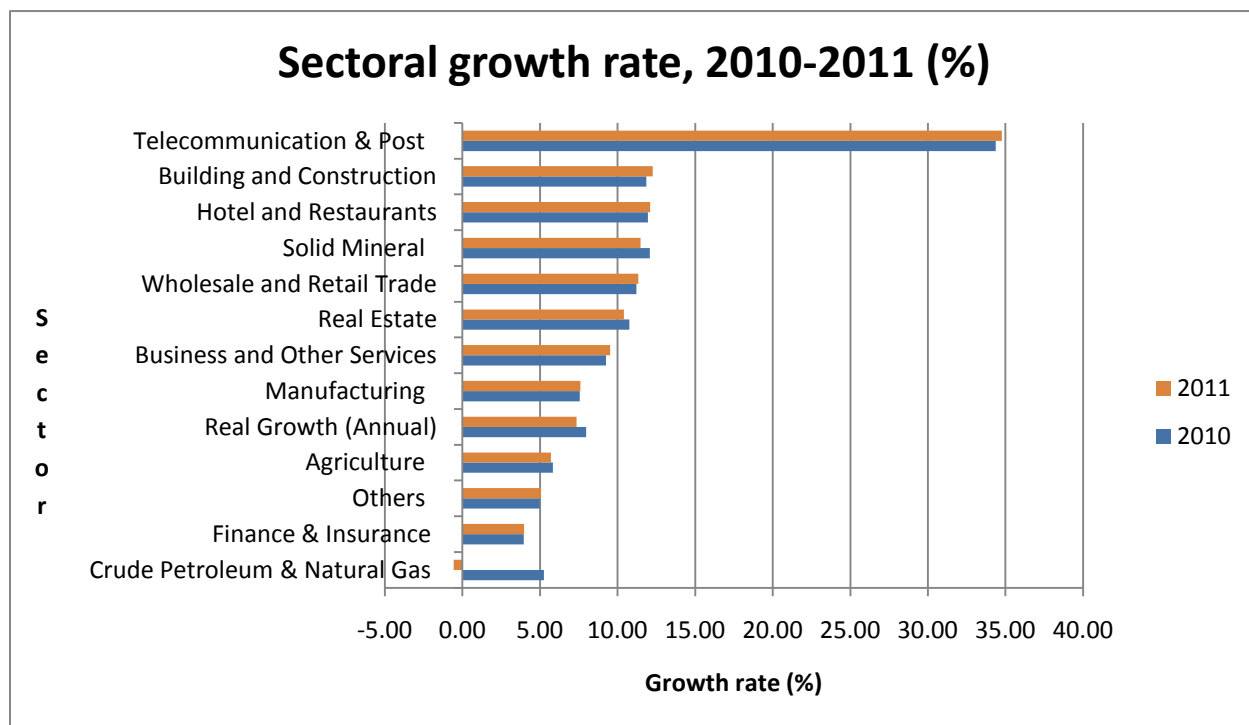

Figure 3: Growth Rates of Key Sectors in the Nigerian economy, 2010-2011

The non-oil sectors of the economy remained vibrant with the telecommunication sector which recorded a growth rate of 34.76% in 2011 (See figure 3). Other sectors including wholesale and retail, building and construction, hotel and restaurants and real estate posted double digit growth rates in 2011 with 11.33%, 12.26%, 12.09%, and 10.41% respectively. Between 2006 and 2010, these sectors have grown at a real average rate of 13.44 percent, 12.58 percent, 12.53 percent and 11.38 percent respectively. The crude oil and natural gas sectors recorded a decline of 0.57%, significantly down from 5.25 percent in 2010.

B. Inflation:

The country's **headline inflation rate** trended lower in 2011 compared to 2010, even though 2011 was an election year with the potential for large monetary inflows within the economy. The average inflation rate for 2011 was recorded at 10.9%, down from the average of 13.8% in 2010,

which had witnessed a year-on high of 15.6% (year-on-year) in February of 2010. As shown in Figure 4, the headline rate ranged between 9.3% (August) and 12.8% (March) settling at 10.3% by December 2011. This was 1.53 percentage points lower than December 2010 and a further 3.65 percentage points lower than December 2009.
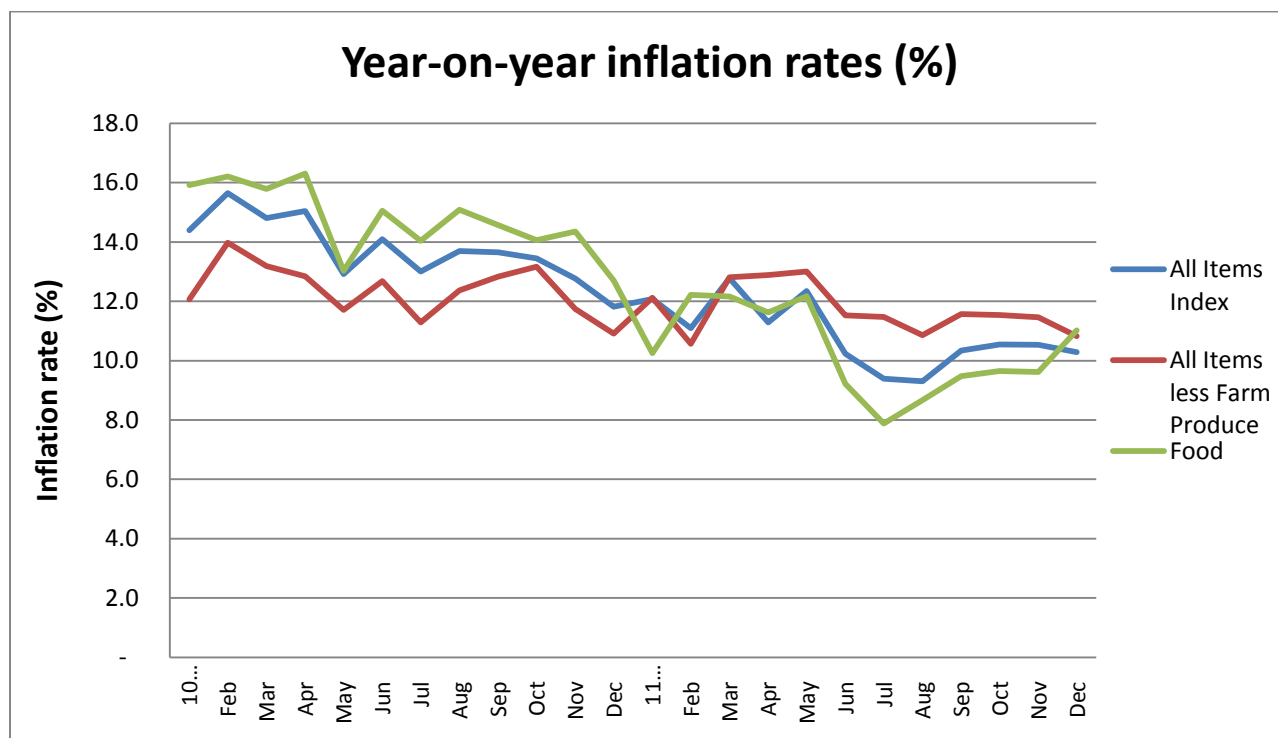
**Figure 4: Trends in measures of inflation rates in 2010 and 2011 (%)**

The "all items less farm produce index" (also known as the "core" index) which excludes prices of more volatile agricultural products peaked in May of 2011 at 13.0% and trended lower till the end of the ycpear. By December 2011, the rate settled at 10.8%, down marginally from the 10.9% recorded in December 2010 and 0.4 percentage points lower than the 11.2% recorded in December 2009. The reason for the early build up in the core index was as a result of increases in prices of household items, building materials and kerosene prices. Towards the end of the year, the upward pressure on prices appear to have been moderated by the relatively late release of allocations to federal state and local governments, as well as end of year sales in various parts of the country. Proactive but very restrictive monetary policy implemented by the Central Bank

of Nigeria in the early part of last year also appears to have countered possible fiscal effects in the latter part of the year.

The Food index which records prices of agricultural products climbed higher during the earlier part of the year to reach a maximum of 12.2% in May 2011 before generally trending downward. The increases in prices were partially as a result of the planting season. Prices receded between May and July of the year to reach a low of 7.9% in July. Prices then climbed higher to end the year at 11.0%, albeit 1.7 percentage points lower than the 12.7% recorded in December of 2010 and 4.5 percentage points lower than the 15.5% recorded in December of 2009.

C. The Value of Total Trade

In 2011, the value of total trade merchandise was recorded at N29.07 trillion. This was 47.9% higher than the value estimated in 2010. This was as a result of increases in the value of both crude and non-crude oil exports which increased by 48% and 42.4% respectively over figures reported for 2010. Over the four quarters of 2011, the value of total trade increased (year-on-year) by 66.48%, 43.04%, 42.97%, and 44.10% respectively.
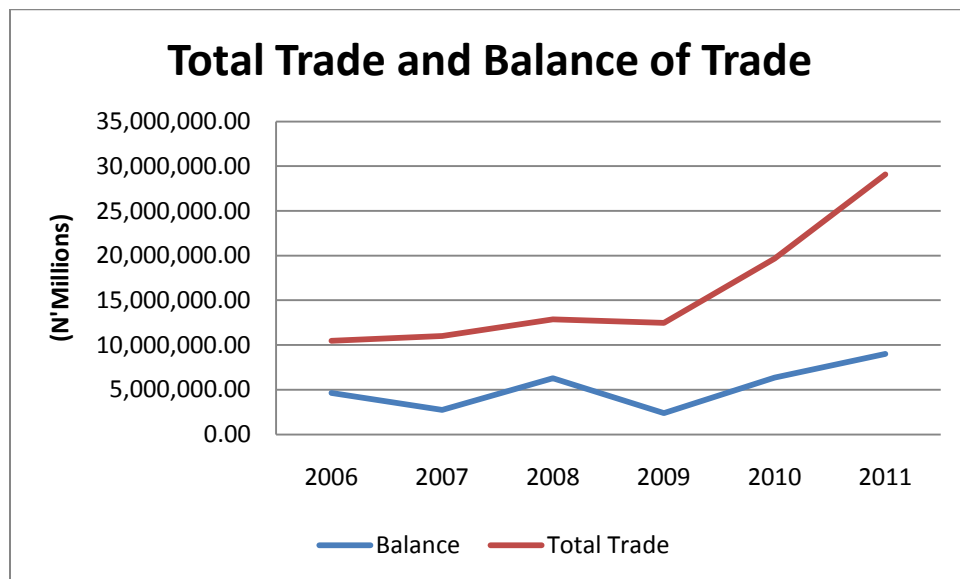

Figure5: Balance of trade and total trade 2010-2011 (Nmillion)

Between 2006 and 2010, the value of total trade has increased constantly, growing by a constant average annual growth rate of 13.41% over the period, as a result of an increase in the value of both imports and exports. Over this period, imports have grown by 17.87% (CAGR) while exports have grown by 11.48% (CAGR).

C. 1 Imports

In 2011, the value of imports increased from N 3,107.55 billion in the first quarter to N3,325.34 billion in the second quarter, more than double levels recorded in the first and second quarters of 2010 respectively. However recorded imports declined in the second and third quarters from levels reported earlier in the year. The value of imports dropped to N2203.23 billion in the third quarter before declining further to N1, 397.07 billion by the end of the year. This was 1.83% higher than the third quarter of 2010, but 21.17% lower than import values recorded in the fourth quarter of 2010. The declines toward the end of the year could be partially attributable to the import bans instituted earlier in the year. Some key imported products during the year were: Motor spirit, Technology specified rubber, flowers, used cars, floor coverings, wholly milled rice and wheat.
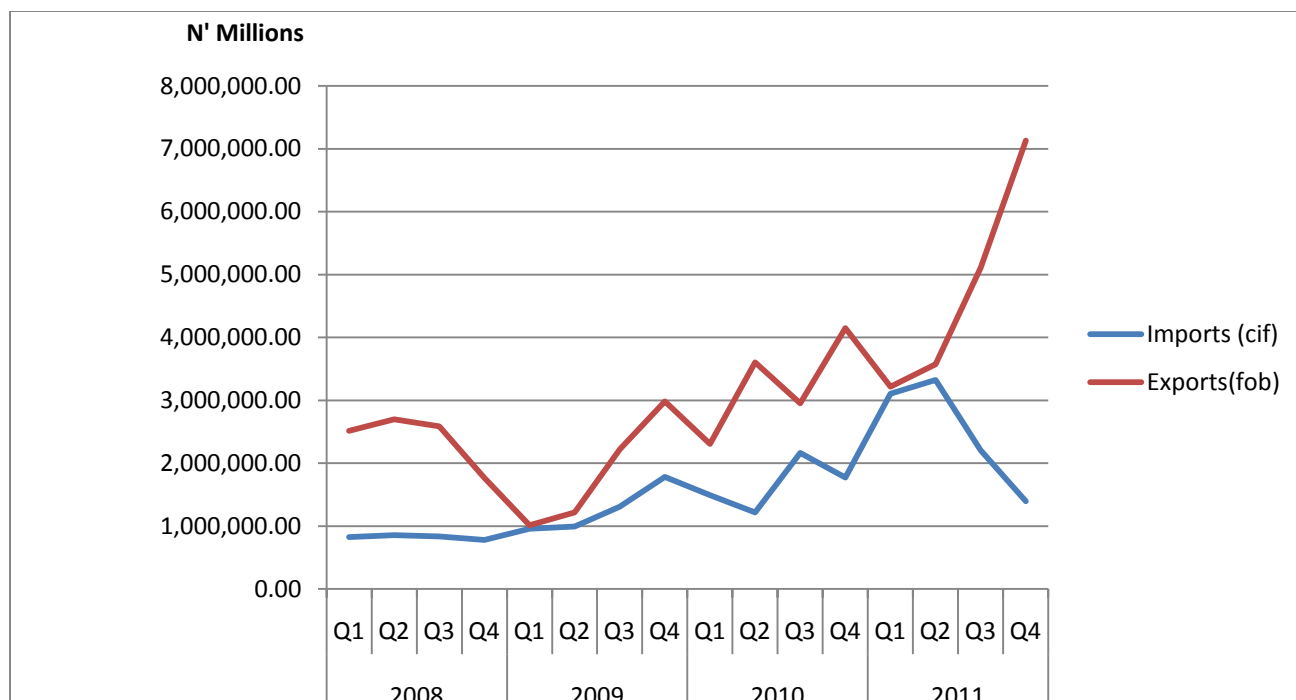
Figure 6: Import and Export Values (N'Millions)

C.2 Exports

In the first half of 2011, the values of the nation's exports were N3217.7 billion and 3573.8 billion respectively in the first and second quarters respectively. These were 39.47% (year on year) higher than q1 2010, but in comparison to q2, 2010, the export values were significantly lower by 81.26%. Exports values however rebounded in the third and fourth quarters to 5112.2 billion and N7132.2 billion during the year. This was an increase of 73.11% and 72% respectively. The rebound was particularly noticeable in the third quarter for crude oil exports which doubled year-on-year, and in fourth quarter for non crude oil exports as the values increased by 176.6% year-on-year. Over the year, the destinations of the country's exports were highest to the United States, India, and Brazil except for the fourth quarter where exports to the UK topped India. Export products of importance were Petro-oils, leather, technology specified rubber, other medium petroleum oils, and motor spirit, and liquefied natural gas.

PART B: **ECONOMIC OUTLOOK FOR 2012 – 2015**

1. **Introduction**

In this section, the report provides further analysis of the trends described in Part A, and makes projections on their likely direction for 2012 to 2015. In addition, econometric evidence using a Bayesian vector autoregressive (BVAR) model is provided. The objective is to give baseline projections of the Nigerian economy over 2012 to 2015 given historical data. It is important to note that the projections stated are a baseline, which could trend higher or lower given unforeseen developments in the economy. However, given several reforms being implemented by the current administration (such as increased budgetary allocation to capital projects, improved credit to the agricultural sector, discontinuation of petroleum subsidy payments, the expected passage of the Petroleum industry bill, etc) projections could be even more positive than the conservative estimates put forward in this report. Equally important are potential risks to economic growth forecast, which include rising political tensions, security challenges and international economic contagion.

Projecting key macroeconomic indicators is one of the main tasks of policymakers, and it is a prerequisite ingredient in facing the unknown with greater levels of confidence. The key macroeconomic variables used in projections are GDP, inflation, exchange rate, interest rate, oil exports, nonoil exports and trade. In addition, for GDP, inflation, and trade, we consider it important to forecast their growth rates as well. That Nigeria is a small open economy informs that it is necessary to incorporate a measure of foreign demand into the projections. This is proxied by the US GDP. Also important to the analysis is that Nigeria is a major oil exporting economy, hence an attachment of the importance of crude oil price in forecasting the future trends of the endogenous variables. In this section of the report, results of the analysis and some pointers on what the results suggest for the economy are presented.

2. Overview of methodology[1]

In going about the set objective, the estimation technique used is called the Bayesian vector autoregressive (BVAR) approach. This method was chosen after the classical VAR failed the stability test. In forecasting, it is a basic prerequisite that the estimated system be stable, otherwise such instability will filter into the data, implying that the forecasts cannot be carried out with an acceptable measure of reliability. An associated problem also is that one is not able to control much of the classical VAR model conventionally and generally used for this purpose. Hence, the BVAR is employed. In BVAR, the analyst is granted some measure of control through the use of prior information. What is done is to downplay past influences on the present by weighing the lags appropriately. The model emphasizes the importance of own-lags of a variable relative to those of the other explanatory variables. Stability was achieved by invoking the Litterman priors and the model yielded more reliable results in comparison with the VAR.
It is important to highlight that the following projections are based on quarterly data from 1996 through 2011. Specifically, the projected growth rate for real GDP are computed from the trends of the historical GDP series, extracted using the HP filter. Thus, the report presents a "base-line" forecast from 2012-2015 given historical trends in the economy up through 2011.

3. Discussion on the 2012- 2015 Projections

The projections for the annual growth rate of real GDP, annual inflation rate, and the annual growth rate of the Value of Total Trade from 2012 through 2015 are reported in Table 1 (See Appendix I), while Table 2 presents their quarterly projections. Table 3 gives the forecast levels for real GDP and Value of Total Trade from the BVAR model. The projected growth rates are calculated based on a year-on-year approach. We now highlight the projected series for the variables.

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[1] More detailed technical notes on the BVAR model are provided in Appendx II.

3.1 Gross Domestic Product

The BVAR model projections (based on the trends extracted from the HP filter) for the Gross Domestic Product growth rates are further adjusted for the economic losses as a result of the nationwide strike in January 2012, and also takes into consideration the likely effects of the increase in pump prices as a result of the partial removal of fuel (PMS) subsidy. The projected growth rate of real GDP in 2012 is 6.5%, a decline from 7.36% posted in 2011. Figure 7 below graphically illustrates the average annual growth for real GDP up to 2015.

Real GDP growth rate (2007-2015)

	2007	2008	2009	2010	2011	2012f	2013f	2014f	2015f
Real GDP growth rate	6.45	5.98	6.96	7.98	7.36	6.5	8.04	7.43	7.25
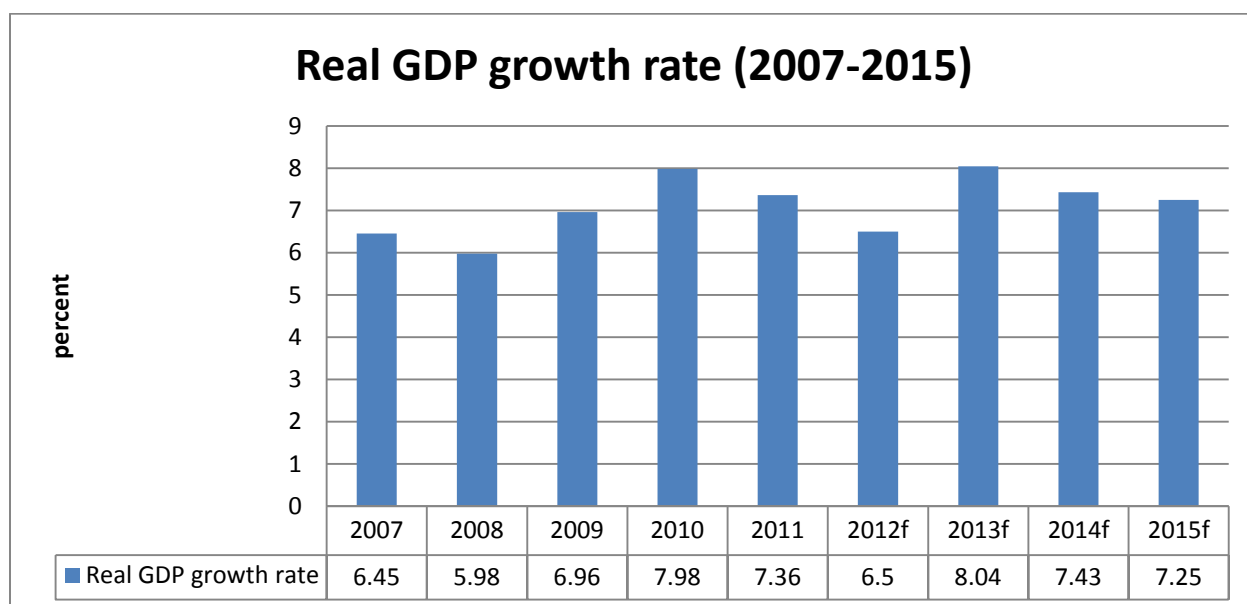
**Figure 7: Projected growth rate of real GDP (2007-2015)**

The projected lower economic growth in 2012 could be partially attributed to external shocks from existing growth concerns in the US, Euro-area, and China. Slower growth in these economies could also put downward pressure on the global demand for crude oil (and thus depress crude oil prices). Lower economic growth could also result from possible lower domestic crude oil production due to supply disruptions which have recently been on the increase. Other threats facing the economy include inflationary pressures, as well as the lingering effects of the partial (and likely eventual) removal of the subsidy on Premium Motor Spirit (PMS) on household incomes. Nevertheless, we expect that a major driving factor behind the growth in the coming years will remain the non-oil sector that has been growing in leaps and

bounds. Key underlying sectors will continue to be telecommunications, wholesale and retail trade, building and construction, and hotels and restaurants – which have exhibited double digit growth over 2010 and 2011. Over the period, we find that the growth rate will actually decline towards the end of the forecast period. The growth rates obtained from the BVAR model for other projected years are 8.04 percent in 2013; 7.43 percent in 2014; and 7.25 in 2015. On a nominal basis, GDP is expected to be valued at N 43,134.77 billion in 2012, an increase of 15.63 percent from 2011. Nominal GPD is expected to increase over the forecast period by 17.28 percent in 2013, 15.53 percent in 2014, and 14.19 percent in 2015.

3.2 Inflation

Although trending downwards since January 2009, the headline inflation rate determining the cost of living has remained double-digit and is expected to remain so in 2012. Based on the estimates from the BVAR model, the projected inflation rate in 2012 will be 13.57 percent; 12.21 percent in 2013; 12.04 percent in 2014; and 11.91 percent in 2015. There is also the probability that inflation rates may trend higher, but the non-accommodative policy stance by the Central Bank, which targets single-digit inflation, is expected to keep higher rates of inflation in check. A broader view of the historical and the projected series for inflation can be gotten from Figure 8.

**Average Annual Inflation Rates, % (2007-2015)**
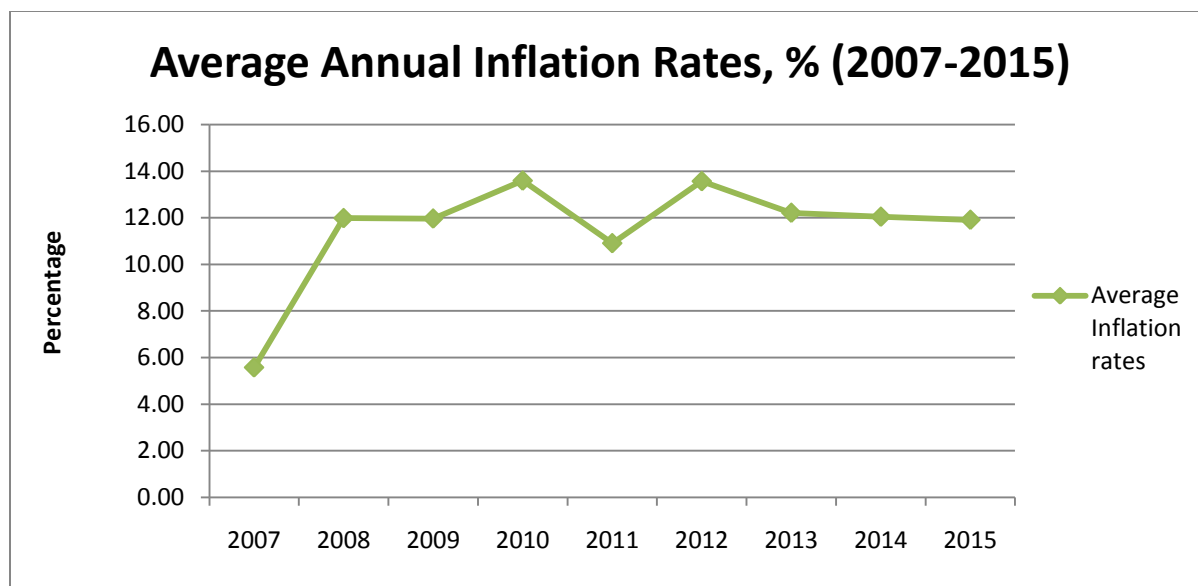
Figure 8: Average annual inflation rate, 2007-2015

Inflation is expected to trend up in 2012 mostly due to the lingering effects of the partial removal of the fuel subsidy on food and non food prices as a result of higher transportation costs. Inflation rates could trend even higher if the PMS subsidy is fully removed, as expected, towards the end of the year. The delayed passage of the budget could also imply high volume fiscal releases later in the year, which could further fuel inflationary pressures. However, as stated earlier, the Central Bank's restrictive monetary policies may dampen inflationary pressures towards 2015, and the final result will depend on what the CBN decides to do with monetary policy.

3.3 Trade

In 2012, trade is expected to decline by 11.03 percent, and then rebound in 2013 to 11.25 percent. This is expected to be followed by 20.6 percent and 16.44 percent in 2014 and 2015 respectively. The decline in the value of total trade in 2012 could be partially due to the recent

declines exhibited by the value of imports in the latter part of 2011 and the implementation of the import ban on certain products. Also, expected declines in crude oil exports as a result of supply disruptions such as those experienced in 2011 will cause the value of total trade to decline. However beyond 2012, the value of total trade is expected to rebound driven by non-oil exports from 2013 to 2015.
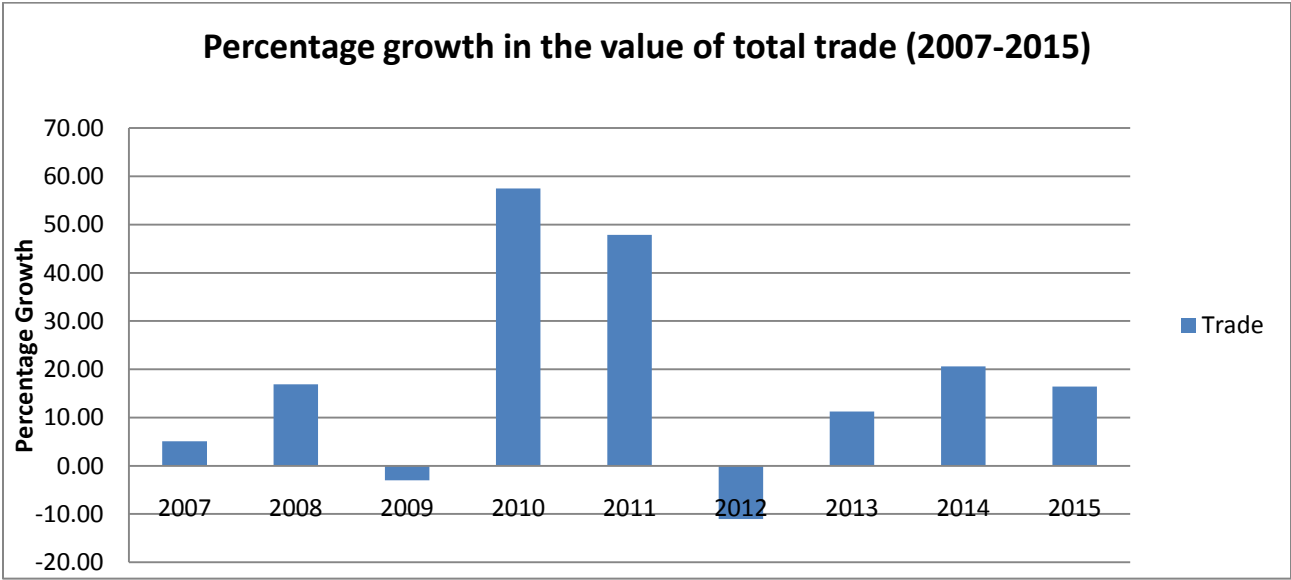
Figure 9: Growth rate of the value of total trade

CONCLUSION

This report has attempted to provide evidence on the likely trend and growth rates of key macroeconomic variables from 2012- 2015. Both qualitative and quantitative approaches were employed using quarterly data from 1996-2011. The results of the Bayesian Vector Autoregression (BVAR) model indicate that overall economic performance in 2012 is likely to increase, albeit at a slower pace from 2011. In 2012 specifically, the growth rate of real GDP is expected to fall, inflationary pressures are likely to be higher, while the value of total trade is forecast to decline. As in recent years, GDP growth is expected to be driven by the non-oil sector. However, threats of increased supply disruptions in the oil sector remain strong, thus affecting overall GDP growth in 2012. The overall growth for the year is also expected to be affected by the economic loss from the nation-wide strike action following the partial removal of fuel subsidy in January 2012.

Furthermore, inflationary pressures could have a dampening effect on GDP growth as a result of possible higher food prices around the country. Inflationary pressures from imported food is another likely source of higher domestic food prices in 2012, as global food prices have been on a steady increase since last year. Lastly, the partial removal of petrol subsidy, which has raised fuel prices in the country by almost 50% will feed into the overall price level further contributing to the inflationary pressures in the economy. Finally, the implementation of the import ban policy of government combined with a possible decline in crude oil export is expected to add further pressure on total trade resulting in its forecast decline in 2012.

Despite these downside risks to the economy, government interventions in agriculture, increased capital budget allocation for infrastructure development, likely passage of the petroleum industry bill and other policy initiatives present opportunity to stimulate growth and overall economic productivity.

APPENDIX I: 2012- 2015 PROJECTION TABLES & CHARTS

Table 1: Historical and Projected Growth rates for GDP, Inflation and Trade (%)

Year	2007	2008	2009	2010	2011	2012f	2013f	2014f	2015f
GDP	6.45	5.98	6.96	7.98	7.36	6.50	8.04	7.43	7.25
Nominal GDP	11.27	17.62	2.05	37.07	8.46	15.63	17.28	15.53	14.19
Trade	5.08	16.88	-3.00	57.49	47.87	-11.03	11.25	20.60	16.44
Inflation	5.57	11.98	11.97	13.59	10.91	13.57	12.21	12.04	11.91

Table 2: Projected Quarterly Growth Rates for the period 2012- 2015

	2012Q1f	2012Q2f	2012Q3f	2012Q4f	2013Q1f	2013Q2f	2013Q3f	2013Q4f
Real GDP (%)	5.34	6.37	6.85	7.07	9.08	8.12	7.72	7.55
Nominal GDP (%)	13.16	16.17	16.36	16.40	20.12	16.87	16.50	16.22
Total Trade (%)	3.76	-12.33	-11.86	-20.24	-2.91	8.29	17.46	21.66
	2014Q1f	2014Q2f	2014Q3f	2014Q4f	2015Q1f	2015Q2f	2015Q3f	2015Q4f
GDP (%)	7.53	7.46	7.4	7.36	7.34	7.29	7.23	7.17
Nominal GDP (%)	15.98	15.71	15.41	15.11	14.77	14.41	14.04	13.65
Total Trade (%)	23.67	21.15	19.29	19.02	18.95	16.57	15.01	15.64

Table 3: Historical and Projected estimates for Real GDP and Trade (N' Millions)

Year	2008	2009	2010	2011	2012f	2013f	2014f	2015f
GDP	672,203	717,036	776,332	833,437	887,593.04	958,924.23	1,030,140.37	1,104,807.56
Nominal GDP	24,296,329.29	24,794,238.66	33,984,754.13	37,303,405.3	43,134,779.66	50,588,120.25	58,442,431.67	66,733,642.69
Total Trade	12,868,046	12,482,413	19,658,432	29,069,147	25,862,305	28,771,930	34,700,380	40,404,836

APPENDIX II: FORECAST METHODS OF ESTIMATION

I. *Vector autoregressive (VAR) model*

One of the major workhorses available for forecasting is the VAR model. In an N-variate VAR model, variable $i \in N$ is expressed in terms of its own lag and the lags of the other N-1 variables and, if available, the exogenous variables. However, given that the number of parameters in a VAR model quickly increases, consuming the degree of freedom and rendering inference imprecise, an alternative VAR method grounded in the Bayesian tradition has been applied to estimate the model. The VAR(p) model estimated has a general form given by

$$y_t = \theta_0 + \theta_1 y_{t-1} + \theta_2 y_{t-2} + \cdots + \theta_p y_{t-p} + \varepsilon_t \tag{1}$$

It is sometimes convenient to put this model compactly as a VAR(1) model such as

$$\mathbf{Y}_t = \boldsymbol{\theta}_0 + \boldsymbol{\Phi}\mathbf{Y}_{t-1} + \boldsymbol{\varepsilon}_t \tag{2}$$

with $\boldsymbol{\Phi}$ is the companion matrix in which the p matrices containing the coefficients are stacked together to form order 1 matrix.

$$\Phi = \begin{bmatrix} \theta_1 & \theta_2 & \cdots & \theta_p \\ 1 & 0 & \ddots & 0 \\ \cdots & \cdots & \cdots & \cdots \\ 0 & 1 & \cdots & 0 \end{bmatrix}$$

and $\mathbf{Y}_t = [y_t \ y_{t-1} \cdots y_{t-p}]'$ is also conformably defined. Since our goal is to forecast over h periods ahead, our forecast is generated by the following system

$$\mathbf{Y}_{T+h} = \hat{\boldsymbol{\Phi}}^h \mathbf{Y}_T + \sum_{i=0}^{h-1} \hat{\boldsymbol{\Phi}}^i (\boldsymbol{\theta}_0 + \boldsymbol{\varepsilon}_{T+h-i}) \tag{3}$$

with the forecast starting from the end of the historical data , *T*.

If the system is stable in the sense that the eigenvalues of $\hat{\boldsymbol{\Phi}}$ are all within the unit circle, then forecasting with the above system will be reliable. However, if the system is unstable, the

powering up of $\hat{\Phi}$ will magnify the instability and render the forecasts from the system unreliable. Hence, we need to ensure that the system is stable so that the forecasts too are accurate enough. We examine the stability of the system by examining the placement of eigenvalues in relation to the unit circle. The occurrence of eigenvalues outside the unit circle indicates that the system is unstable. If the system contains unit roots or the variables are near cointegration, the equilibrium-correction model (EqCM) becomes a better choice of estimation.

Due to the proliferation of parameters in the VAR model as stated above, the degree of freedom is quickly consumed up as a higher order is entertained. One way not feasible in our case is to use longer dataset to be able to estimate the system and ensure the adequacy of the forecasts. In particular, given the small sample size we have had to work with, an alternative approach might need to be adopted. In this respect, Doan, Litterman and Sims (1984) have suggested a Bayesian alternative, namely Bayesian VAR, to the pure frequentist approach outlined previously. A major difference between these approaches is that the BVAR model is grounded in the Bayesian paradigm, in which the variables are considered as fixed, while the environment (the set of model parameters) is seen as stochastic. This is a diametrically opposing paradigm to the classical where the environment is considered as fixed and the variables stochastic. This method is thought superior to the classical VAR estimation method because it allows a fair control over the estimation procedure. In particular, it allows us to input our judgments regarding the importance of a given variable in the dynamic equation endogenizing another variable and the importance of the past in influencing the present. In the BVAR model, as time goes by the past will have less and less impact on the present such that the further in the past the less influence on the estimated and consequently the predicted time series. This is achieved by imposing a Minnesota prior on the VAR model specified in Equation (1) above.

The Bayesian VAR model warrants some conceptual clarifications, which are now discussed. Let $\alpha_i \sim N(1, \sigma^2_{\alpha_i})$ be the priors on the coefficients associated with the lagged dependent variable in each of the equations and $\alpha_j \sim N(0, \sigma^2_{\alpha_j})$ the priors on the coefficients of any other dependent variable in the equation. The assumed priors therefore assign a mean value of 1 to the lagged dependent variable since this variable is thought to be most important in dynamically determining its own future behavior. The mean value of 0 assigned to the coefficients of other

variables featuring in this equation, on the other hand, is indicative of the lesser role they are to play in driving the dynamics of the dependent variable. If the assumed variances are tight enough, therefore, one can downplay the importance of these other variables as desired. To overcome the proliferation of parameters, which informs our choice of the BVAR method of estimation in the first place, we used the method suggested by Doan, Litterman and Sims (1984) to shrink the deviation of variable j in equation i at lag k:

$$\sigma_{ijk} \sim \phi\omega(i,j)k^{-\eta}\left(\frac{\tilde{\sigma}_{\varepsilon_j}}{\tilde{\sigma}_{\varepsilon_i}}\right)$$

where $\dfrac{\tilde{\sigma}_{\varepsilon_j}}{\tilde{\sigma}_{\varepsilon_i}}$ is a scaling construct adjusting for the varying magnitudes across the equations, ϕ is a measure of overall tightness and $0 \leq \eta \leq 1$ gives the rapidity with which lags in the model get discounted in the shrinkage formula. Lastly, $\omega(i,j)$ is the weighting function assigning tightness to variable j in relation to the own-lags in each equation.

II. *The Bayesian Vector Autoregression Model*

We estimate the BVAR model on endogenous variables over the period between the first quarter of 1996 and the last quarter of 2011. The seven endogenous variables are those for which the data were available. The National Bureau of Statistics (NBS) supplied the data on real GDP, inflation rate, exchange rate, interest rate, oil exports, nonoil exports, trade, price of crude oil and US real GDP. The last two variables – real GDP and US GDP – were considered as exogenous variables. Real GDP, exchange rate, oil exports, nonoil exports, trade, price of crude oil and US real GDP were transformed to their logarithm for estimation. Figure 1 displays the historical data at level.

We adopt a two-stage estimation approach to forecasting using the BVAR model. The approach can be understood as follows. In the first stage, we estimate a BVAR model for the exogenous
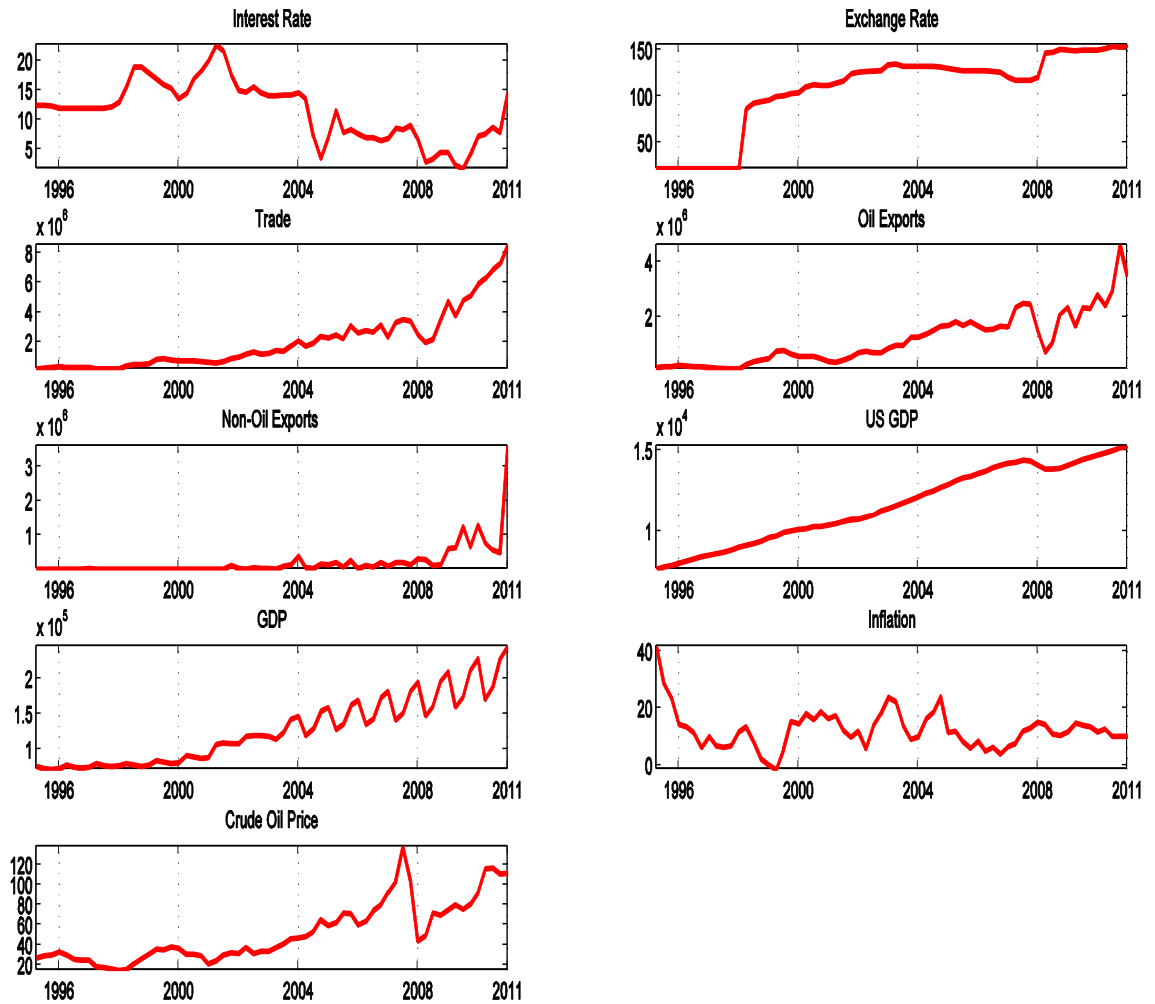
Figure 1: The historical data used for forecast

variables considering these variables as endogenous variables at this stage. In that case, the model estimated has the form:

$$X_t = AX_{t-1} + \xi_t$$

where $X = [USGDP, OILPRIOCE]$. Based on the estimated model, we carry out the forecast for the projection period. We therefore obtain the forecast, X_t^f, for the US GDP and crude oil price.

In the second stage, we bring on the historical as well as the projected series in the first stage for the two exogenous variables. These projected estimates serve as new information in estimating the BVAR at the second stage. Thus, at the second stage, we employ the seven endogenous variables namely real GDP, inflation rate, exchange rate, interest rate, oil exports, nonoil exports and trade. We the estimate the BVAR model again using the model of the form stated above with the modification that the variables now include the seven endogenous variables as well as the exogenous term:

$$Y_t = AY_{t-1} + BX_t^f + \varepsilon_t$$

Given the above formulation, we then forecast the endogenous variables as reported in this paper.

Reference

Doan, T., Litterman R.B. and Sims C., 1984. Forecasting and conditional projection using realistic prior distribution, *Econometric Reviews*, vol. 3, pp 1-100