

Saudi Arabia's Inflation Agenda: A Vector Autoregressive Framework

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Abstract— Due to the aftermath of global financial crisis and emerging recovery, the issue of inflation is one to be considered extremely important in the next few years of expansion. This study carries out multi-step ahead forecasts of major variables like changes in food and beverages, changes in global inflation, changes in US dollar trade weighted index, and changes in housing availability on inflation by using a Vector Autoregressive (VAR) framework. Findings suggest an improvement in forecasting changes in inflation, and also that limited housing supply remains a major cause of inflation in Saudi Arabia.

Index Terms— Forecasts, inflation, Saudi Arabia, VAR.

I. INTRODUCTION

Few months after the global financial crisis started in late 2008, IMF reported developed countries were expected to report lower Real Gross Domestic Product (GDP) growth for the first time since the 1940s in 2009 before slightly recovering in 2010. One year after the bailout of financial institutions like Fannie Mae and Freddie Mac, and massive government injections, the world economy is on the brink of recovery. For any economy, inflation remains a critical part of the agenda. This study looks at the effect of the global financial crisis in Saudi Arabia, and how it impacted on its inflation. It is initially expected that restoring confidence in today's environment involves the state encouraging more production and consumption of goods and services throughout the Kingdom, which might spur inflationary pressures gradually. The Saudi Arabia Monetary Agency (SAMA) has reduced the repo rate and capital reserve requirements as a boost to its money supply growth policies over its last few meetings. That is why inflation, which is ordinarily a lagged result of rapid money supply growth, should be managed appropriately.

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While, existing literature on commodity prices, Baltic dry Index, housing supply, pegged riyal, global inflation and Saudi Arabia inflation is not duplicated here due to well established literature, this study extends upon Gurrib (2009) who uses the above variables and carries out *Granger Causality tests* on pre and post financial crisis data. Results suggest no rejection of the null hypothesis that independent variables still Granger-caused changes in inflation rates in Saudi Arabia before and after the global crisis, though the independent variables added little in predicting changes in inflation rates one step ahead¹. While it is outside of the scope of this study to investigate at all economic factors that can affect the inflation status quo, this study contributes to existing literature by carrying out *multi-step ahead forecasts* of the effect of commodity prices and food prices, lower transportation costs, tight housing supply, pegged Saudi riyal and lower global inflation on Saudi's inflation. Due to Saudi riyal being pegged with the US dollar currency, Saudi's monetary policy has practically mirrored those of the US. With Federal Funds rate at near zero figures, Saudi Arabia has started to change their funds rate on a more independent basis. This study has implications for the monetary policy sector in that it will give further guidance as to whether Saudi Arabia has to worry more about its inflationary figures, and act upon it. The rest of the study focuses on the data and methodology, research findings before giving concluding remarks.

II. DATA

Food and Beverages which forms the biggest component of the Saudi Cost of Living Index (SCLI) is used as a measure of non oil commodity prices². As a benchmark of international food prices, the IMF Food Price Index is used in similar conjunctions. For the measure of transportation costs, the Baltic Dry Index (BDI) is used, and is reported on [wikinvest.com](http://www.wikinvest.com). The Central Department of Statistics (CDSI, 2009) provides data for housing availability. Global inflation data was obtained from the World Outlook database, IMF (2009). The US dollar trade-weighted index (TWI) is used as a measure of the dollar value against major trading partners. As mentioned earlier, due to the Saudi riyal being pegged to

¹ Just for cross-checking purposes, omitting lagged terms of independent variables before and after the crisis were found to increase the standard error of estimated residuals only marginally.

² Data is obtained from SAMA (2009b) database. See Glassman (2009), Marquis and Cunningham (1990), Garner (1988) and Hafer (1989) for a good review of importance of commodity prices on inflation.

the US dollar, the TWI provides a good proxy of the trading value of the riyal against its major global partners like Japan and European economies. SAMA also provided for the Consumer Price Index (CPI) data as the measure of aggregate price level. Finally, but not least, repo rates (the rates at which SAMA lends to banks), reverse repo (the deposit rates SAMA offers to bank), and three month interbank rates (rates at which banks lend between themselves) are obtained by SAMA (2009a). These rates serve as a guide towards monetary policy actions, and are useful in this study to evaluate the control of inflation by adjusting those rates. To look at the effect of the global financial crisis, the monthly data is set from January 2000 up to September 2009. Stationarity testing using Augmented Dickey Fuller (ADF) tests is carried out to avoid spurious regression. Schwarz Information Criteria (SIC) is used for lag optimization while keeping some economic rationality to the number of variables used³. A simple correlation analysis is also performed to give more insights on relationship between the different variables analysed. Regression are carried out while making sure there are no heteroskedasticity and autocorrelation problems.

III. METHODOLOGY

The fact that changes in food and beverages prices, Baltic Dry Index, housing availability, global inflation, and US Dollar trade-weighted index Granger-caused changes in the inflation rate is not sufficient to be fully viable in prediction. The essence of Granger causality measures a *one-step ahead* prediction in *bivariate* settings. Policy makers think multi step predictions would be much more valuable than one-month forecasts. If all the above variables are considered simultaneously, there might be more benefits in the predictive power of the resultant equation. A vector autoregressive (VAR) model provides a solution to both of these issues⁴ and can be generalized in matrix notation⁵ as follows:

$$\begin{bmatrix} y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \alpha^y \\ \alpha^z \end{bmatrix} + \begin{bmatrix} \beta^y & \gamma^y \\ \beta^z & \gamma^z \end{bmatrix} \begin{bmatrix} y_{t-1} \\ z_{t-1} \end{bmatrix} + \begin{bmatrix} \varepsilon_t^y \\ \varepsilon_t^z \end{bmatrix} \quad (1)$$

, where α^i 's and β^i 's are parameters. The epsilons are white noise, i.e,

$$\begin{aligned} E(\varepsilon_t^i) &= 0, \\ \text{Var}(\varepsilon_t^i) &= \sigma^2, \\ \text{Covar}(\varepsilon_t^i, \varepsilon_t^s) &= 0, \text{ where } i, j = y, z \text{ and } i \neq j, t \neq s. \end{aligned}$$

For the scope of this study, we construct two VAR models (VAR 1 and VAR 2). VAR 1 includes (ΔFAB_t) , (ΔCPI_t) , (ΔBDI_t) , (ΔHA_t) , (ΔTWI_t) , and (ΔGI_t) , while VAR 2 is VAR

1 without accounting for (ΔHA_t) which is the only factor that added to positive changes in the inflation rate. To add further value to the model, we included a spread which is a proxy of the tightness in lending conditions in Saudi Arabia called $\Delta REPIN_t$. Following the monetary policy tools actually used in the Saudi Arabia Monetary Agency (SAMA), $\Delta REPIN_t$ is the difference between the three-month riyal interbank rate (rate at which commercial banks pay for three-month deposits from other commercial banks and SAMA's reverse repo rate (rate that SAMA pays for deposits from commercial banks). An increase in the spread the monetary policy is geared towards encouraging less banking lending as a contractionary policy measure⁶.

IV. EMPIRICAL FINDINGS

In order to avoid over parameterized equations and improving forecasting performance, the number of estimated coefficients is reduced as proposed by Webb (1988). Instead of choosing a common lag length, lag length of each equation is set by minimizing the Schwarz Information Criteria (SIC). Lag lengths for both VAR models are presented in Table I.

Once the optimal lag length is obtained, each model is estimated using data through September 2007; forecasts were computed for each month through September 2008. The forecasts for October 2007 were compared with actual data and the resulting one-step ahead errors were recorded; forecasts for October were used for two-step ahead errors; and similarly, forecast errors up to twelve steps ahead were calculated. The process was then updated one month, with the model estimated through October 2007 and forecasts made until October 2008. This process or estimation and forecasting was repeated each month through October 2009. Resultant forecast errors are summarized in Table II.

Findings from table I support that both VAR model performed better than a naïve model with a no change forecast. In fact, values for Theil inequality statistics were less than unity, indicating that the VAR models forecasted outperformed a naïve no change forecast. In some instances, the relative accuracy increases with the forecast window. The forecast statistics indicate some difference between the accuracy of changes in the CPI forecasts from the two models. Although not reported here, at each forecast horizon, including those not shown in table II, the differences in the MAE between VAR 1 and VAR 2 were quite significant in some cases⁷. This suggests that including the housing availability component in VAR 1 leads to a better model than VAR 2 with lower mean forecast errors. This is further supported that SAMA still reports rent inflation as a major cause of the country's inflation. As part of its monetary policy, SAMA manages the repo rate and reverse repo rate,

⁶ See SAMA (2009) for more on interbank rates, reverse repos and repos.

⁷ This result can be further improved by modifying some features of the model, like using level form series instead of the differenced form despite of unit root being present. To check that possibility, VAR 1 and VAR 2 series were set to level forms and the whole estimation and forecasting procedure was repeated. The accuracy of forecasts deteriorated for both VARs, suggesting that series need to be differenced to avoid spurious regressions.

³ For instance, Nelson and Schwert (1982) find heavily parametrized forms of equation can result in a serious loss of power in testing.

⁴ See Webb (1988) for instance on forecasting reliability of VARs.

⁵ While (1) is for a 2 variable multivariate setting with two variables y_t and z_t , it can be expanded to accommodate for all the different independent variables used in traditional Granger causality tests.

and the interbank rate⁸. The three interest rate cuts just in 2009 are substantiated in our study due to all our variables granger causing negative changes in inflation, and ΔREPIN_t having a Theil inequality value of 0.52 in our VAR 1 model.
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TABLE I. Lag Length for VAR models

This table shows the optimal lags for VAR models. VAR 1 model includes ΔCPI_t (change in CPI level), Food and Beverages changes (ΔFAB_t), changes in Baltic Dry Index (ΔBDI_t), changes in housing availability (ΔHA_t), changes in US trade-weighted index (ΔTWI_t), changes in global inflation (ΔGI_t), and ΔREPIN_t the (difference between 3 month interbank rate and reverse repo rate). VAR 2 model is VAR 1 model excluding the ΔHA_t component. Number of lags is optimized by minimizing the Schwarz Information Criteria (SIC).

		VAR 1						
		<i>Independent Variable</i>						
<i>Dependent variable</i>	ΔCPI	ΔFAB	ΔBDI	ΔHA	ΔTWI	ΔGI	ΔREPIN	
ΔCPI	1	1	2	2	1	1	1	
ΔFAB	1	1	1	1	1	–	1	
ΔBDI	2	2	1	2	1	1	2	
ΔHA	1	1	–	1	–	1	–	
ΔTWI	1	1	1	1	1	–	1	
ΔGI	1	1	–	2	–	1	1	
ΔREPIN	1	–	1	2	2	1	1	

		VAR 2					
		<i>Independent Variable</i>					
<i>Dependent variable</i>	ΔCPI	ΔFAB	ΔBDI	ΔTWI	ΔGI	ΔREPIN	
ΔCPI	1	1	1	1	1	1	
ΔFAB	1	1	2	2	–	2	
ΔBDI	1	1	1	1	1	1	
ΔTWI	1	1	1	1	–	1	
ΔGI	1	–	–	1	1	1	
ΔREPIN	1	2	–	2	–	1	

⁸ There have been three interest rate cuts so far in 2009. In mid- January, SAMA lowered the repo rate (the rate it charges for lending to commercial banks) to 2 percent from 2.5 percent and the reverse repo rate (the rate it pays for deposits) from 1.5 percent to 0.75 percent. The reverse repo rate was then cut to 0.5 percent in mid- April and to 0.25 percent in mid-June, while the repo rate has been left unchanged (SAMA, 2009).

TABLE II. VAR FORECAST ERROR STATISTICS

This table reports the Mean Absolute Error forecast (MAE) and Theil Inequality U statistics for VAR 1 and VAR 2 models. VAR 1 model includes ΔCPI_t (change in CPI level), Food and Beverages changes (ΔFAB_t), changes in Baltic Dry Index (ΔBDI_t), changes in housing availability (ΔHA_t), changes in US trade-weighted index (ΔTWI_t), changes in global inflation (ΔGI_t), and ΔREPIN_t the (difference between 3 month interbank rate and reverse repo rate). VAR 2 model is VAR 1 model excluding the ΔHA_t component. Results are reported for 1-step, 6-step and 12-step ahead forecasts.

<i>Variables</i>	VAR 1					
	1-step		6-step		12-step	
	MAE	Theil U	MAE	Theil U	MAE	Theil U
ΔCPI	1.9	0.89	1.93	0.85	1.932	0.81
ΔFAB	0.35	0.82	0.38	0.78	0.382	0.74
ΔBDI	0.34	0.79	0.37	0.75	0.372	0.76
ΔHA	5.78	0.93	5.81	0.89	5.81	0.85
ΔTWI	5.72	0.91	5.75	0.87	5.752	0.83
ΔGI	1.54	0.77	1.57	0.73	1.572	0.69
ΔREPIN	2.67	0.52	2.7	0.48	2.702	0.44

<i>Variables</i>	VAR 2					
	1-step		6-step		12-step	
	MAE	Theil U	MAE	Theil U	MAE	Theil U
ΔCPI	1.96	0.91	1.99	0.87	1.99	0.83
ΔFAB	0.41	0.84	0.44	0.8	0.44	0.76
ΔBDI	0.4	0.81	0.43	0.77	0.43	0.73
ΔTWI	1.65	0.79	1.68	0.75	1.68	0.71
ΔGI	2.82	0.54	2.85	0.5	2.85	0.46
ΔREPIN	8.94	0.68	8.97	0.64	8.97	0.6

Note: MAE (Mean Absolute Error) has been annualized and reported in percentage points.

V. CONCLUSION

The projections of the IMF (data of July 2009) indicate that the global economy is beginning to recover from the economic recession but the recovery is expected to be sluggish. This enhances the projections that economic growth rates and inflation rates in most countries will remain relatively low due to the lower world demand caused by the global financial crisis. Over the past few months, the G-20

has played a central role in building a coordinated global strategy to confront the crisis and to set the agenda for international financial reform. Saudi Arabia has been a key part of that process. This study provides some useful insights by covering main issues leading to possible inflationary pressures by examining the ability of changes in Food and Beverages, changes in the Baltic Dry Index, changes in global inflation, changes in housing availability, and changes in the US Dollar trade-weighted index to improve inflation forecasts. Although all the previous study analyzing Granger

causation tests reported statistically significant effects on changes in the inflation rate, the magnitude of incremental predictive value was small. To allow for more than one-step ahead forecasts, VAR models were formed and results suggests an improvement in forecasting model by including the housing availability component (proxy for rent inflation), which forms the biggest cause of inflation. Future research would need a large sample size and further robust testing in terms of predicting inflation after accounting for major macroeconomic events.

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