



# Structural breaks and long memory in modeling and forecasting volatility of foreign exchange markets of oil exporters: The importance of scheduled and unscheduled news announcements

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## ABSTRACT

This paper analyzes the dual long memory properties of four major foreign exchange markets of the world oil exporter Saudi Arabia, using the ARFIMA–FIGARCH model under several global events. It discerns the impacts of both scheduled and unscheduled news announcements and structural changes on changing persistence. The results show little evidence of long memory in the conditional mean but provide strong support for long memory in conditional volatility for the four Saudi exchange rates versus major currencies. Moreover, scheduled news announcements have no significant impact on both expectations and volatility, while unscheduled news announcements demonstrate significant effects on the conditional volatility for all exchange rates. Furthermore, we detect at least five structural changes for the exchange rate with the yen and four for the rest of the exchange rates. The structural breaks seem to have greater impacts on changing persistence, and that the ARFIMA–FIGARCH model coupled with the dummy variables of the unscheduled news announcements and the structural changes is the most suitable for examining the long memory processes of these foreign exchange markets in in-sample. Finally, the out-of-sample forecasts provide mixed results and indicate that none of the specifications of the volatility model is appropriate for analyzing the LM dynamics in the Saudi Arabian exchange market. Overall, our results have implications for portfolio managers and policy makers in oil-producing countries.

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## 1. Introduction

Modeling together long memory (LM), structural breaks and news announcements has been an important focus area in the empirical economics and finance literature that deals with return and volatility persistence and correlations. A better understanding of the LM process is a key component of determining the optimal investment strategies and portfolio management because of its relevance to market efficiency.<sup>2</sup> The presence of LM in asset returns contradicts the validity of EMH because it

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<sup>2</sup> The efficient market hypothesis (EMH) in its weak-form suggests that the asset prices reflect all available information, implying the impossibility of generating abnormal returns. As a result, the return series should follow a random walk, meaning no benefits from forecasting returns, rendering future asset returns unpredictable.

means the existence of significant correlations between observations that are widely separated in time. Moreover, evidence of the LM in volatility implies volatility persistence, which suggests that uncertainty is an important determinant of the behavior of exchange rates. Thus, this stylized fact is important to investors and forecasters but the literature has not reached a consensus on how to examine it, particularly when it is related to emerging and frontier markets such as those of the oil-exporting countries which will be the focus of this study. Still, the literature recognizes this fact and has used several methods such as the rescaled range (R/S), the modified R/S test, the Geweke and Porter-Hudak (GPH) method, the Gaussian semi parametric (GSP) approach and the exact maximum likelihood (EML) method, among others to test the long-memory hypothesis.

The most recognized model used to examine LM in the conditional mean is the fractional integrated autoregressive moving average (ARFIMA) model. However, since the pioneering work of *Bollerslev (1986)*, the GARCH-family processes become the most popular specifications that capture stylized facts including persistence and volatility clustering, among others. In these processes, the analysis of LM has been extended from focusing on persistence in the conditional mean to also examining persistence in the conditional volatility of financial time series. Newer specifications of these processes such as the fractionally integrated GARCH (FIGARCH) class models pay special attention to the LM property because this stylized fact is an important distributional feature of financial variables like the ones indicated above. Previous studies on this topic examine the LM process in mean and in variance separately, while shocks that occur in the markets affect both the conditional mean and the conditional variance. To overcome this shortcoming, the joint ARFIMA–FIGARCH model provides the useful way and the ability of capturing the dual LM in mean and variance in financial time-series. On the other hand, ignoring structural changes begets spurious LM effects in the data. That is, large variance persistence large variance persistence as in the Integrated GARCH (IGARCH) may be induced by the failure to identify sudden changes.

When the LM property is prevalent after adjusting for sudden changes and news announcements, then the evidence supports the hypothesis that structural changes and news announcements are not linked to the assessment of the LM property in the volatility of the exchange markets under investigation, suggesting that the LM property is an inherent characteristic of the market under consideration. The foreign exchange market of Saudi Arabia is a good candidate to examine this hypothesis. The kingdom's foreign exchange reserves depend overwhelmingly on oil revenues which are affected by announcements from OPEC and structural breaks in the world markets. Moreover, the Saudi Arabian riyal exchange rate (SAR) is pegged to the U.S. dollar but not to other major currencies like euro, yen and British pound. The Saudi Forex market has experienced many episodes of upheavals that led then to devaluations of the riyal. Nevertheless, the riyal has been fixed against the dollar at SR3.75:\$1 since 1986, but has appreciated/depreciated against other major floating currencies. The riyal's devaluation at that time was particularly due to lower global oil prices, widening Saudi budget imbalances, falling Saudi foreign exchange reserves and a deteriorating Saudi balance of payments. In addition, the devaluation of the riyal continues in 1997 after the total collapse of some East Asian currencies and the collapse in oil prices.<sup>3</sup> With little room for maneuvering, the government took a number of measures to curb spending and raise revenues. In this case, the LM property should incorporate two important exogenous variables, the structural changes and macroeconomic news announcements for the foreign exchange markets under consideration. These news announcements may be divided into scheduled and unscheduled news announcements in order to take account of the potential asymmetric effects on modeling returns and volatility.

Only a few studies have focused on the impact of LM, structural breaks and announcements on the exchange rate markets and those who have are related to developed markets, despite the sensitivity of exchange rate markets to new information. However, no studies have been devoted to the LM and structural changes in the exchange market of Saudi Arabia or any other oil-exporting countries. It will be interesting herein to investigate if the exchange rate markets of major oil exporting countries exhibit such characteristics. This subject should be interesting since oil prices are sensitive to OPEC announcements and have been subjected to major disruptions because of global events. Oil prices are also priced in U.S. dollars and pegged to the greenback. It will also be helpful if this investigation on the link with the dollar exchange rate is done in comparison with the behavior of the exchange rates of other major currencies. The broad objective of this paper aims to use the ARFIMA–FIGARCH model to examine the LM properties in returns and volatilities of the exchange rates of the world's largest oil exporter, Saudi Arabia. More importantly, we employ this model to test the impact and the magnitude of scheduled (including OPEC interventions) and unscheduled news announcements on the persistence of the Saudi exchange rates with respect to the U.S. dollar and other major currencies. Saudi Arabia is not only the largest-oil exporter and the leading member in OPEC but also a frontier economy that pegs its currency to the dollar but not to the euro, the British pound and the yen. Moreover, we examine the potential effects of the presence of LM, news announcements (scheduled news such measured by OPEC announcements, and unscheduled news announcements of major events) and structural breaks on persistence of Saudi exchange rates. The structural breaks will be detected by using the Iterated Cumulative Sum of Squares (ICSS) algorithm.

In this study, we find significant effects of unscheduled news announcements on the conditional volatility of the daily Saudi Arabian exchange rates, while scheduled news announcements have no significant effect on both the conditional mean and the variance of SAR. The ARFIMA–FIGARCH model with dummy variables for unscheduled news and structural breaks is the most suitable for analyzing the LM processes in those foreign exchange markets. Finally, using four symmetric forecasting error statistics, the out-of-sample analysis provides mixed results and indicates that none of the volatility model specifications is appropriate for analyzing the LM dynamics in the SAR exchange market.

This research differs from previous studies in at least four aspects. First, a vast amount of empirical works have assessed the long memory in the first and second moments independently in stock and energy markets, while few studies focus on the dual long memory in the foreign exchange markets, particularly for the oil-exporting countries. This study essentially examines the

<sup>3</sup> The reader can visit <http://www.sama.gov.sa> for further information.

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