# 4. MEASURING THE MACROECONOMIC IMPACTS OF FISCAL POLICY SHOCKS IN THE SAUDI ECONOMY: A MARKOV SWITCHING APPROACH

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## Abstract

*This study aims to highlight whether macroeconomic aggregates respond significantly to fiscal policy shocks for the Saudi economy from 1969 to 2015. Contrary to prior studies, our analysis opts for a recent and robust technical setting within the framework of multivariate two-state Markov switching models. The findings indicate that the model is well suited to deal accurately with switching behaviour of the cointegrated relationships due to international economic events. The impulse response analysis reveals that government spending changes have a significant impact on output, consumption, investment, and reserves, with varied reactions for the last two aggregates across regimes. The effects are persistent throughout the impulse response horizon, except for reserves over the second regime. In comparison with an analysis based on a single regime model, the results point to the importance of differentiating the impulse responses between two regimes in order to maximize the effectiveness of the fiscal policy. The findings could help policymakers to establish efficient economic decisions to boost the economy. Favourable economic repercussions may result from an effective policy coordination in decision making.*

**Keywords:** fiscal policy; Markov switching; regime-shifts; vector error correction; impulse response analysis; Saudi Arabia

**JEL Classification:** C32; E20; E32; E62

## 1. Introduction

In the current economic literature, there are no consensual conclusions about the macroeconomic effects of fiscal policy shocks.[2] Within this context, Afonso and Sousa (2012)

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[2] *Various conclusions are drawn from previous studies anchoring on the classical and Keynesian thought schools. The classical position stipulates that private investment is completely crowded out by government spending, and that the latter does not affect the economy. However, the*

show evidence of varied impacts of fiscal policy shocks on different economic aggregates across four developed countries. Agnello *et al.* (2013) find that the reaction of private spending to discretionary fiscal policy changes depends on regions, income groups, and countries' economic features, such as openness to international trade, country size and economic development level. Jooste *et al.* (2013) reveal that for South Africa, government expenditures positively affect the output over the short-run and do not exert any impact over the long-run. Moreover, the output responds significantly (but negatively) to taxes increases in the short-run, and the impacts are negligible in the long-run.

Other studies provide evidence of significant responses of major macroeconomic aggregates to fiscal policy (spending and tax) shocks, but they have not resulted in robust conclusions as to the choice of the most effective component of fiscal policy in stabilizing the economy (Abbas *et al*., 2011; Romer and Romer, 2010; Ocran, 2011; Afonso and Sousa, 2012; and Jooste *et al*., 2013). Akanbi (2013) attempts to bring a more appealing discussion in this context by analyzing the macroeconomic impacts of fiscal policy changes for South Africa. The results show more effective fiscal policy actions coming from government expenditure changes in the context of no structural supply constraints in the economy. However, there is evidence of more effective tax revenue changes under major structural supply constraints in the economy.

In another strand of the literature, Hong and Li (2015) examine how fiscal policies alleviate the effects of the 2008 global financial turmoil on Taiwan's economy. They reveal that the outcomes of the fiscal policies based on the public work investment and the consumption vouchers are narrowly related to the industry structure of Taiwan. They conclude that these fiscal policies could transform effectively the Taiwan's economic system in the long-run. Hur and Lee (2017) reveal that for South Korea reductions in GDP and government debt by 3% and 1%, respectively, would have been achieved between 2009 and 2015 if decision-makers had not opted for expansionary fiscal measures. Jawadi *et al.* (2016) provide evidence of an accommodative stance between fiscal and monetary policies when assessing their effects on macroeconomic aggregates for the BRICS economies. More recently, Cavalcanti *et al.* (2018) outline that for Brazil the extent of GDP losses following a monetary policy shock varies according to the fiscal adjustment adopted. Specifically, the performance of the economy deteriorates in case of public investment cuts-based fiscal adjustment.

The current study contributes to the existing debate on how fiscal policy shocks spread to macroeconomic aggregates by focusing on Saudi Arabia. We use government spending as a measure of the fiscal policy instrument, since Saudi Arabia does not rely on taxes in its economy over the study period. Saudi Arabia is currently trying to diversify the economy in order to reduce its dependence on oil revenues and create permanent sources of income, which is the most important goal of the 2030 Vision. In this context, the government has imposed a value added tax (VAT) of 5% starting from 1 January 2018 in addition to encouraging investments, privatizing some assets, and activating tourism through the developement of tourism areas.

The empirical evidence from the Saudi economy is attractive for some reasons. First, the Saudi economy depends largely on oil exports. Therefore, changes in oil export revenues would affect government spending that is largely financed through these revenues. This explains why we should pay more attention to fiscal policy shocks and their impact on

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*Keynesian position supports that the economy can be stabilized in the short-run by fiscal policy actions. Galí* et al. *(2007), Afonso and Sousa (2012), Unal (2015), and Cavallari and Romano (2017) attempted to identify the 'crowding out' effect for the private sector.*

macroeconomic aggregates. Second, the public debates on government spending and its implications on the whole economy, especially recently due to the oil price falls, favor the analysis of the reactions of macroeconomic variables to fiscal policy shocks. Third, is government spending as a measure of the fiscal policy instrument for a strong frontier market economy, such as Saudi Arabia, that relies heavily on oil exports an influential and effective macroeconomic stabilization tool? Lastly, given the numerous studies in the field, no attention has been paid to fiscal policy in Saudi Arabia, despite its important role for the economy.

To conduct the empirical analysis, we innovate by using the Markov Switching Vector Error Correction (MS-VEC) model recently developed by Balcilar *et al.* (2015).[3] The approach is well-suited to model the changing responses of macroeconomic variables to fiscal policy shocks through changes in coefficients across regimes. We believe that, despite the occurrence of several influential international events affecting the Saudi economy over the past decades, the MS-VEC model with two regimes could represent these events and, thus, provide a good characterization of the data. The impulse response functions drawn from the estimation of the model are used to show how a given fiscal policy shock spreads to all macroeconomic aggregates. These functions incorporate the regime history into the spread period to determine the differences in the dynamic responses of the variables to fiscal policy shocks across the economy states (low and high growth) by generating the appropriate impulse responses for each regime. Under these conditions, standard impulse response functions based on single regime VEC model are likely to provide sorely fallacious conclusions, as they are due to Gaussian innovations, even though other shocks may affect the variables (Krolzig *et al*., 2002).

More specifically, we examine the impacts of fiscal policy shocks on major macroeconiomic aggregates for Saudi Arabia, namely Gross Domestic Product (GDP), investment, consumption, and total reserves over the period 1969-2015. The additional value from incorporating total reserves into the model lies in its importance for the Saudi economy by dint of oil price revenues.[4] Considering a fairly large number of variables could help avoid biased empirical findings, thus leading to reliable conclusions. We assess the persistence of the macroeconomic effects of fiscal policy shocks and highlight whether they are similar or exhibit asymmetry across aggregates and states and relative to the linear VEC model.

The empirical results point to the suitability of the two-regime MS-VEC model to examine cointegrated relationships for the Saudi economy in order to measure the macroeconomic impacts of fiscal policy shocks. The model clearly detects the switches of the two regimes that are found to be closely linked to influential international events, with an asymmetry in their persistence across regimes. The state-dependent impulse analysis shows that economic activity (consumption) reacts positively (negatively) and persistently to fiscal policy shocks. The responses of investment are mixed across regimes. For reserves, the effect is positive over the first regime, but it becomes mixed over the second regime. The macroeconomic effects of government spending changes are persistent for all variables, except for reserves over the second regime. Finally, the study shows evidence of asymmetric results across linear and nonlinear models, and reveals that the impulse responses are

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*[3] The MS-VEC model, apart from it has not previously been used to analyze the sensitivity of macroeconomic aggregates to fiscal policy shocks is a robust technical setting that may provide pertinent results for this strand of macroeconomic modeling.*

*[4] Saudi authorities turned to reserves to cover their spending and thus achieve budget balancing in recent years, as government revenues have decreased due to oil price falls.*

amplified when opting for a two-regime MS-VEC model rather than a single regime VEC model. These conclusions outline the importance of conditioning the macroeconomic relationships on two states, with a view to avoiding problematic results and maximizing the effectiveness of the fiscal policy, especially for the economic activity. The findings may offer worthy economic insights and could be useful not only for Saudi policymakers to formulate effective economic decisions in order to stimulate the economy, but for all Gulf decision-makers given that Gulf countries share common economic characteristics.

The rest of the study unfolds as follows. Section 2 presents the two-state MS-VEC model used in the study. Section 3 describes the data, and discusses the empirical findings. Lastly, concluding comments and policy recommendations are provided in Section 4.

## 2. Econometric Methodology

Hansen (2001) and Perron (2006) suggest that econometric applications should clearly account for structural changes, given that influential international events affect the macroeconomic time series. Various econometric models in the literature have addressed several forms of structural breaks. One of the most attractive approaches is the Markov switching method that was adopted by Krolzig (1997, 1999) for Vector Auto-Regressive (VAR) and VEC models. MS models are found to fit well time series with influential structural changes and business cycles (Filardo and Gordon, 1998; Psaradakis *et al*., 2004; Balcilar *et al*., 2015; among others).

We opt for the MS-VEC model, developed by Balcilar *et al.* (2015), to capture the dynamic features of cointegrated relationships by allowing coefficients to be time-varying, with a view to obtaining economically intuitive results. The model structure is inspired by the model specification for multiple time series considered by Krolzig (1997, 1999) and Krolzig et al. (2002). Practically, we consider the following system:

$$\begin{cases} \Delta Y_t = C_{S_t} + \sum_{k=1}^{p-1} \Phi_{S_t}^{k} \Delta Y_{t-k} + \Pi_{S_t} Y_{t-1} + u_t, \quad t = 1,2,\ldots,T \\ u_t \big| S_t \to N\left(0, \Omega_{S_t}\right) \end{cases} \tag{1}$$

where: $Y_t$ is a vector of endogenous variables that are assumed to be non-stationary and cointegrated, $p$ is the order of the model, which is selected using the Bayesian Information Criterion (BIC) based on a linear VAR( $p$ ) model in levels, $C_{S_t}$ is a vector of intercepts, $\Phi_{S_t}^{k}$ is a matrix of short-run adjustment parameters, $\Omega_{S_t}$ is a positive definite error covariance matrix, $\Pi_{S_t}$ is defined as $\Pi_{S_t} = \alpha_{S_t}\beta'$, with $\beta$ the $(n\times r)$ matrix of long-run coefficients and $\alpha_{S_t}$ the $(n\times r)$ matrix of adjustment speeds to the long-run equilibrium ( $r$ is the number of cointegrating equations). As seen, except of $\beta$ that is constant across regimes, all model coefficients, including the covariance matrix, are state-dependent. The latent state variable $S_t$ follows a Markov process with two regimes, where the transition probability matrix is given by

$$P = \begin{pmatrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{pmatrix}, \quad \sum_{j=1}^{2} p_{ij} = 1 \quad \forall i \in \{1,2\} \tag{2}$$

with $p_{ij} = \Pr[S_t = j | S_{t-1} = i, \Im_{t-1}]$ the probability of being in state $j$ at time $t$, given that the economy was in state $i$ at time $(t-1)$, and $\Im_t = \{Y_\tau | \tau = t, t-1, \ldots, 1-p\}$ an information set.

A two-step procedure is used to estimate the MS-VEC model as suggested by Krolzig (1997) and Krolzig *et al.* (2002). First, the Johansen (1988) method is used to determine the number of long-run relationships[5] and thus the equilibrium errors. Second, these predetermined equilibrium errors are used to estimate the MS-VEC model. The maximum likelihood (ML) procedure, the expectation maximization (EM) algorithm, and the Bayesian Markov-Chain Monte Carlo (MCMC) integration method based on the Gibbs sampling are commonly used to estimate the model coefficients.[6] The Bayesian MCMC method used here to estimate the model provides asymptotically normally distributed estimators and, thus, the usual statistical inference can be applied (Krolzig, 1997; Saikkonen and Luukkonen, 1997; and Krolzig *et al.*, 2002).

We can calculate the regime-dependent impulse response functions (RDIRFs) to examine the propagation of a shock to a variable to the other variables over time by integrating the regime history into the spread period (Ehrmann *et al.*, 2003) as follows:

$$\psi_{ki,h} = \frac{\partial E_t Y_{t+h}}{\partial \varepsilon_{k,t}} \Big|_{S_t = \cdots = S_{t+h} = i}, \qquad h \geq 0 \tag{3}$$

where: $\varepsilon_{k,t}$ is the structural shock to the $k^{th}$ variable. The identification problem raises, as the reduced-form shocks $u_t$ are correlated across the equations of the system, and $u_{k,t}$ does not correspond to $\varepsilon_{k,t}$. One possible solution is to identify the structural shocks according to the recursive identification scheme (Sims, 1980) based on the Cholesky decomposition of the covariance matrix as $\Omega_{S_t} = L_{S_t} L'_{S_t}$. Thus, the structural shocks are identified as $\varepsilon_t = F_{S_t}^{-1} u_t$ with $F_{S_t} = L_{S_t}$. The RDIRFs are then used to highlight whether the impulse responses vary across regimes and thus depend on the economy state (turmoil, recovery, etc.). Confidence bands for the RDIRFs are calculated by the MCMC integration method of Gibbs sampling (Balcilar *et al.*, 2015).

# 3. Data and Empirical Analysis

### *3.1 Data and Descriptive Analysis*

Quarterly or annual data may mask intrinsic features of the variables and lead to non-meaningful results as the sample size will be small. In this study, we use monthly data for Saudi Arabia from December 1969 through December 2015 (yielding 553 observations) in order to accurately examine the reactions of macroeconomic aggregates to fiscal policy

[5] *Saikkonen and Luukkonen (1997) affirm that the presence of regime switching does not affect the consistency of the cointegrating vectors estimated by the Johansen procedure.*

[6] *The ML and EM approaches experience slow convergence and usually fail for some models where the full vector of likelihoods cannot be computed for each state for each period. However, the MCMC procedure avoids these problems by considering only one sample path for all states rather than a weighted average of sample paths over all states (Fruhwirth-Schnatter, 2008; and Balcilar* et al., *2015).*

shocks, given the sufficient information contained in the data. The sample period is a period of much change, as it records the occurrence of many notable domestic and international events, such as inter alia the OPEC oil price shocks, the 1997 Asian financial crisis, the World Trade Center attacks, the 2007-2009 global stock market crash, the increased global economic uncertainty in 2011, the unrests in 2012 and early 2013, and the sharp declines in oil prices since late 2014. Under these conditions, the MS-VEC model may be a promising specification to represent these events when investigating the macroeconomic effects of fiscal policy changes.

The variables incorporated into the MS-VEC model are as follows: 1) government spending (GS), which is measured by the general government final consumption expenditure and considered as the fiscal policy instrument; 2) GDP, which represents the economic activity and business cycle; 3) investment (IVT), which is proxied by the gross fixed capital formation as a percentage of GDP; 4) consumption (CSP), which corresponds to the final consumption expenditure; and 5) total reserves (TR), which is an important aggregate for the Saudi economy.[7] The variables are transformed into natural logarithm, and data is sourced from the World Bank. Some results and graphs are not shown to save space, but are available upon request from the author.

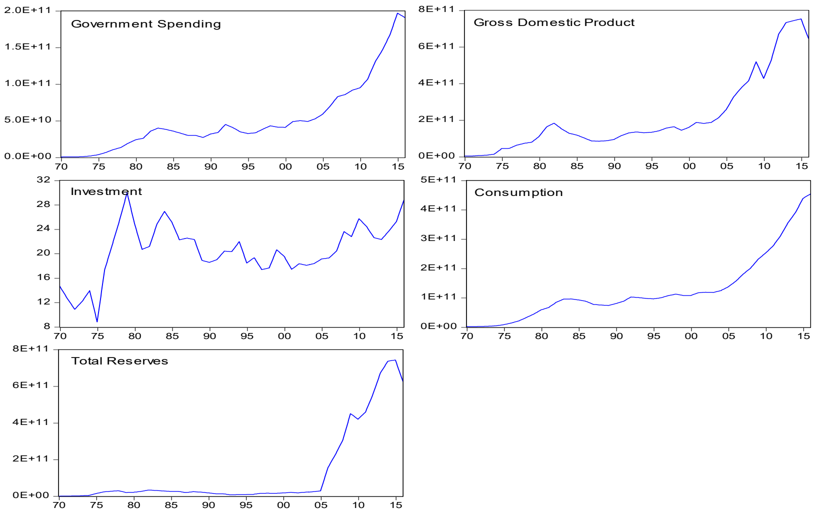
The macroeconomic aggregates are graphed in Figure 1.[8] At first sight, there is evidence of similar and strong trends in government spending, GDP, and consumption, thus suggesting increases in their values that have expanded from 2005. Investment exhibits some business cycle fluctuations, with noticeable increases throughout most of the study period. Total reserves record stable patterns until 2005, and increase strongly after that.

[7] *All macroeconomic aggregates are significantly and positively correlated with government spending (0.977 for GDP/GS; 0.497 for IVT/GS; 0.997 for CSP/GS; and 0.940 for TR/GS). These results provide an initial assessment of the nature of the linkages between variables, and are not, in any event, decisive regarding causality patterns.*

[8] *Government spending, GDP, and total reserves exhibit slight declines since late 2014 because of the oil price falls.*

**Figure 1**

**Patterns of the Macroeconomic Aggregates**




This graphical analysis could reveal potential regime-dependent linkages between the variables, as several events characterize the data, thus justifying recourse to the MS-VEC model to pick up the regime switching behavior of the macroeconomic relationships.

### *3.2 Unit Root and Cointegration Tests*

The MS-VEC model assumes that all variables are non-stationary and cointegrated. For this purpose, we first assess the non-stationarity properties of the aggregates by applying the unit root tests of Elliott et al. (1996) (ERS) and Narayan and Popp (2010) (NP).[9] Contrary to conventional unit root tests such as ADF and PP, the usefulness of the ERS test lies in its good power properties for trending series (Figure 1). The NP test is very useful in presence of breaks in the data compared to unit root tests without structural changes that suffer from power loss in this situation. It accounts for two unknown breaks in the level and in the level and slope of trending series under the null and alternative hypotheses.[10] Using specifications with intercept and with intercept and time trend, the ERS and NP test results reported in Table 1 indicate that all variables are integrated of order one, *I*(1), as their log levels are non-stationary and their logarithmic differences are stationary at the conventional levels. The break dates estimated when applying the NP test and provided in Table 2 are similar for the two specifications, thereby testifying the accuracy of the estimated break dates by the NP test. The detected dates may be related to important international events, such as the second oil price shock, the 1991 Gulf war, the 1997 Asian financial crisis, and other domestic events. These findings may confirm that econometric applications should clearly account for structural changes, as argued by Hansen (2001) and Perron (2006).

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*[9] The use of two tests aims to provide overwhelming evidence on non-stationarity of the variables.*

*[10] Narayan and Popp (2013) argue that the NP test has good properties in terms of size, power, and estimation of the break dates compared to other tests with two breaks.*

**Table 1**

## Unit Root Test Results

| Variable | ERS | | NP | |
|---|---|---|---|---|
| | Intercept | Trend | Level breaks | Level and slope breaks |
| GS | 682.058 (17)<br>1.482*** (4) | 164.471 (17)<br>4.629** (3) | -3.637 (1)<br>-4.065** (0) | -2.766 (1)<br>-4.432* (0) |
| GDP | 421.745 (17)<br>0.937*** (1) | 100.883 (17)<br>2.212*** (2) | -3.254 (1)<br>-5.526*** (0) | -3.486 (1)<br>-5.917*** (0) |
| IVT | 12.873 (16)<br>0.780*** (5) | 11.482 (16)<br>1.613*** (5) | -3.482 (1)<br>-5.873*** (0) | -3.428 (1)<br>-5.822*** (0) |
| CSP | 788.230 (18)<br>3.429* (11) | 178.721 (18)<br>6.846* (10) | -2.815 (1)<br>-3.932* (0) | -2.921 (1)<br>-4.594* (0) |
| TR | 173.391 (17)<br>0.432*** (1) | 48.171 (17)<br>1.555*** (1) | -2.769 (1)<br>-10.830*** (0) | -3.329 (1)<br>-10.570*** (0) |

Notes: *Top value: log levels of the variables; and bottom value: first differences of the log variables. The tests are constructed under the null hypothesis of unit root. For the ERS test, the optimal Bandwidth is selected by the Newey-West method using Bartlett kernel. For the NP test, the optimal lag length is selected by the technique proposed by Hall (1994). The optimal values are in parentheses. ***, ** and * denote stationarity at the 1%, 5% and 10% levels, respectively.*

**Table 2**

## Detection of Break Dates in the Variables

| Variable | Level breaks | | Level and slope breaks | |
|---|---|---|---|---|
| | Break 1 | Break 2 | Break 1 | Break 2 |
| GS | 1980:12 | 1991:12 | 1980:12 | 1991:12 |
| GDP | 1981:12 | 1998:12 | 1981:12 | 1998:12 |
| IVT | 1993:12 | 1994:12 | 1993:12 | 1994:12 |
| CSP | 1980:12 | 1991:12 | 1980:12 | 1991:12 |
| TR | 1992:12 | 2004:12 | 1992:12 | 2004:12 |

Given that all variables under study are $I(1)$, we proceed to a long-run analysis based on cointegration tests. As for unit root tests, we use two different procedures to provide overwhelming evidence on cointegrated relationships. First, we analyze the cointegration properties of the variables within the framework of a linear VAR model by applying the Johansen (1988) procedure to the VEC representation. The results shown in Table 3 indicate that the trace and maximum eigenvalue tests reveal cointegrated relationships between the macroeconomic variables at the conventional levels regardless of the specification. Second, the cointegration analysis is supported by the application of two tests recently developed by Perron and Rodríguez (2016), which are generalized least-squares (GLS) detrended versions of single-equation static regression. The tests are then applied to five single-equation static regressions in which we consider a given variable as endogenous and the others as exogenous.[11] The authors show, via Monte Carlo simulations, that the proposed tests provide important and stable gains in power over their ordinary least-squares (OLS) counterparts across various configurations. The results reported in Table 3 confirm the detection of long-run equilibrium relationships between the aggregates. Therefore, we can adopt the MS-VEC model to capture the dynamic features of the relationships in order to obtain economically intuitive findings as regards the reactions of GDP, investment, consumption, and total reserves to fiscal policy shocks.

**Table 3**

## Cointegration Test Results

| Johansen | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Trace statistic** | | | | **Maximum Eigenvalue statistic** | | | |
| **Null hypothesis** | Model 1 | Model 2 | Model 3 | **Null hypothesis** | Model 1 | Model 2 | Model 3 |
| r=0 vs. r>0 | 120.821*** | 116.763*** | 134.555*** | r=0 vs. r=1 | 58.442*** | 58.346*** | 60.336*** |
| r=1 vs. r>1 | 62.379*** | 58.418*** | 74.219*** | r=1 vs. r=2 | 28.166* | 27.017* | 30.330* |
| r=2 vs. r>2 | 34.213* | 31.400** | 43.889** | r=2 vs. r=3 | 22.258* | 19.915* | 20.599 |
| r=3 vs. r>3 | 11.955 | 11.485 | 23.290 | r=3 vs. r=4 | 9.375 | 9.267 | 16.400 |
| r=4 vs. r=5 | 2.580 | 2.218 | 6.889 | r=4 vs. r=5 | 2.580 | 2.218 | 6.889 |

| Perron-Rodríguez | | | | | | | |
|---|---|---|---|---|---|---|---|
| $MP_T$ **statistic** | | | | $MZ_t$ **statistic** | | | |
| **Dep. variable** | Model 1 | Model 2 | Model 3 | **Dep. variable** | Model 1 | Model 2 | Model 3 |
| GS | 10.995* | 11.654** | 10.793* | GS | -3.958* | -4.508** | -3.957* |
| GDP | 18.480 | 27.872 | 18.136 | GDP | -3.026 | -2.884 | -3.026 |
| IVT | 16.433 | 13.638* | 16.134 | IVT | -3.238 | -4.173* | -3.236 |
| CSP | 12.613 | 12.349** | 12.388 | CSP | -3.696 | -4.378* | -3.694 |
| TR | 35.867 | 36.230 | 35.221 | TR | -2.017 | -2.525 | -2.017 |

Notes: *For the Johansen tests, Model 1 stands for restricted constant and no deterministic trend, Model 2 stands for linear deterministic trend, and Model 3 stands for restricted linear deterministic trend. The optimal number of lags in the log level VAR model selected by BIC is 2. For the Perron-Rodríguez tests, Model 1 stands for constant in regression and non-trending data, Model 2 stands for constant and time trend in the regression (with or without trending data), and Model 3 stands for constant only in the regression with trending data (deterministic cointegration). ***, ** and * denote rejection of the null hypothesis at the 1%, 5% and 10% levels, respectively.*

### 3.3 The MS-VEC Model

The optimal lag length of the MS-VEC model selected by BIC in the VAR in levels is 2. For the Bayesian MCMC integration method, we consider 50000 posterior draws and 20000 burn-in draws. The model splits the sample into recession and expansion regimes based on switches in the mean growth rates of the variables. Notice that the sharp fluctuations in oil prices are one of the main reasons for the economic instability in Saudi Arabia. The economic cycles in Saudi Arabia are dependent on government spending, which in turn

[11] *The Perron-Rodríguez approach is simply an exercise to provide support for the cointegration between the variables, and does not compete with the Johansen procedure whose outcomes will be used when estimating the MS-VEC model, as documented in Section 2.*

leads both the boom and the recession. Indeed, when oil price increases, there is a sharp rise in government spending. However, in case of oil price falls, government spending decreases, thereby affecting negatively economic growth. In a similar study, Combes *et al.* (2017) provide evidence of nonlinear fiscal policy cyclicality for a set of 56 economies from 1990 to 2011 conditional upon public debt.

The transition probability matrix is given by

$$P = \begin{pmatrix} 0.908 & 0.092 \\ 0.397 & 0.603 \end{pmatrix}$$

These estimates point to the persistence of regime-shifts as $p_{ij} \neq p_{ii}$ for $i \neq j$, and that no regime is permanent as $p_{ii} \neq 1$ for all $i$. The probability of staying in the first (second) regime is 0.908 (0.603), implying an expected duration of 10.87 (2.52) months.[12] Therefore, the MS-VEC model provides evidence of asymmetric cycles. The ergodic probability (long-run average probability of the Markov process) of the first (second) regime is 0.817 (0.183), suggesting that the first (second) regime is expected to occur on 450 (101) occasions, that is, 81.7% (18.3%) of the time.

From the smoothed probabilities of the first regime (not shown), a noticeable feature is that almost all periods of the two regimes are clearly detected (probability equal to or near to unity). The great deal of dissimilarity across regimes emerges at the duration and persistence of these detected periods. Indeed, for the second state, most periods are very shorter lasting (they often last 1 month)[13] compared to those identified by the first regime, which are longer lasting (they often last 11 months). Most switches identified in the first regime are closely related to influential international economic events, such as inter alia the 1973 and 1979 oil shocks, the 20-year decline of oil price (during the 1980s and 1990s),[14] the 1997 and 2007-2009 financial crises, the World Trade Center attacks, the strong falls of oil prices since late 2014. Therefore, the two-state MS-VEC model is a good statistical representation of the macroeconomic relationships for the Saudi economy.

### 3.4 Impulse Response Functions

We examine the propagation of a unit standard deviation shock in the government spending (fiscal policy shock) to GDP, investment, consumption, and total reserves over time across regimes by analyzing the 1 to 20 step regime-dependent impulse response functions (Figures 2 and 3). We add the 95% confidence bands computed by the MCMC integration method with Gibbs sampling (50000 posterior draws and 20000 burn-in draws).

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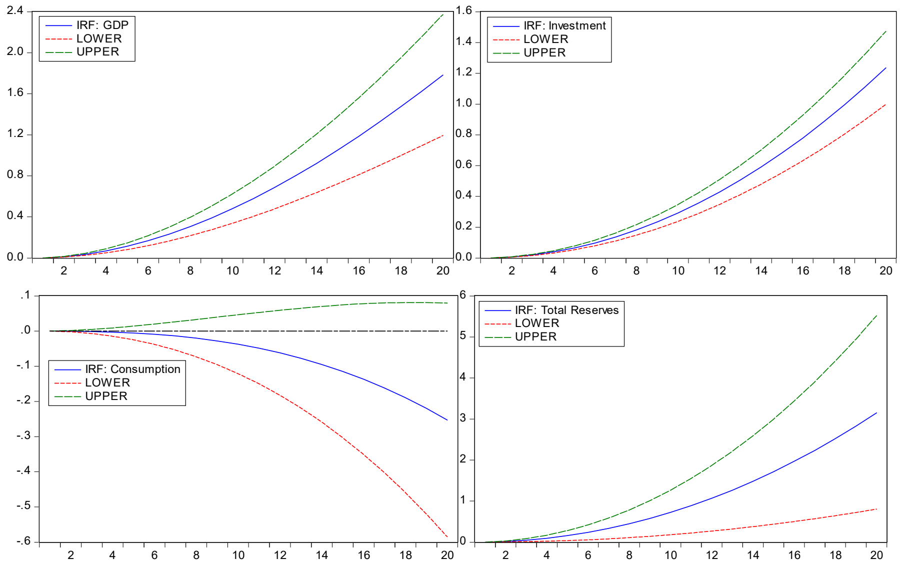
[12] *The expected durations of the first and second regimes are computed as* $1/(1-0.908)$ *and* $1/(1-0.603)$*, respectively.*

[13] *The few periods that are longer lived are 1971:1-1971:4, 1973:1-1973:9, 1974:1-1976:3, 1977:1-1978:1, and 2005:1-2006:1. The 1970s witnessed a boom in the Saudi economy due to higher oil revenues. This has prompted the government to adopt successive increases in its spending, thus accelerating GDP growth and increasing surpluses, which has enabled authorities to build up huge reserves. Saudi Arabia rarely recorded a deficit in its budget and a decline in its oil revenues during the 1970s.*

[14] *The 1980s and 1990s witnessed stagnation in the Saudi economy due to the declines in oil revenues, which has slowed the growth rates of some economic aggregates compared to the growth rates achieved in the 1970s.*

**Figure 2**

**Response of Variables to Fiscal Policy Shock in Regime 1**




Inspection of the graphs indicates that the responses of GDP to a unit impulse in government spending are significantly positive over both regimes. The expansionary impact is in accordance with the traditional 'Keynesian' model, and supports the outcomes of Blanchard and Perotti (2002) for the US, Beetsma and Giuliodori (2011) for EU countries, Afonso and Sousa (2012) for the UK and the US, Jooste *et al.* (2013) for South Africa, Ambriško *et al.* (2015) for the Czech economy, Fève and Pietrunti (2016) for Canada, the UK and the US, and Jawadi *et al.* (2016) for the BRICS zone. For investment, the reactions to a government spending shock are positive over the first regime, supporting the findings of Beetsma and Giuliodori (2011) for European Union (EU) economies, and Fève and Pietrunti (2016) for Canada, the UK and the US. However, there is evidence of a negative impact of government spending changes on investment over the second regime, which is aligned with the outcomes of Blanchard and Perotti (2002) for the US, and Afonso and Sousa (2012) for the UK and Germany. The impulse response analysis also reveals a significant negative reaction of consumption to the fiscal policy shock over both states, supporting the findings of Afonso and Sousa (2012) for Germany and Italy, and Fève and Pietrunti (2016) for Canada, the UK and the US. The impulse responses of total reserves to the fiscal policy shock are positive over the first regime and mixed over the second regime.

Results are in line with expectations, and a number of plausible economic explanations for the responses of the considered aggregates to government spending shocks exist. Indeed, the positive reactions of GDP and investment may be supported by the fact that oil price increases lead to higher oil revenues and thus a sharp rise in government spending, which leads to positive economic growth due to increases in output and investment. Saudi Arabia's reliance on oil revenues to finance government spending (current and capital expenditures) makes its budget vulnerable to instability because oil prices are unstable globally. In this context, the government cuts capital spending during some periods to maintain the level of current expenditures (wages, salaries, social expenses, etc.) which are difficult to reduce and usually increase permanently. All these factors explain the negative reactions of investment to changes in government spending over the second regime.

The negative reactions of consumption are because increases in government spending lead to inflationary effects on the Saudi economy. Therefore, ceteris paribus, consumption decreases. In this case, Saudi Arabian Monetary Authority (SAMA) must follow a balanced monetary policy to mitigate these inflationary effects in order to boost consumption and achieve macroeconomic stability.

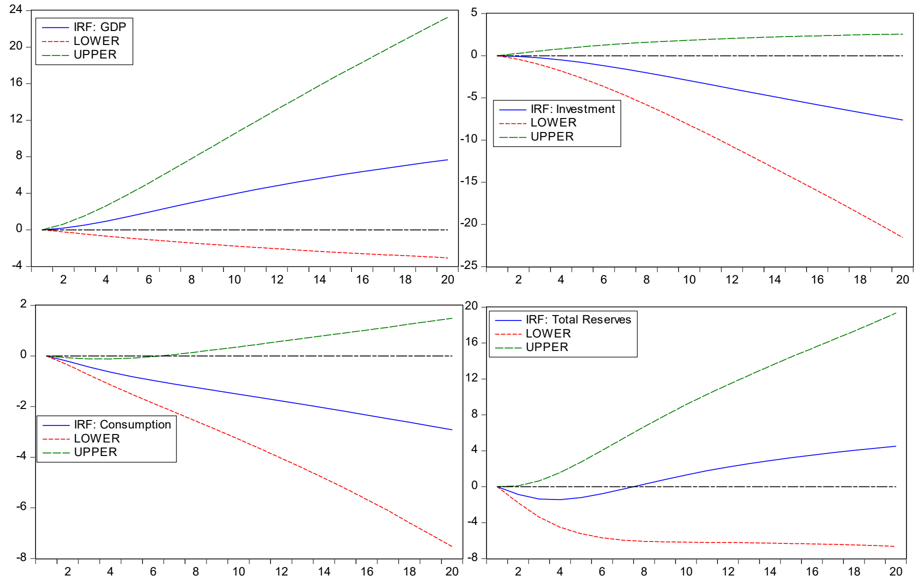
Increases in government spending coincide with the rise in total reserves in case of higher oil revenues, which supports the fact that oil is an important channel to explain the positive causal relationship between reserves and government spending. The negative reactions of reserves during the first periods of the second regime are due to transient declines in oil revenues, which makes the government maintains its level of spending at the expense of increased reserves.

The reactions of all aggregates to the government spending shock over the first regime are very persistent throughout the impulse response period. For the second regime, the impacts are persistent throughout the considered horizon for GDP, investment, and consumption, while for total reserves, the response is negative in the first months, but the effects are not persistent as they disappear after eight months and even become positive in the remaining months. The findings outline that the effects of the fiscal policy shock exhibit, in general, dissimilarity across the variables. A salient feature is that the speed of the propagation of a one standard deviation shock in the government spending to all macroeconomic aggregates over time proves faster in the contraction regime than in the expansion regime, as shown by the shape of the impulse response functions. However, the magnitude of the responses seems to be more important in expansion periods than in recession periods for all variables, thereby suggesting that fiscal policy proves more effective in expansion environment. Therefore, a 1% fiscal policy shock leads to a sizable impact on all aggregates in the second regime compared to the first regime.

To highlight the effects of ignoring nonlinear dynamics on the macroeconomic impacts of fiscal policy shocks, we compute the impulse response functions within the framework of a linear VEC model. When we do not condition on two regimes, the impulse response functions (not reported) reveal that the effects of the government spending shock on GDP, consumption, and total reserves are positive, with a peak at after nine months for the latter. In addition, there is evidence of a mixed response of investment to the fiscal policy shock, with a trough at after twelve months. The speed of the propagation of the fiscal policy shock to GDP and consumption over time is close to that of the second regime. However, it differs from that of the two regimes for investment and total reserves. In addition, the magnitude of the responses is weaker than that of the two regimes for all aggregates, thereby minimizing the effectiveness of the fiscal policy for the economic activity when opting for a single regime VEC model.

**Figure 3**

**Response of Variables to Fiscal Policy Shock in Regime 2**




In summary, the differences in the macroeconomic impacts of the fiscal policy shock and in the response magnitude (and thus fiscal policy effectiveness) across linear and nonlinear models reveal the noticeable effect of the Markov switching properties on the findings. Therefore, this points to the importance of differentiating the linkages between two regimes and thus generating regime-dependent impulse response functions to illustrate the susceptibility of the analysis to changing coefficients, as the linear model cannot reflect the global effects of both regimes, as documented by Balcilar *et al*. (2015). Moreover, compared to the VEC model, the MS-VEC model captures additional dynamic features, such as the asymmetric adjustment to the equilibrium, the asymmetric and history dependent response, etc. (Balcilar *et a*l., 2015). Within the same context, Krolzig *et al.* (2002) argue that compared to the linear models, the Markov switching models have appealing economic interpretations, as they capture accurately business cycle features.

To confirm the importance of conditioning the linkages on two regimes, the likelihood ratio test (Ang and Bekaert, 2002) is applied to test the null hypothesis of a single regime VEC model against the alternative hypothesis of a two-state MS-VEC model. The test favors the nonlinear VEC model (LR = 31795.686), even when invoking the Davies (1987) upper bound (*p*-values are equal to 0). Further, other model selection procedures (log-likelihood and information criteria) confirm this result.

## 4. Conclusion and Policy Implications

The study provides a thorough empirical analysis of the reactions of macroeconomic variables to fiscal policy shocks for the Saudi economy from 1969 to 2015 by employing a recently developed approach within the framework of Markov switching models for multiple time series. The procedure is a robust technical setting that can deal accurately with regime-shifts characterizing macroeconomic relationships due to influential international events, thereby leading to pertinent findings for the considered strand of macroeconomic modeling.

The empirical evidence reveals that the two-state MS-VEC model represents well the cointegrated macroeconomic relationships for Saudi Arabia over the study period. The estimation results point out that: *i*) the regime-shifts are persistent, and no state is permanent; *ii*) the first regime is found to be more persistent than the second regime; and *iii*) almost all switches in the two regimes are clearly detected, and most of them are closely attributed to major economic events, with an asymmetry in their persistence across states. The impulse response analysis indicates that fiscal policy shocks: *i*) have an expansionary and persistent impact on economic activity, which is in line with the predictions of the IS-LM model; *ii*) have a mixed effect on investment across regimes; *iii*) lead to a fall in consumption; and *iv*) affect positively total reserves over the first regime, but impacts become mixed over the second regime. The reactions of all variables to fiscal policy changes are persistent throughout the impulse response horizon, except those of total reserves that are not persistent for the second regime. Similar response analysis based on a linear VEC model reveals dissimilar results compared to those of the nonlinear VEC model. In particular, it is also found that the response magnitude is more important for all variables when estimating a two-state MS-VEC model rather than a single regime VEC model. These findings point to the importance of differentiating the linkages between two regimes in order to avoid problematic conclusions and maximize the effectiveness of the fiscal policy, especially for the economic activity.

From a policy perspective, we believe that the empirical findings are relevant and may offer worthy economic insights. This could help Saudi policymakers establish sound and judicious economic decisions to boost the economy by using the fiscal policy (government spending) as an important macroeconomic stabilization tool. The repercussions on the Saudi economy can be more beneficial in case of effective policy coordination between all stakeholders in decision making and the existence of control measures on government spending in order to raise its efficiency. Another way that could really be beneficial for the Saudi economy is the establishment and activation of sovereign wealth funds to collect the financial surpluses resulting from higher oil prices and benefiting from them in cases of lower prices that lead to fall government spending and thus negatively affect economic aggregates. Additionally, specialized government development funds are required to provide easy financing to boost investment by supporting vital sectors of the economy, thereby increasing production and economic growth. The study findings may also be useful for the other Gulf decision-makers given that Gulf countries share common economic characteristics.

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