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Macro-Econometric Model for Kuwait Economy: Policy Simulation and Analysis

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Abstract

Resembling most countries in the world, Kuwait had multiple attempts to estimate the wide macro-econometric models for its own economy. These models are based entirely on annual time series data. The aim of this paper is to develop a macro-econometric model for Kuwait's economy based on quarterly time series data. Accessibility of quarterly GDP data is vital for economic analyses and decision-making process. The quarterly GDP gives a wide understanding of the general economic activities, especially on the fluctuations of business cycles and on the economic turning points. The purpose of this paper is the specification of the first Kuwaiti quarterly macroeconomic model and its estimation using quarterly data from first quarter 1995 to fourth quarter 2012. This paper lays empirical groundwork for macroeconomic models. I have compiled, expanded and improved a Kuwaiti macro-financial dataset at quarterly frequency. I make use of optimization method to transform GDP from annual basis to quarterly frequency. The construction process of the quarterly macro-monetary model has taken into consideration the theoretical and practical argument concerning the inclusion of various variables and their role in forecasting key macroeconomic variables. Estimation results using GMM are highly significant and the main diagnostic tests indicate that the model is well specified. Accordingly, the model has been tested for short run quarterly forecasting over the period from first quarter 2013 to fourth quarter 2015. Assessments of the model implications for an array of shocks that was often examined in policy simulations were performed and concluded that model output was consistent with macroeconomic theory, particularly with regards to short run/long run impacts.

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Introduction

The availability of GDP data at quarterly frequency is important for economic analysis and decision making process. The quarterly GDP data give an insight in to the general economic activities, on the fluctuations of business cycles and the economic turning points. Until the time of writing this paper, the Kuwaiti national statistics agency (the Central Statistical Bureau)had not published quarterly GDP. The footpath to the achievement and consolidation of short-term forecasting of quarterly GDP goes through the construction of models that explain the GDP fluctuations through their historical trend. This paper lays empirical groundwork for macroeconomic models. I have compiled, expanded and improved a Kuwaiti macro-financial dataset at quarterly frequency. I have implemented an optimization method to transform GDP from annual basis to quarterly frequency in order to overcome quarterly GDP data short coming. The first concern of this paper is to specify and estimate a macroeconomic model for the purpose of explaining quarter-on-quarter GDP changes and other relevant macroeconomic variables(1). Another aim of this paper is to provide forecasts at shorter-term horizons than those accomplished through existing macroeconomic models, which have strict requirements with regards to the fulfillment of macroeconomic equilibrium conditions and long-term growth patterns. Results obtained from the estimation of the quarterly macroeconomic model, based on the currently published information, serve as intermediate steps that guide decision-makers and market agents regarding the performance of the economic activities for the reference and forthcoming quarter.

The remainder of this paper is organized as follows. Section I provides macroeconomic modeling literature survey. Section II describes model specification and implementation. Section III discusses policy simulation analysis and policy implications of the model. Section IV presents a conclusion.

Macroeconomic Modeling Literature overview

History of macroeconomic modeling thought

The aim of macroeconomic modeling is to explain, predict and possibly show what can be learned about the macro-economy. Macroeconomic modeling literature survey focuses on Keynesian and Neo-Keynesian contributions and

(1) Foreign country experiences include Celiku (2009, Ercey (2006), Vincent (2002) and Xinhua (2003).

their critics. Keynes (1940) developed a model of inflation with price rigidities. This is a demand side model and the nominal wage rate (labor market) is the main source of price rigidities. Frisch(1983: 230) note that in “ this model of “inflation gap”, Keynes describes a redistribution process in which inflation acts like a pump that transfers income from wage earners who have a low propensity to save and a low marginal tax rate to the entrepreneurial sector with a higher propensity to save and a higher marginal tax rate”. The rationale of inflation dynamics is that an unexpected aggregate demand increase (e.g. as in the case of a war) implies a price increase under full employment conditions. Price increase creates unanticipated profits for firms while nominal wages remain temporarily constant. More profits create an additional excess demand in the goods market. However, past firms attempt to satisfy the initial excess demand in the goods market creates an excess demand in the labor market. More competition among firms for fully employed labor pushes nominal wages higher until restoring realwages to their initial level. Real wages increase induces a new demand pressure in the goods market. Prices will increase again. If the wage-lag mechanism still continues to work, an inflation spiral occurs which can be defeated only by reducing aggregate demand (tax increases and/or cuts in government spending...) and/or reducing nominal rigidities (e.g. an appropriate income policy implementation).

The inflationary gap model developed in Keynes(1940) is an inflation demand-pull model including wage rigidities in the short-run and excluding details on the money market developments (as in the quantity theory of money). Furthermore, as mentioned by Humphrey (1981), the Keynesian nonmonetary demand-pull inflation model was influenced by some cost-push inflation. Most Keynesian economists (cf. A. Smithies(1942), G.Ackley(1978), S. Maital(1982) and J. A. Trevithick(1983) treated demand-side shocks as the primary cause of inflation but accepted the possibility of inflationary effects originating from supply-side shocks. Arthur Smithies (1942) and the others introduced a formal presentation of Keynes verbal analysis of inflationary gap model and their explanations prevailed until the mid-1970s. The Neo-Keynesian macroeconomics, or Keynesian neoclassical synthesis, is based primarily on:

1. The IS-LM closed-economy model developed mainly by Hicks, 1937 and Modigliani in the late 1930s and 1940s.
2. The Phillips curve (developed,1958, by Phillips and Richard Lipsey 1950s, and extended by Samuelson and Robert Solow).
3. The Fleming-Mundell (F-M) small-open-economy model popularized by the IMF in the 1960s.

Keynes-Smithies investigated income redistribution causes of inflation. This channel is not included in the standard IS-LM model. That is, there was no room for continuous price increases, or inflation, in the neo-Keynesian IS-LM setup. On the other hand, the difference between Keynesian and classical theories of income determination was reduced to differences in money demand interest-rate sensitivity and, accordingly, to the shape of the curve for money market equilibrium (LM).Hence, the Keynesian and neoclassical synthesis incorporated labor market dynamics into the IS-LM model by taking into account the Phillips curve (PC) to remove the missing wage-price loop enabling inflation equation integration in the equilibrium system.

According to the demand-pull explanation for inflation, the trade-off(or negative correlation) between inflation and unemployment was interpreted as a signal for excess demand in labor factor and hence in goods markets. Regarding observed evidence, the demand-side determination of inflation within the IS-LM-PC framework failed to explain economic crises (stagflation in the late 1960s and 1970s). First and second oil-price shocks in 1973-74 and 1978-79 created world-wide recessionary and cost-push inflationary effects at the same time. The observed evidence on incompatibility between the PC relationship and the co-existence of stagnation and inflation was actually predicted by monetarist economists. Fried-man and Phelps proposed an expectations-augmented PC in the late 1960s. In the short-run, there is still a (PC) negative relationship between inflation and unemployment for a given expected inflation rate. That is, inflation expectations act as a shift variable in the model and in the long-run; the PC must be vertical according to the monetarist critique of the standard PC.

To monetarist economists, the formation of inflation expectations is back-ward-looking, or adaptive, in the sense that not all information is available to economic agents during their formation of price expectations (the expected rate of inflation at time t is only a weighted average of the actual inflation rate and the expected inflation rate in the previous period).

Macroeconomic models used for overall assessment of current and future economic performance in individual countries have evolvedina number of ways during the last 60 years. Few key variables are used tocapturetheessentialforces at workin the economy. OECD (2011) distinguished the following set of key variables:

- Domestic expenditures variables including private consumption and saving rates, real disposable income, household wealth, changes in the rate of inflation, monetary aggregates, leading indicators of consumer confidence and retail prices, output and capacity utilization, fixed capital formation, financial variables (cash flow and interest rates), business sentiment and survey information, residential construction, demographic trends, and housing stocks.

- Employment, wages and prices variables including employment, productivity trends, capacity constraints and costs, unemployment, participation rates, wage and earnings, domestic prices, and inflation trends.
- Output gaps variables including potential output, structural unemployment rates and underlying "non-accelerating inflation rates of unemployment" (NAIRU).
- Foreign trade and balance of payments variables including international trade volumes and prices, export to import price ratio, and competitiveness indices.

The forecasting procedure in policy environment is characterized by several special features. The standard practice among institutions makes it necessary to justify the GDP growth forecast. The projection of the various GDP components therefore facilitates the interpretation of the resulting GDP forecast and, accordingly, disciplines the design of models. The level of disaggregation is conditional on the quality and availability of the data as well as on the ability to forecast the different variables. Figure 1, provides a stylized presentation of GDP determination and forecasting (cf. Esteves and Rua, (2012)).

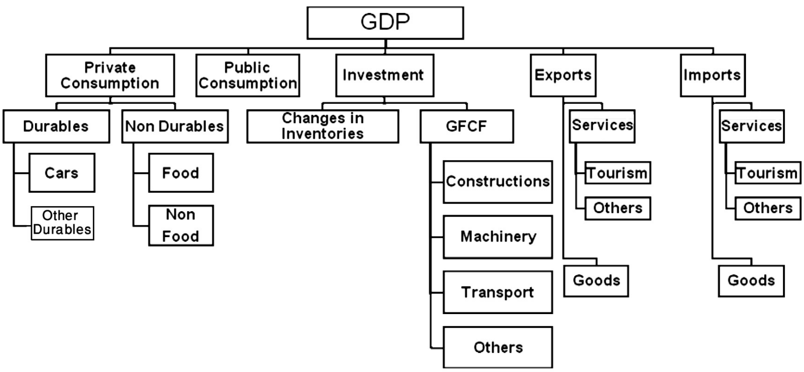

Figure 1
Bottom - Up Approach for GDP Forecasting

Fukac and Pagan (2010) reviewed history of macroeconomic modeling over the past sixty years with emphasis on recent and current period. They identified four generations of macroeconomic models in use for policy design and implementation spanning from aggregate demand-based models, to aggregatesupply-aggregate demand macroeconomic models (AS/AD models), to deterministic long-run steady state-based models to stochastic long-run general equilibrium models (shocks are explicitly part ofthe macroeconomic model). History of economic thought allows little support to Fukac and Pagan (2010) reading; however, data availability (coverage, reliability and accuracy), statistical methods and computing capabilities over the past sixty years have the most important role in macroeconomic modeling evolution. Fair (2015) pointed out that "The specification of the structural equations to be estimated was constrained by economic theory, but fairly loosely... Macroeconomics began as an empirical discipline. In the early days the data were not very good, and considerable effort was needed to understand the data, both their strengths and weaknesses." (p. 446).

The synoptic table (Appendix 1)draws largely on Fukac and Pagan (2010) and gives anoutline of the macroeconomic modeling according to model theoretical foundations, core equations and minimum data required for model estimation and computing.

Macroeconomic Models for State of Kuwait.

Like most other countries, a number of attempts have been made to build macroeconomic models for State of Kuwait. One of the earliest efforts to estimate economy-wide macro-econometric model for State of Kuwait is Khouja and Sadler (1979). The most important and relevant attempts to estimate economy-wide macro-econometric model for State of Kuwait, which were undertaken by Kuwait Institute for Scientific Research (KISR) and Ministry of Planning (MoP), are Sirageldin et al. (1986), referred to as KISR-I; Ahmed et al. (1997), referred to as KISR-II and MoP. In terms of analytical framework, all Kuwaiti macro-econometric models are basically demand derived and follow standard Keynesian macroeconomic framework that relies on national income-expenditure accounting approach to the determination of national income, and assumes that aggregate demand in the economy determines the level of production and hence employment. These models are based on annual time series data, have relied on Two Stage Least Squares (TSLS) and Ordinary Least Squares (OLS) estimation methods. The structures of the three models are somewhat similar, but the time period used to estimate the models are different. Khouja and Sadler (1979) is relatively small and consisting of 10 equations, of which only six are behavioral, and it uses data covering the period from 1961/62 to 1975/76. It focuses mainly on the aggregate demand components (i.e., private consumption, private investment, net exports, and government expenditure), government revenues, and money supply. The model is estimated by 2SLS and OLS methods, and is used primarily for structural analysis of Kuwaits economy. The KISR-I model consists of 139 equations, of which 70 are behavioral relations and the remaining identities;it uses annual data covering the period from 1969 to 1981 for the estimation. The KISR-II model consists of 81 equations, of which 45 are behavioral relations. It is based on annual data covering the period from 1970 to 1989 for the estimation, and uses 2SLS and OLS estimation techniques. The MoP model developed by KISR consists of 354 endogenous and 48 exogenous variables, of which 26 are policy variables and the remaining are external variables and 77 behavioral equations. The model is estimated on the basis of annual time series data covering the period from 1983 to 2000 and updated up to 2004.

The most important attempts to build computable general equilibrium for State of Kuwait, which were undertaken by Kuwait Institute for Scientific Research (KISR) and Ministry of Planning (MoP), are the static standard CGE model and the dynamic CGE model of Kuwait. The static CGE model of Kuwaitis in the neoclassical-structuralist modeling tradition presented in Dervis et al. (1982). It incorporates additional Kuwaiti features. Among these, some have been incorporated to address features characterizing the Kuwaiti economy, including demander subsidies and labor market rigidities. The model database consists of a social accounting matrix (SAM 2001)and a more detailed database for 2001, elasticities for production, consumption, and trade, as well as a set of optional physical factor quantities. The model is implemented in GAMS.

The static standard CGE model is extended to a recursive dynamic model in which selected parameters are updated based on the modeling of inter-temporal behavior and results from previous periods. The process of capital accumulation is modeled endogenously, with previous-period investment generating new capital stock for the subsequent period. The dynamic model is also exogenously updated to reflect demographic changes. Population growth is exogenously imposed on the model based on separately calculated growth projections. The Dynamic CGE model of Kuwait includes data on SAM for 2001.

Kuwait Quarterly Model specification and implementation

Baseline model

In this sub-sectionIdevelopa baselineframeworkthatcaptures thekey features ofthe quarterlymacroeconomicmodel. The reduced form of the model includes an aggregate demand-aggregate supply equilibrium (the IS Curve), a Phillips curve to account for price rigidities, a money supply-money demand equilibrium to account for money market (the LM curve) and an interest rate setting equation to account for Central Bank discretionary monetary policy(2). Let y indicates total

(2) Interest rate equation is the Central Bank reaction function. The short-term niminal interest rate is adjusted so that the ex post real interest rate rises when inflation exceeds its constant target value, or when output growth rises above some target value.

real output, $\dot{p}$and $\dot{p}^e$ are inflation and expected inflation rate respectively, g is the output gap, *m* indicates money supply and *i* is the interest rate. The following equation system provides functional specification with special focus on main explanatory variables of total real output, inflation dynamics, money supply and interest rate target together with the sign of their partial derivatives.Equation (1) and (2) are the same as in core equation (1) and (2) of the macro-econometric large scale models panelpresented in Appendix 1. Equation (3) is the liquidity preference and money supply curve and it shows the combinations of interest rates and levels of real income for which the money market is in equilibrium. It is an upward-sloping curve representing the role of finance and money. Equation (4) is introduced to account for Central Bank discretionary monetary policy (cf. Sauer (2007) and Woodford (2003)). Sauer (2007) compared short-run gains from discretion over rule-based policy and long-run losses from discretion under various state variables conditions and stated that "There exists a discount factor? small enough such that discretion is superior to timeless perspective as long as some weight is given to output [stabilization] and prices are not perfectly flexible" (Proposition 2, p.15). The best-known example of a proposed rule for setting interest rates is the one proposed by Taylor (1993), both as a rough description of the way that policy had been made by the US Federal Reserve Bank and as a normative prescription on the basis of stochastic simulations using a number of econometric models. According to the Taylor rule, the Feds funds rate operating target is set as a linear function of measures of the current inflation rate and the current gap between real and potentialoutput. The original version of Taylor rule is $i_t = \pi_t + \ +r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \bar{y}_t)$ whereis i_t the target short-termnominal interest rate, π_t is the inflation rate, π_t^* is the desired rate of inflation, π_t^* is the assumed equilibrium real interest rate, y_t is the logarithm of realGDP, and $\bar{y}_t$ is the logarithm of potential output. In the Taylor equation, both a_π and a_y should be positive. The equation system leaves all functional specification open to other explanatory variables(3). The list of variables to be included will be discussed below in the model implementation sub-section.

IS Curve: ... ... $y = \varphi(i, g, .); \varphi_i'(.) < 0$ (1)

Phillips Curve (PC): .... $\dot{p} = \theta(\dot{p}^e, g, .)\ ;\ \theta_g'(.) > 0$ (2)

LM Curve: .... $m = \mu(i, y, g, .);\ \mu_i'(.) < 0$ (3)

(3) Other explanatory variables include fiscal variables g and any other relevant instrumental variable.

Discretionary policy:.................. $i = \psi(m, y, g, .); \psi'_m(.) < 0$ (4)

Quarterly model estimation

This sub-section provides description of data used to implement the macro-monetary model, discusses econometric estimation issues and presents main estimation results.

Database

It is the data used for macro-monetary model implementation span, at quarterly frequency, in the period from 1995q1 to 2012q4 (72 observations). Data are collected from the most updated sources. Appendix 2 provides all model variables documented by acronym, brief description and source.

Data on GDP at constant prices are not available at quarterly frequency and this paper makes use for the first time of such detailed information because this variable is central in the model specification as a direct measure of economic activity level and as indirect measure of output gap.The algorithm designed in order to derive estimation of quarterly real output includes the following steps:

1. Making use of daily averaged into quarterly data on oil price and monthly averaged to quarterly data on government oil income (total crude oil revenue less production costs) to derive government oil revenue at constant prices, sticking to year 2010 as base year to be in line with other data.
2. Making use of the year by year quarterly structure of government oil revenue at constant prices together with oil GDP yearly data at constant prices (base, 2010) from the Central Statistical Bureau (CSB)'s National Accounts database to estimate oil GDP quarterly data.
3. Converting CSBs National Accountson Non-oil GDP yearly data into quarterly frequency after running the following GAMS Subroutine

$$Min \sum_{q=q1}^{q4} e_q(t)^2$$

$S.c$:

$$e_1(t) = y(t, q1) - \frac{1}{4}\left(a \sum_{q=q1}^{q4} y(t-1, q) + (1 - a + b) \sum_{q=q1}^{q4} y(t, q) - b \sum_{q=q1}^{q4} y(t+1, q)\right)$$

$$e_2(t) = y(t,q2) - \frac{1}{4}\left(-c\sum_{q=q1}^{q4} y(t-1,q) + (1+c+d)\ \sum_{q=q1}^{q4} y(t,q) - d\sum_{q=q1}^{q4} y(t+1,q)\right)$$

$$e_3(t) = y(t,q3) - \frac{1}{4}\left(-d\sum_{q=q1}^{q4} y(t-1,q) + (1+c+d)\ \sum_{q=q1}^{q4} y(t,q) - c\sum_{q=q1}^{q4} y(t+1,q)\right)$$

$$e_4(t) = y(t,q4) - \frac{1}{4}\left(-b\sum_{q=q1}^{q4} y(t-1,q) + (1-a+b)\ \sum_{q=q1}^{q4} y(t,q) + a\sum_{q=q1}^{q4} y(t+1,q)\right)$$

$$0 < a < 1; 0 < b < 1; 0 < c < 1; 0 < d < 1; 0\ a = b + c + d;$$

Where y(t,qi) is non-oil real GDP at year t and quarter qi.

Potential output (YHP) is estimated using Hodrick and Prescott (HP) filter and the output gap is defined by the total output ratio potential output (Y/YHP).

Table 1 provides descriptive statistics of all model endogenous variables(4). Sample mean and median of each variable are very close, and the ratio between the extreme values is small enough. Endogenous variables oscillate around a trend rate of growth.

Table 1
Descriptive Statistics of all Model Endogenous Variables

	GDP (constant prices 2010, Million KD)	CPI (2010 = 100)	M2 (Million KD)	I (%)
Mean	7489.792	79.733	42765.150	5.164
Median	7096.873	73.147	32440.490	5.750
Maximum	10987.520	108.825	87181.030	7.500
Minimum	4633.860	63.761	21069.500	2.000
Max. to Min ratio	2.371	1.707	4.138	3.750
Skewness	0.253	0.816	0.746	-0.247
Kurtosis	1.542	2.229	1.975	1.483
Jarque-Bera	7.143	9.781	9.828	7.636
Probability	0.028	0.008	0.007	0.022
Observations	72	72	72	72

(4) Y, CPI, M2 and I are Kuwaiti proxy of y, $\dot{p}$, m and i in the theoretical marcoseconomic model (equations (1) to (4)) respectively.

According to Jarque-Bera test of normal distribution, thenull hypothesisis a joint hypothesis of the skewness being zero and theexcess kurtosisbeing zero (which is the same as a kurtosis of 3). All related Probability values are less than 5% and evidence supports normal distribution of model endogenous variables.

Econometric Estimation Method

Equation system (1) to (4) is a canonical reduced form; accordingly, econometric estimation is very hard due to identification issues, simultaneity bias, contemporary correlation and other issues related to data quality.

1. Correlation between explanatory variables and residual term within the same equation due to presence of other equation dependent variables in the right hand side and measurement errors.
2. Autocorrelation of equation residuals.
3. Residual autocorrelation across equations, for example, firms act as supplier in the goods market (IS equation) and as asking for financial support in the money market (LM equation). Households act as demander in the goods market (IS equation) and develop inflation expectations and wage bargaining (Phillips Curve equation). Central Bank controls money supply (LM equation) and designs discretionary monetary rule (equation 4).
4. In order to correct for estimation bias, I make use of a large array of instrumental variables including Non-oil government deficit (Total government expenditure minus non-oil government income), Final government consumption (chapter one and chapter 2 of Government budget) as percentage of total government expenditure, Kuwait currency to US dollar exchange rate and lagged dependent variables. Lagged dependent variables were used to improve the fit of the equations and could be justified either as picking up partial adjustment effects or as reflecting adaptive expectations.Generalized Method of Moments (GMM) is used as an estimation method(5).

GMM estimators use assumptions about the moments of the random variables to derive an objective function. The assumed moments of the random variables are known as the population moments. The data provide the sample moments. GMM minimize the objective function to select the parameters that yield the smallest differences between the population moments and the sample moments.

(5) VAR/ECM approach provides an altemative estimation method, cf. Sims (1980), Gale (2007), Hilde (2000), Webb (1999), Stock and al. (2003).

GMM estimator belongs to a class of estimators known as M-estimators. They are defined by minimizing a criterion function. GMM estimator is a robust estimator because this econometric method does not require information of the error term exact distribution.

GMM estimation is based upon the assumption that the disturbances in the equations are uncorrelated with a set of instrumental variables. The GMM estimator selects parameter estimates so that the correlations between the instruments and disturbances are as close to zero as possible, as per defined by a criterion function. By choosing the weighting matrix in the criterion function appropriately, GMM can be made robust to heteroskedasti city and/or auto-correlation of unknown form.

To sum up this paper makes use of GMM to estimate macroeconomic system of equations and notes the possibility of using other econometric methods, in particular cointegration methods. It is beyond its scope to draw comparisons or evaluate this method.

Estimation Output

The model presents a very high goodness of fit, since adjusted R-square in each equation is greater than 98%. DW statistics show no residual autocorrelation in equation 2 to 4. All estimated coefficients are highly significant (see p-value in the last column of table 3) except interest rate in inflation equation. To further assess the model's goodness of fit, coefficients are estimated from 1995 first quarter to 2010 third quarter keeping 8 out of sample observations. Figure 2providesthe main findings of the model's past simulations and gives strong support to goodness of fit. Since the observed and estimated variable plot shows how they are close, the mean absolute error of each equation is very low with 2.32% for GDP, 0.53% for inflation,1.62% for Money supply and 0.61% for the interest rate. Durbin-Watson statistic is less informative in quarterly frequency estimation due to seasonal effects and autocorrelation is more likely between residual for the same quarter at current and last year respectively.

All variables except those in percentage points (interest rate, discount rate and US interest rate) are in log-value, so equation coefficients are elasticities. The third column of table 2provides GMM coefficient estimation of all model parameters. One period lagged dependent variable coefficient is focused on since this is a measure of the partial adjustment speed. Values are 0.128 for GDP, 0.881 for inflation, 0.643 for Money aggregate and 0.171 for the interest rate.

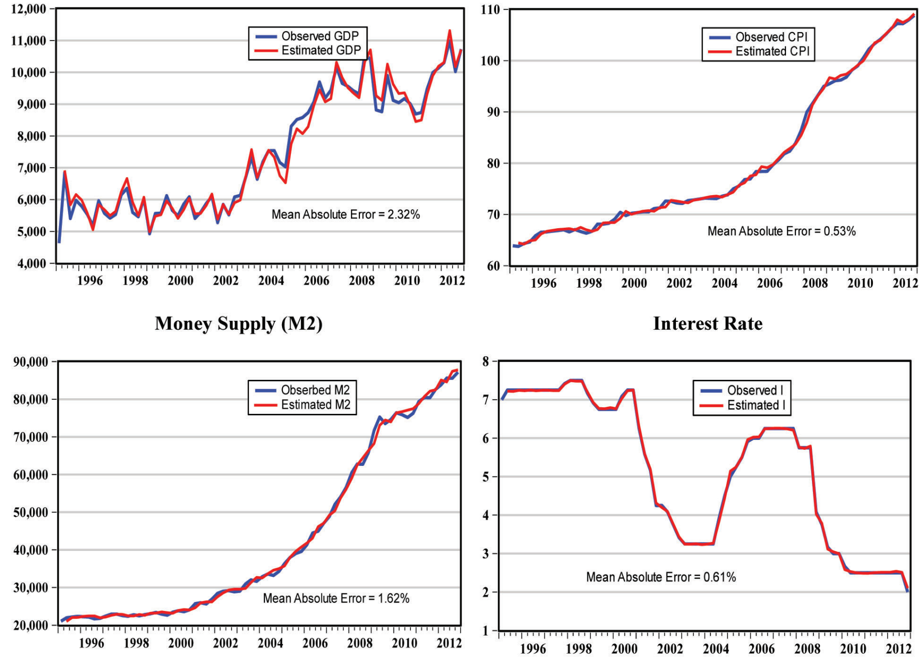

Figure 2
Past Simulations Graphs

It can be concluded that prices and money stock are adjusted quickly while GDP and interest rate have witnessed slow adjustment dynamics. The second array of coefficients to be considered is related to IS and LM slope. The coefficient of interest rate in GDP equation is negative in line with IS down sloping curve, while the coefficient of GDP and Interest rate in M2 equation are positive in line with the predicted sign. Regarding equation (1) (IS Curve), interest rate is the key variable and its estimated coefficient is negative and consistent with theory restriction $\varphi_i'(.) < 0$ in equation (1).

Government expenditure is the key variable in equation (2) (the Phillips Curve) and its coefficient is correctly signed and highly significant. Interest rate and money supply estimated coefficient is also consistent with theory restrictions in equation (3) and (4) respectively. The last coefficients of interests in the model are those for government expenditure and output gap variables. An increase in government expenditure indicates an aggregate demand shift and will push up output through a multiplier effect and inflation through demand pressure.

Model estimated coefficient are 0.014 and 0.006 for output equation and inflation equation respectively and are consistent with macroeconomic theory. Also, an

Table 2
Estimation Output

Estimation Method: Generalized Method of Moments
Sample: 1995Q3 2012Q4
Included observations: 70
Total system (balanced) observations 280
Kernel: Bartlett, Bandwidth: Fixed (4), No pre-whitening
Linear estimation after one-step weighting matrix

Equation	Variables	Coefficient	T-Statistic	Prob.
GDP EQUATION (IS CURVE) DEPENDENT VARIABLE: Y	Constant	5.214	52.553	0.000
	Y(-1)	0.128	10.034	0.000
	CPI	-1.218	-23.048	0.000
Adjusted R-squared = 0.978	M2	0.745	36.447	0.000
Durbin-Watson stat = 0.754	Y/YHP	1.457	39.283	0.000
	I	-0.014	-6.335	0.000
	G	0.014	3.772	0.000
INFLATION EQUATION (PHILLIPS CURVE)	Constant	0.249	2.704	0.007
	Y	-0.039	-2.971	0.003
DEPENDENT VARIABLE: CPI	CPI(-1)	0.881	43.025	0.000
	M2	0.056	5.202	0.000
Adjusted R-squared = 0.998 Durbin-Watson stat = 1.417	Y/YHP	0.107	4.602	0.000
	I	0.000	-0.056	0.956
	G	0.006	5.942	0.000
MONEY (M2) EQUATION (LM CURVE)	Constant	-2.595	-17.856	0.000
	Y	0.463	18.766	0.000
DEPENDENT VARIABLE: M2	CPI	0.517	10.281	0.000
	M2(-1)	0.643	25.058	0.000
Adjusted R-squared = 0.998 Durbin-Watson stat = 2.008	Y/YHP	-0.705	-16.850	0.000
	I	0.216	7.919	0.000
	E	-0.210	-7.672	0.000
	G	-0.006	-2.039	0.043
INTEREST RATE EQUATION	Constant	-0.061	-0.735	0.463
DEPENDENT VARIABLE: I	I(-1)	0.175	14.094	0.000
	CPI	1.341	3.466	0.001
Adjusted R-squared = 0.999	Y/YHP	0.157	2.463	0.014
Durbin-Watson stat = 2.024	M2	0.006	0.792	0.429
	T-BILLS	0.089	8.117	0.000
	T-BILLS(-1)	-0.114	-9.341	0.000
	E	0.851	67.728	0.000
	G	-0.012	-2.794	0.006

increase in output gap signifies a higher aggregate demand pressure and vice-versa, so predicted signs are positive for output activity level and inflation and negative for money supply and interest rate. GMM estimation indicates that these coefficients have the correct sign and they are high in absolute value for GDP (1.457) and M2 variable (-0.705) and too low for inflation (0.107) and interest rate (0.157).

System Residual Normality Tests

The set of instrumental variables and GMM have a crucial role in model estimation outcome; to confirm this advanced statistical tests are performed. Recall that GMM does not require information of the exact distribution of the disturbances. Appendix 3 provides a normality test of system residuals. Skewness and Kurtosis statistics (Normal distribution third and fourth moments) show that the null hypothesis (residual are multivariate normal) is rejected for IS and LM and interest rate equation and is accepted at 3% risk level for the inflation equation, while the joint multivariate distribution is rejected by Skewness statistic and is accepted by Kurtosis statistic at 3.4% risk level. Jarque-Bera statistic shows that the joint multivariate normal distribution could be accepted at 4.8% risk level. Hence, the set of instrumental variables and GMM contributed positively to push towards normality distribution and this will not be the case for the estimation method (two or three stage least squares) based on the normality hypothesis.

Contemporaneous Correlation matrix between residual equations

Contemporaneous cross-equation residual correlation is the main econometric estimation issue of simultaneous equation system. A set of instrumental variables including government final consumption and government non-oil budget deficit is used to tackle this challenge. Table 3provides a correlation matrix between residual of IS and inflation and LM and Interest rate equations.

The highest partial correlation, in absolute value, (0.49) is between IS and LM residuals. This value is less than the critical value (0.8) for a significant partial correlation. Evidence supports correction for a contemporaneous cross-equation correlation.

Table 3
Correlation Matrix between Residual Equations

	LOG(Y)	LOG(CPI)	LOG(M2)	I
LOG(Y)	1.000000	0.408699	-0.495540	-0.374660
LOG(CPI)	0.408699	1.000000	-0.288365	-0.221984
LOG(M2)	-0.495540	-0.288365	1.000000	-0.090542
I	-0.374660	-0.221984	-0.090542	1.000000

Policy simulation analysis

The model I have developed could be used as a quantitative tool for policy analysis. Oil real GDP (YOIL) is exogenous because crude oil extracted quantity (million barrels per day) is fixed by OPEP quota. This fact is accounted for by slightly modifying the econometric system of equations. New endogenous variable (non-oil GDP (YXOIL) and new equation using the identity YXOIL = Y- YOIL are added, so the first equation of the model determines total GDP and, given oil GDP, non-oil GDP is estimated using that identity.

The following model text includes five equations (4 econometric relations and one identity) and five endogenous variables (Y, CPI, M2, I and YXOIL) and five exogenous variables (YHP, YOIL, EXPENDITURE, E and T-bills)

LOG(Y) = 5.21445040463 + 0.127953249872* LOG (Y (-1))- 1.2176031404* LOG(CPI) + 0.744989694089* LOG(M2) + 1.45713143142* LOG (Y /YHP) - 0.0139814536907* I + 0.0136187459183* LOG(EXPENDITURE)

LOG (CPI) = 0.248747454105- 0.0392563303149* LOG(Y) + 0.880887503437* LOG (CPI (-1)) + 0.0560594764319* LOG (M2 (-0)) + 0.106903571178* LOG(Y / YHP)- 3.38244228135e-05* I + 0.00600939875063* LOG (EXPENDITURE)

LOG (M2) = - 2.59545611117 + 0.462642196835* LOG(Y) + 0.517050897967* LOG (CPI (-0)) + 0.643175087339* LOG (M2(-1))- 0.705314183884* LOG(Y/ YHP) + 0.215615490017* I- 0.209872816369* E-0.00586010545203* LOG(EXPENDITURE)

I = - 0.0611481992096 + 0.174745066893* I(-1) + 1.34144099479* DLOG(CPI) + 0.157423316896* LOG(Y/YHP) + 0.00610450585719* LOG(M2) + 0.0888210454439* T_BILLS- 0.113741779037* T_BILLS(-1) + 0.85119202114* E- 0.0121774428763* LOG(EXPENDITURE)

YXOIL = Y- YOIL

……

The period from 2013Q1 to 2015Q4 is taken as a forecasting horizon. Policy simulations analysis starts with the baseline scenario calibration (Scenario S0)). In this step, exogenous variables are forecast using their past trend[6]. Next the model for endogenous variables is solved. Columns headed S0 in table 4 provide detailed forecasts for the baseline scenario. Model solution from each other scenario will be interpreted as macroeconomic shock to the baseline scenario.

(6) Past trends are determined by an exponential smoothing method.

Table 4
Policy Simulation Scenarios

Years	GDP (Million KD, constant prices 2010)				INFLATION (price Index Base 2010)				MONEY M2 (Million KD)				INTEREST RATE (%)			
	Scenario S0	Scenario S1	Scenario S2	Scenario S3	Scenario S0	Scenario S1	Scenario S2	Scenario S3	Scenario S0	Scenario S1	Scenario S2	Scenario S3	Scenario S0	Scenario S1	Scenario S2	Scenario S3
2013Q1	10,819.4	11,468.8	10,692.9	10,806.3	110.1	110.4	110.1	110.2	87,093.7	85,092.0	87,698.8	87,082.8	2.41	2.85	2.43	2.41
2013Q2	11,025.2	11,445.7	10,958.8	11,034.2	111.5	111.9	111.4	111.6	88,700.3	87,197.0	89,130.8	88,665.0	2.35	2.86	2.35	2.35
2013Q3	11,299.2	11,689.5	11,262.2	11,318.8	112.8	113.4	112.8	113	90,033.2	89,226.2	90,215.1	89,987.3	2.37	2.89	2.36	2.37
2013Q4	11,591.5	11,877.1	11,597.0	11,626.3	114.3	115	114.3	114.5	91,353.6	91,268.3	91,293.4	91,302.5	2.41	2.93	2.41	2.41
2014Q1	11,855.7	12,068.8	11,896.9	11,904.6	115.8	116.6	115.8	116.1	92,878.8	93,437.3	92,607.9	92,830.1	2.46	2.98	2.45	2.46
2014Q2	12,091.9	12,230.4	12,167.9	12,155.6	117.4	118.3	117.4	117.8	94,638.0	95,781.5	94,183.0	94,598.2	2.49	3.01	2.48	2.49
2014Q3	12,306.4	12,380.0	12,414.2	12,385.1	119	119.9	119	119.4	96,591.5	98,262.7	95,976.6	96,567.4	2.51	3.02	2.5	2.51
2014Q4	12,508.1	12,522.0	12,645.7	12,602.4	120.6	121.6	120.6	121.2	98,690.3	100,840.8	97,936.5	98,688.4	2.52	3.03	2.51	2.52
2015Q1	12,703.2	12,663.4	12,868.4	12,813.4	122.2	123.3	122.3	122.9	100,897.7	103,483.8	100,023.6	100,924.8	2.52	3.04	2.52	2.52
2015Q2	12,895.5	12,806.8	13,086.6	13,022.1	123.9	125	124	124.7	103,191.1	106,174.0	102,213.4	103,253.9	2.53	3.04	2.52	2.53
2015Q3	13,087.1	12,953.8	13,302.5	13,230.6	125.6	126.7	125.8	126.5	105,558.1	108,902.9	104,491.9	105,663.5	2.53	3.04	2.52	2.53
2015Q4	13,278.9	13,104.9	13,517.3	13,440.0	127.3	128.4	127.6	128.4	107,992.8	111,668.3	106,851.7	108,147.7	2.53	3.04	2.53	2.53

Scenario S1: According to this scenario, suppose that the Central Bank raises the discount rate by half percentage point (50 base points) by the first quarter of 2013. Columns headed S1 in table 4 provide detailed forecasts for the scenario S1. Main findings as per compared tobaseline scenario are:

1. Positive and declining impact on GDP growth from 2013Q1 to 2014Q4 and negative impact on GDP growth by the first quarter 2015.
2. Higher inflation pressure.
3. Upward shift of interest rate for around 0.5 percentage point.

Scenario S2: According to this scenario, suppose that US authorities raise T-bills by 0.25 percentage point (25 base points) by the first quarter of 2013. Columns headed S2 in table 4 provide detailed forecasts for the scenario S2. Main findings as per compared to baseline scenario are:

1. Negative impact on GDP growth from 2013Q1 to 2013Q3 and positive impact on GDP growth by the fourth quarter 2013.
2. High inflation pressure.

Scenario S3: According to this scenario, suppose that Government expenditures will increase at 5% per annum. Columns headed S3 in table 4 provide detailed forecasts for the scenario S3. Main findings as per compared to baseline scenario are:

1. Positive impact on GDP growth by the second quarter 2013.
2. Low inflation pressure.
3. Increased money supply.
4. Interest kept unchanged.

To sum up, simulation analysis stresses the sensitivity of endogenous variable to small change in exogenous variables. The impact of monetary policy on short-term economic growth is avery important finding of the model and can offer advice to decision makers. Short run and long run effects have different directions.

Conclusion and recommendations

This paper has laid a first guided map for Kuwait economy macro-econometric quarterly model. This model can be utilized in GDP estimations and policy-making stimulations. The major obstacle faced during the course of writing this paper was the absence of quarterly GDP data. This obstacle was overcome by implementing an algorithm for GDP estimation at quarterly frequencies.

The main findings of this paper are summarized in the following recommendations. The estimated results and the main diagnostic tests outcomes of the model have indicated that:

1. They are generally well specified.
2. Main results emphasize that the constructed model is constructive if used for short-term time horizons than for one to four quarters.
3. Estimation results show that the constructed model has good statistical qualities. However, as the data availability is still an issue the estimation of the best model remains challenged.
4. Quarterly model implications for an array of shocks that are often examined in policy simulations allow the conclusion that the Kuwaiti economy is consistent with macroeconomic theory predictions and short-run/long-run impacts have different directions.
5. Recommendations for future research include official release of National Accounts at quarterly basis and output gap determination using production function in lieu of statistical filtering.

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Appendix 1
A Comparison Macroeconomic Models Summery

Models	Modelling Perspective	Core Equations and Data Requirements
Macro-econometric models: • Models of the1950s and 1960s.	* The model was associated with the IS/LM framework and the modeling perspective was largely about the determination of demand. * Adaption of model to policy use involved disaggregation of GDP components. * Dynamics were imposed using the Partial Adjustment Model (PAM) * Awareness of the importance of expectations in macroeconomics. They could be measured as a combination of the past history of a small set of variables * Link between the real and nominal sides of the economy viewed prices as a markup over wages that is often influenced by business conditions. * Because the supply side in these models was mostly ignored, less attention paid to stocks and flows.	* Targeted consumption equation $c_t^* = ay_t + br_t$ (1) Where is targeted consumption, yt is income and rt is the interest rate. * Augmented Phillips Curve $\pi_t = \propto \pi_{t-1} + \delta(u_t - \bar{u}) +$ $\gamma\ (p_{t-1} - \ u1c_{t-1}) + \epsilon_t$ (2) Where π_t is price inflation, u_t is the unemploymentrate, p_t is the log of the price level and ulc_t is unit labor cost and ε_t is an error term. * **Minimum data Requirements:** Annual historical data from national income accounts, Government budget and Balance of payments
Macro-econometric large scalemodels: • Models of early 1970s and 1980s. • References: Helliwell etal. (1971), Brayton and Mauskopf, (1985)	* The model was that as sociated with the AS/AD framework which recognized the need for a supply side block and a production function to place a constraint on aggregate supply, particularly over longer horizons. * The model retained much of the structure of the first generation (disaggregated demand). * Therewasmovementtowardsderivingtherelationshipsastheconsequenceofoptimization problems solved by agents (the consumption decision and the choice of factors of production). * Inter-temporal consumption was introduced through the use of life-cycle hypothesis. * Dynamics were introduced through PAM determining the desired levels. The introduction of a production function, the presence of household wealth and the capital stock meant that there were dynamics presenting the model which stemmed from depreciation and savings. Dynamic stability of the complete system became a pressing issue.	* Consumption equation $c_t^* = ay_t + bw_t$ Where is c_t^* targeted consumption, y_t is financial wealth and w_t is the current labor income. * Dynamics in consumption $\Delta c_t = \delta \Delta c_t^* + \alpha(c_{t-1} - c_{t-1}^*)$ The second term of this equation acts as an error correction form. * Dynamics in prices $\pi_t = \propto 1\pi_{t-1} + \delta(u_t - \bar{u}) + \epsilon_t$ Where $\bar{u}$ is the NAIRU. * **Minimum data Requirements:** Annual historical data from national income accounts, Government budget and Balance of payments, Input - Output tables, labor market key variables, stock of capital, demographic trends, participations rates

Cont. Appendix 1
A Comparison Macroeconomic Models Summery

Models	Modelling Perspective	Core Equations and Data Requirements
Computable and Dynamic computable general equilibrium (CGE - DCGE) models * Models dominantinthe1990s. * Murphy (1988), McKibbin (1988), McKibbin and Sachs (1989), Blacketal (1997), Brayton and Tinsley (1996) Black et al,	* Steady state model (deterministic growth path, or balanced growth path) and extra dynamics grafted on to it in order to broadly represent the data. * stock-flow consistency requires that-decisionsaboutexpenditureitemscame-fromwell-definedoptimization choices for households and firms, and rules were implemented to describe the policy decisions of monetary and fiscal authorities. * In a strict steady state (SSS) dynamics have ceased and values oft he variables consistent with these equations will be constant.	* Choose c_t to minimize the objective function: $\frac{1}{2}\sum_{j=0}^{\infty}\beta^j E_t\{(c_{t+j}-c^*_{t+j})^2+\phi(\Delta C_{t+j}-E(\Delta c_{t+j}))^2\}$ Where c^*_t is the short-run steady state path, E_t (.) is the expected value conditional upon the informationavailable at t. * Setting $E(\Delta c_{t+j})=0$ would produce an optimal rule for determining c_t $c_t=\lambda c_{t-1}+\frac{\lambda}{(1-\phi)}E_t\sum_{j=0}^{\infty}(\beta\lambda)^j c^*_{t+j}$ Where λ depends on β and φ.
* (1994), Colettietal, (1996), Blanchard (1985) and Yaari (1965).	* The model could allow for a constant steady state growth path,but a generating the steady state has embedded in it intrinsic dynamics that describe the transition from one steady state position to another. * In the short-run steady state (SRSS) dynamics come from the fact -that the capital stock depreciates and assets accumulate. Consequently, solving the model produces a transitional steady state solution for the model variables i.e. these variables will vary over time due to the fact that movements from one point to another are not instantaneous. Some variables were taken to be exogenous (determined outside the model). Since it is unlikely that these will be at their steady state values over any period of time, the endogenouss variable solutions usingeitherthepureortransitionalsteadystatemodelwillneedtoreflect thetime-variation of these exogenous variables.	Note that the quadratic optimization schemed escribed above would resul tin an ECM connecting and when the latter is constant (cf. Nickell (1985) and Rotemberg (1982)) * Price dynamics $\pi_t=\alpha 1\pi_{t-1}+(1-\alpha_1)E_t\pi_{t+1}+\delta\Delta mc_t+\omega(p_{t-1}-mc_{t-1}),$ Where mc_t was the log of nominal marginal cost and $mc_{t-1}-p_{t-1}$ was lagged rea lunit labor costs. *** Minimum data Requirements:** Quarterly historical data from national income accounts, Government budget and Balance of payments, Input - Output tables, flow of funds tables, labor market key variables, stock of capital, demographic trends, participations rates.

Cont. Appendix 1
Comparison Macroeconomic Models Summery

Models	Modelling Perspective	Core Equations and Data Requirements
Dynamic stochastic general equilibrium (DSGE) models, VAR and Structural VAR (SVAR)-models and Short Term forecasting models **References:** Murchinson and Rennison (2006), Medinaand Soto (2005), Laxtonand Pesenti (2003), Harrisonetal, (2005), Brubakk et al, (2006), Kai et al, (2008), Adolfson et al, (2007), Kuismanen et al, (2003), Ercegetal, (2006), Bene?setal, (2009).	* An underlying steady state representation. * Shocks are explicitly part of the model rather than being appended at the end of the modeling process. Given that shocks are unobservable this inevitably points to the need to quantify the parameters of the model from data. * There is no second-stage process to introduce dynamics. Instead, the adjustment cost terms used to rationalize slow adjustment appear directly in the primary objective. The short and long-run responses are found simultaneously rather than sequentially. * The structural equations of the model are now kept in Euler equation form rather than using a partially solved-out version. * Because shocks were an integral part of the model, solution methods needed to be shaped to account for them; all expectations (“forward” and “backward”) are now formed using information available at time t, and so technically all depend on past observations * Prompt identification of turning points in the movements of the main macroeconomic variables is crucial for guiding economic policy decisions. * The release of fundamental indicators, such as industrial production and GDP and its components takes place with a certain delay with respect to the reference period. * Short-term forecasting procedures based on different methodological approaches (including models with Bayesian factors and Mixed Data Sampling (MIDAS).	* The optimal inter-temporal rule describing consumption decisions: $c_t = \beta E_t(c_{t+1}\ r_{t+1})$, * Production function for a continuum of micro-units over (0, 1) $$Y_t = \left[\int_0^1 Y_{it}^{\frac{\sigma-1}{\sigma}}\right]^{\frac{\sigma}{\sigma-1}}$$ Where Y_{it} is output level of i^{th} ith micro-unit and σ is the elasticity of substitution * Structural equations $B_0 c_t = B_1 c_{t-1} + FE_t C_{t+1} + G\ \epsilon_t$ Note that when ϵ_t has noserial correlation the solution will be $c_t + Ac_{t-1} H \epsilon_t$ The level of disaggregation considered in the bottom-up approach is conditional on the quality and availability of the data as well as on the ability to forecast the different variables. **Minimum Data Requirements**. Quarterly business confidence survey, quarterly consumer confidence survey, Hours of production workers, Value of new orders for consumer goods, Building permits for private houses, quarterly corporate financial statements, quarterly historical data from national income accounts, Government budget and Balance of payments, Input - Output tables, flow of funds tables, labor market key variables, stock of capital, demographic trends, participations rates.

Appendix 2
Data Source and Method

Variables			
Status within model	**Acronym**	**Description**	**Source**
Endogenous Variables	Y	GDP at constant prices	CSB* and paper algorithm
	CPI	Consumer price index, Base = 2010	CSB
	M2	Money	CBK**
	I	Interest Rate (Lending)	IFS***
Exogenous Variables	YHP	GDP potential level	Paper calculation
	E	Discount rate	CBK**
	T-Bills	US - 3 month treasury bills rate	IFS***
	Y(-1)	GDP at constant prices, one quarter lag.	CSB* and paper algorithm
	CPI(-1)	Consumer price index, Base = 2010, one quarter lag.	CSB
	M2(-1)	Money, one quarter lag.	CBK**
	I(-1)	Interest Rate (Lending), one quarter lag.	IFS***
	EXPENDITURE	Total Government expenditures	MoF****
Instrumental Variables	Y(-1)	GDP at constant prices, one quarter lag.	CSB* and paper algorithm
	CPI(-1)	Consumer price index, Base = 2010, one quarter lag.	CSB
	M2(-1)	Money, one quarter lag.	CBK**
	Y(-2)	GDP at constant prices, two quarter lag.	CSB* and paper algorithm
	CPI(-2)	Consumer price index, Base = 2010, two quarter lag.	CSB
	M2(-2)	Money, two quarter lag.	CBK**
	OILPRICE)	Oil price, Dollars per Barrel	EIA*****
	CPIW)	Consumer price index, World average, Base = 2010	IFS***
	CPIADVANCED)	Consumer price index, Advanced countries average, Base = 2010	IFS***
	R	KD to US Dollar exchange rate	IFS***
	T_BILLS	US - 3 month treasury bills rate	IFS***
	E(-1)	Discount Rate, one quarter lag	CBK**
	E(-2)	Discount Rate, two quarter lag	CBK**
	EXPENDITURE-(INCOME-OIL)	Non oil government deficit (Total government expenditure less non oil government income)	MoF****
	(CH1+CH2))/EXPENDITURE	Final government consumption ratio to total government expenditure	MoF****

*: Central Statistical Bureau - State of Kuwait

**: Central Bank of Kuwait

***: International Statistics - IMF

****: Ministry of Finance - State of Kuwait

*****: Energy Information Administration - U.S. Department of Energy.

Appendix 3
System Residual Normality Tests

Orthogonalization: Cholesky (Lutkepohl)
Null Hypothesis: residuals are multivariate normal
Sample: 1995Q3 2012Q4
Included observations: 70

Component	**Skewness**	**Chi-sq**	**df**	**Prob.**
1	0.197620	0.455625	1	0.4997
2	0.727364	6.172352	1	0.0130
3	0.414073	2.000326	1	0.1573
4	-0.508798	3.020216	1	0.0822
Joint		11.64852	4	0.0202
Component	Kurtosis	Chi-sq	df	Prob.
1	3.156972	0.071867	1	0.7886
2	4.275322	4.743802	1	0.0294
3	4.057069	3.259070	1	0.0710
4	3.547880	0.875505	1	0.3494
Joint		8.950244	4	0.0624
Component	Jarque-Bera	df	Prob.	
1	0.527492	2	0.7682	
2	10.91615	2	0.0043	
3	5.259396	2	0.0721	
4	3.895720	2	0.1426	
Joint	20.59876	8	0.0083	

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