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Uncovered Interest Parity and Adjustments in the Money Market: The Case of the Kingdom of Saudi Arabia

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Abstract. This paper investigates the relationship between short-term interest rates in the Kingdom of Saudi Arabia and the Dollar interest rate, which closely follows the Eurodollar rate in international markets. The issue is important for understanding the determination of interest rates in a local economy; whether they are determined according to forces in the money market or via a simple reaction function perhaps dependent on an interest parity condition. The issue also has some bearing on the adjustments undertaken in the local money market whether they tend to fall on money supply or money demand. The paper initially considers Granger causality tests to determine the direction of causation between the two variables and then extends the analysis by incorporating a full-fledged interest rate parity relationship. Results, however, indicate that the determination of local interest rates might be in accordance with a simple reaction mechanism. Since interest rates are exogenously determined and the money supply appears to be sTable, the bulk of adjustments in local money markets would tend to fall on the money demand function.

Introduction

The question of the determination of domestic interest rates and their linkages to world markets is important for the study of international interest rate market integration and for understanding the adjustments in the domestic money markets to outside shocks and disequilibria. But surprisingly there are a lot of conflicting results in the area. Early studies undertaken with respect to the linkages between US and Eurodollar interest rates found that the US market is relatively insulated from the influence of European markets [1,2]; *inter alia*). Other studies determined that causality runs from the Eurodollar market to US domestic markets [3]; Cumby and Mishkin [4]; Duffy and Giddy [5]; Aliber [6]; Thornton [7]. Recently, the bulk of evidence tended to support that causality runs from the domestic US market to the Eurodollar market with some important

feed backs in interest rate transmission mechanisms (Hartman [8]; Swanson [9]). Instabilities and structural breaks were also investigated and found to reverse the causalities operating in these markets over some time periods (Chan and Lee [10]). The absence of instantaneous adjustments in the respective markets would imply the existence of market imperfections and/or transactions costs that prevent adjustment. These imperfections would generally differ between markets being sometimes domestic and in others foreign (Thornton [7]).

In this paper we try to test the factors governing the determination of domestic interest rates in the Kingdom of Saudi Arabia (KSA). The economy of KSA is a highly open one. Studies pertaining to model the money markets of KSA generally hold that domestic rates are determined within a money market equilibrium context (Ghamdi [11], *inter alia*...). A plausible alternative is to hold that domestic rates are determined by a certain reaction function to movements in foreign rates and on expectations of exchange rate movements, i.e. to follow an uncovered interest parity (UIP) condition. This in turn has certain implications for the nature of the adjustments in the domestic money market whether they fall on money supply or are wholly borne by money demand. Money supply was largely passive in KSA as seen from Table 1 which shows the standard deviation (std. dev.) of money supply as measured by M1 in millions of Saudi Riyals (SR):

Table 1. Variability of money supply 1988:7 1996:3

Period	Std. dev.
1988:07-1988:12	1680.481
1989:01-1989:12	2225.027
1990:01-1990:12	2531.769
1991:01-1991:12	4468.776
1992:01-1992:12	3021.154
1993:01-1993:12	5398.060
1994:01-1994:12	2038.522
1995:01-1995:12	3204.294
1996:01-1996:03	1119.964

The standard deviation fluctuated over a narrow band during the sample period 1988:7 -1996:3 in an indication of some passive monetary policy over the period. The implications for the KSA money market are that adjustments were mainly on the money demand side. A conventional money demand function (Crockett [12]; Darrat [13,14]; Metwally and Abdel-Rahman [15]; Presely and Westaway [16]) plus the interest parity reaction function would then suffice to model the money market.

The first section of the paper discusses issues pertaining to the model, the data and the general methodology followed in the paper. Section 2 then deals with preliminary variable and data issues pertaining to causality and stationarity and reports on the various empirical findings related to these issues. A final section then concludes the study.

The Model, Data and Methodology

The UIP condition holds that a domestic interest rate equals the foreign interest rate minus the expected depreciation of the domestic currency. This is represented as follows:

$$i = i^f + \frac{\varepsilon^e_{t+1} - \varepsilon_t}{\varepsilon_t}$$

where:

- i the domestic interest rate
- i^f the foreign interest rate
- ε the exchange rate
- ε^e_{t+1} the expected exchange rate.

Since the UIP hypothesis addresses the connection between the domestic interest rate and the foreign one, we use these two as the basic variables in the tests. As a measure of the local rate we use the KSA nominal three-month interest rate on the Saudi Riyal (SR) deposits (sint) whereas the measure used for the foreign rate is the dollar interest rate (dint). The dollar interest rate closely follows the Eurodollar interest rate ruling in international markets. Other variables included are the nominal effective exchange rate (er) as a measure of the exchange rated used to construct the measure for expected depreciation of the currency.

Monthly Data on local and dollar interest rates were obtained from Saudi Arabian Monetary Agency (SAMA)[1] sources. Data on the nominal effective exchange rate to supplement the interest rate parity condition were obtained from various issues of the *International Monetary Fund (IMF), International Financial Statistics (IFS)*. The period of study extends over 1988:6 to 1996:3. This was determined by availability since data on the relevant variables were not available on monthly basis prior to 1988:6.

The Empirical Results

i) Causality

The UIP condition assumes that causality runs primarily from foreign interest rates variations to local interest rates. However, as is generally known the issue remains an empirical one. To gauge this issue we employ Granger testing procedures to ascertain the direction of causality between the domestic (sint) rate on the one hand and the foreign (dint) one on the other. Results are given in Table 2.

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[1] SAMA is the central bank of the Kingdom of Saudi Arabia.

Table 2. Granger causality

Hypothesis	F-statistics	P-value
d int $\mapsto$ sin t (2)**	13.572	0.000
sin t $\mapsto$ d int (2)	2.087	0.130

* Numbers in brackets are the time lags used in the testing procedures.
** $\mapsto$ Doesn't Granger cause.

As can be seen from the Table, the hypotheses that the dollar interest rate does not Granger-cause the Saudi Riyal interest rate is rejected while that the Saudi Riyal interest rate does not Granger-cause the dollar rate is not.

ii) Conventional regression results

To construct the series for the expected currency movements(depr) we obtained firstly expectations on the exchange rate from the fitted values of the following Box-Jenkins ARIMA(1,1,2) model:

$$\Delta er_t = \underset{(-2.110)}{-\ 0.113} + \underset{(3.995)}{0.572}\ \Delta er_{t-1} + \hat{v}_t - \underset{(-4.375)}{0.509}\ \Delta\hat{v}_{t-1} - \underset{(-5.041)}{0.444}\ \hat{v}_{t-2}$$

$$R^2 = 0.195 \qquad \hat{\sigma} = 1.526 \qquad d = 1.714 \tag{1}$$

where R^2 is the coefficient of determination, $\hat{\sigma}$ is the standard error of the regression, d is the Durbin-Watson statistic and figures in parentheses are t-ratios. These were then used to construct the expected depreciation term.

Preliminary regressions were then run on a static long-run UIP version of the hypothesis. The Ordinary Least Squares (OLS) estimated relationships using expectations generated from the above ARIMA were:

$$\underset{(3.311)\ (49.379)\quad (-1.007)}{\text{sin t} = 0.400 + 0.955\ \text{d int} - 2.747\ \text{depr}}$$

$$\bar{R}^2 = 0.964 \quad \hat{\sigma} = 0.392 \quad F = 1221.769 \quad d = 0.930 \qquad (0.00) \tag{2}$$

The statistical criteria obtained generally point to severe model inadequacies. The Durbin-Watson d statistic was less than the value of the coefficient of determination and thus pointed to the presence of severe serial correlation problems - possibly in reflection of the poor specification of the static version of the model.

In general thus, results for the static UIP version were far from satisfactory with rampant evidence of misspecification in functional form - this despite the fact that the

estimate of the parameter of interest on the foreign rate was significant and within the conjectured bounds.

As a first step towards remedying the situation we attempted to estimate a dynamic variant of the hypothesis. Results obtained via Instrumental Variables(IV)[2] estimation for this amended dynamic version were:

$$\begin{array}{l} \text{sin t} = \underset{(2.329)}{0.343} + \underset{(2.508)}{0.564}\ \text{d int} + \underset{(0.213)}{2.628}\ \text{depr} + \underset{(1.665)}{0.385}\ \text{sin t}_{t-1} \\ \\ \bar{R}^2 = 0.967 \qquad \hat{\sigma} = 0.357 \qquad F = \underset{(0.00)}{822.371} \qquad d = 1.634 \end{array} \tag{3}$$

The results improved somewhat. From the statistical point of view the h statistic indicated the absence of significant serial correlation effects. However, the coefficient of the lagged term was only significant at 10% level. Economically, the short-run UIP effect was of a magnitude of 0.564 whereas its long-run counterpart was equal to 0.917. To further investigate the specification of the UIP reaction function we embarked upon further dynamic analysis along the lines of the succeeding section.

iii) Stationarity and unit roots

Inspection of the graphs of the variables reveals that a potential characteristic for the variables used is non-stationarity. This further raises the possibility noted above of consequent spurious regressions.

The series were then formally checked for stationarity. We performed initially the Augmented Dickey-Fuller (ADF) on the levels and first differences (i.e. rates of growth) of the variables. Results are given in Table 3 below:

Table 3. The stationarity tests

Series	ADF	MacKinnon's 5% significance
Levels:		
sint	-1.384	-2.893
dint	-1.403	-2.893
er	-2.520	-2.894
depr	-5.947*	-2.894
First difference:		
sint	-6.668*	-2.894
dint	-4.792*	-2.894
er	-4.509*	-2.894

* Significant at 5% level.

[2] Logged variables of the regressors were used as instruments in this regression.

Accordingly, we can accept the hypothesis that the interest rates series plus the exchange rate are I(1) and hence their first difference is stationary at 5% level. The expected currency depreciation series on the other hand is I(0).

iv) Error corrections and co-integration

Since the variables are stationary after allowing for structural breaks, we proceeded to estimate dynamic short-run ECMs of the hypothesis. To gain insight into the nature of the lags - or leads - involved we obtained the Cross-Correlation Function (CCF) between (sint) and (dint). This revealed a significant relationship at the first lag and was in turn incorporated in the ECM. Results obtained were:

$$\underset{}{\Delta \text{sint}_t} = \underset{(0.145)}{0.005} + \underset{(7.825)}{1.151}\,\Delta \text{dint}_{t-1} - \underset{(-0.850)}{1.506}\,\Delta \text{depr}_{t-1} - \underset{(-5.354)}{0.494}\,e_{t-1}$$

$$R^2 = 0.475 \qquad \hat{\sigma} = 0.457 \qquad F = \underset{(0.000)}{25.964} \qquad d = 2.084$$

$$AIC = -2.166 \qquad SC = -2.055 \qquad (4)$$

Statistically, the ECM for domestic interest rates passes the usual tests for serial correlation and stability. The coefficient on the disequilibrium ECM is 0.494 in absolute value implying that almost half of any disequilibrium in any one-quarter is compensated for during the following quarter. This reflects a stable ECM, which eventually converges to its long-run path where adjustments are fully realized towards dollar interest rates over a period of two quarters. The coefficient on the lagged Δdint variable was 1.151 and represents the short-run elasticity while that on the lagged Δdepr was a negative 1.506. This latter one was, however, insignificant at 5% level mainly because of the fact that the exchange rate was largely stable during the sample period and hence there were no expectations held of a possible depreciation during the time period. The long-run elasticity could be derived from the disequilibrium ECM but we preferred to estimate it directly via the application of the Johansen co-integration procedure. For, the co-integrating relationship, which describes the long-run relationship between the series used, is a convenient framework in which to couch the UIP hypothesis. Subsequently, in what follows we deploy Johansen's procedure to discover and estimate the co-integrating relationship(s) connecting the different variables over the long run.

Johansen co-integration tests were conducted under the assumptions of the presence of a quadratic deterministic trend. Results are presented in Table 4.

Table 4. Johansen cointegration*

Eigenvalue	LR	5%	No. of CE(s).
0.234	40.320	34.55	None**
0.168	17.529	18.17	At most 1
0.020	1.733	3.74	At most 2

* LR is the Likelihood Ratio Test. no. of CE(s) is the number of cointegrating equations.

** Denotes rejection of the hypothesis at 5% significance level.

The result of the LR test indicates the presence of one cointegrating equation at the specified significance level. The normalized cointegrating equation was estimated as:

$$\underset{}{\text{sint}} = 0.037 + \underset{(0.029)}{0.973\,\text{dint}} - \underset{(7.376)}{10.000\,\text{depr}} + 0.0051$$

$$\text{Loglikelihood} = 371.304 \qquad (5)$$

where figures in brackets are standard errors. According to these estimates, domestic rates were long-run unit responsive to their dollar counterparts at conventional 5% level. The magnitude of the UIP coefficient was a 0.973. This compares to the short-run measure obtained previously from the ECM as 1.151. The depreciation term was not statistically significant due to the same reasons noticed in the preceding ECM formulation estimates. Thus the hypothesis is clearly validated over the long run.

To summarize results on this section, there is a marked similarity in behavior between the (sint) and (dint) variables, which reflected itself in similar short and long run responses. The UIP hypothesis is thus validated for the case of KSA. Models of the monetary sector of the Kingdom could thus comprise a money demand function and an UIP condition. Thus in view of the fact noticed above, monetary policy is extremely conservative in the Kingdom and the money supply is more or less resilient.

Conclusion

This paper investigated the relationship between short-term interest rates in the Kingdom of Saudi Arabia and the dollar interest rate. The issue is important for understanding the determination of interest rates in a local economy and for the study of adjustment mechanisms in the money market. Granger causality tests revealed that the direction of causation runs from the dollar rate to the domestic currency interest rate. Further results indicate that the determination of local interest rates might be in accordance with a simple reaction mechanism, which might incorporate currency expectations. Since interest rates are exogenously determined and the money supply appears to be stable, the bulk of adjustments in local money markets would tend to fall on the side of money demand in the case of KSA.

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تعادل الفائدة المنكشف وعمليات التصحيح فى أسواق النقود
(حالة المملكة العربية السعودية)

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ملخص البحث. تعالج هذه الدراسة العلاقة بين معدلات الفائدة المحلية قصيرة الأجل في المملكة العربية السعودية، ومعدلات الفائدة على الدولار الأمريكي، والتي تتبع معدلات فائدة اليورودولار في الأسواق العالمية، وذلك بصورة لصيقة. ويعتبر الأمر هاما لغرض استيعاب مسألة تحديد معدلات الفائدة في اقتصاد محلي، وما إذا كان ذلك يتم بناء على القوى التي تعمل في سوق النقود أو من خلال دالة رد فعل تعتمد على شرط تعادل الفائدة. ويترتب على الأمر بعض الأشياء المتعلقة بطبيعة التعديلات التي تجرى في سوق النقود المحلي، وبصفة خاصة ما إذا كانت تلك التعديلات تقع بصورة أساسية على جوانب العرض من أم الطلب على النقود. وتتناول الدراسة أولا سببية جرانجر بغرض تحديد اتجاه العلاقة التي تربط بين المتغيرين الأساسين، ومن ثم تعمم التحليل من خلال تضمينه لعلاقة تعادل معدل فائدة متكاملة. وتفيد النتائج المتحصل عليها أن تحديد معدلات الفائدة المحلية قد يكون تبعا لآلية رد فعل مبسطة. وبما أن معدلات الفائدة محددة خارجيا وعرض النقود يعد مستقرا، فإن معظم التعديلات التي تطرأ في سوق النقود المحلي ستقع على جانب طلب النقود.