Interest rate dynamics and speculative trading in a fixed exchange rate system

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Abstract

Recent evidence provided by Diebold, Gardeazabal, and Yilmaz (1994) for the post-1973 floating rate period points toward the predictive superiority of a martingale representation of exchange rate evolution over that of an error correction model that assumes rates are cointegrated. This is an appealing result from the perspective of efficient assimilation of randomly arriving information. As a direct extension of informational efficiency in a fixed exchange rate regime, I show that information is processed and assimilated through the medium of interest rates. Specifically, I demonstrate that interest rates cannot be represented as a cointegrated system, even when the central bank is willing to establish its determination and resolve to maintain the fixed rate rule over a sustained and prolonged period of time. Evidence provided in this paper is for the interest rate behavior of the Saudi Arabian Riyal with respect to the euridollar interest rate, the interest rate on the intervention currency. © 1999 Elsevier Science Inc. All rights reserved.

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1. Introduction

With the introduction of flexible exchange rates in 1973, a considerable amount of work has been done on examining the dynamic behavior of real and nominal interest rates, and of spot and forward exchange rates, by Meese and Singleton (1982), Meese and Rogoff (1983), Hakkio (1981), and Hansen and Hodrick (1980), among others. Preliminary evidence from Baillie and Bollerslev (1989) suggested that nominal exchange rates are cointegrated (at least for the major currencies in the developed economies), implying a linear equilibrium relationship across currencies. More recently however,
Diebold, Gardeazabal, and Yilmaz (1994), using the same data set, but employing more sophisticated statistical methods, reject the initial findings of Baillie and Bollerslev, showing that exchange rates cannot be viewed as a cointegrated system. This raises an interesting question: How is the intrinsic unpredictability in nominal exchange rates manifested under a fixed exchange rate policy? Clearly it must be the case that there is a translation from nominal exchange rates (held fixed) spilling over into interest rates, the non-cointegrability in exchange rates (if allowed to float) reflecting itself in the structure of interest rates across the currencies.

Fixed exchange rates are the exception rather than the rule, and yet a number of economies actively pursue a policy of fixed exchange rates, generally pegged to the US dollar. This has been particularly true of the foreign exchange “rich” OPEC countries, such as Saudi Arabia and the Gulf Cooperative Council (GCC) states in the Middle East. Loss of monetary control is a natural consequence of such a policy (Kimbrough, 1984), where domestic credit availability has to be matched with demand. Discretionary control is lost, as external deficits have to be matched by the sale of foreign exchange from government reserves, reducing high powered money stock. More importantly, arbitrage activity in a fixed exchange environment places more strain on the management of foreign reserves causing disruptions to system liquidity. As pointed out by Kimbrough (1984) monetary authorities have to offer to exchange money for bonds at a price equal to the domestic currency price of foreign bonds which is consistent with the spot rate rule. This is no more than an operational statement asserting that interest rates for equivalent investments must be equal across the two currencies. This places readily testable implications on the behavior of interest rates in such an environment.

Scant attention has been paid in the literature on the behavior of interest rates in such a pegged environment, especially with respect to the ability of the central bank to maintain its credibility and avoid speculative attacks on government stocks. In this paper, I look at the specific case of Saudi Arabia, in particular from the period of January 1988 to March 1994 (the period for which published data on short term interest rates are available). A credible policy of pegged exchange rates would imply a stable equilibrium relationship between the domestic interest rates (domestic cost of credit) and the interest rate in the intervention currency (the dollar interest rate). I examine whether short term rates in the two currencies can be modeled as a cointegrated system—a direct test of the effectiveness of the stated exchange rate policy—while speculative trading induced through expectations of currency realignment should destroy the equilibrium in interest rates across the two currencies. As long as market participants in each period assign a non zero probability (which could be time varying) to the realignment event, it should preclude a linear stationary representation of the system of interest rates. Probability evaluations will be strongly influenced by macroeconomic signals, in particular the balance of payments and the level of foreign exchange reserves required to defend the policy regime. A number of studies have examined exchange rate expectation processes in a flexible exchange rate system—notably, Dornbusch (1976), Frenkel and Froot (1987) and Genberg (1984)—identifying various macroeconomic variables that influence expectations.
The paper is organized as follows. Section 2 provides an overview of the exchange rate policy in Saudi Arabia and discusses the basis of the proposed tests. Section 3 presents the principal findings of the study; section 4 concludes.

2. Methodology

2.1. Issues

The international monetary system is characterized for the most part by a flexible market determined exchange rate system. However, within this larger framework, a number of significant economies choose to operate under a fixed exchange rate regime. The principal focus of this paper is to examine the implications for local interest rate dynamics in the context of the global floating rate structure. Specifically, I look at the experience of Saudi Arabia, the dominant oil related economy within OPEC. There is a unique set of economy-specific factors that have influenced the choice of a fixed rate pegging policy. In what follows, I provide a brief overview of the policy objectives and exchange rate history.

About 90% of foreign exchange earnings in Saudi Arabia are from receipts generated through international oil sales by the government. Since oil is priced and sold in dollars, foreign exchange earnings are unrelated to the domestic exchange rate policy. Although there is a trend toward expanding the domestic productive base, the country is heavily dependent on imports for practically all consumption and investment goods. Exchange rate policy thus primarily influences the domestic price level (devaluations causing imported inflation and vice versa) and to a lesser extent the level of price elastic imports. The emphasis of government policy therefore has been to pursue a stable pegged exchange rate program. Historically, the Saudi Riyal has been alternately fixed against the US dollar, or as in the mid 1970s, against the SDR when the US dollar experienced excessive volatility.

Over the period from 1970 to June 1986, there were a number of revaluations and devaluations. Government policy therefore was not transparent enough, occasional rumors of impending devaluations prompting speculative activity. More recently, declining oil revenues, declining reserves, and current account deficits have introduced an element of uncertainty in the central bank’s ability to hold the line on exchange rates. In spite of this economic background, there has been an extraordinarily prolonged period of exchange rate stability—the value of the Saudi Riyal (SR) has held firm at 3.75 SR/$ since July 1986, a period of nine years. While the central bank (SAMA) exercises considerable authority over commercial banks and can effectively “jaw-bone” banks to reduce their speculative dollar positions and limit bank participation in syndicated Riyal loans during periods of extreme pressure against the domestic currency, official policy has always been one of free convertibility. In addition, the development of the offshore Riyal market in Bahrain has encouraged financial arbitrage trading based on economic fundamentals. The interest rates for the Saudi Riyal used here, taken from the monthly data on interest rates in the offshore Gulf Currency market, are competitively determined by large banks, trading on relevant current information.
2.2. Interest rate dynamics

Interestingly enough, the relationship between interest rates can be inferred from the observed link in the spot versus future exchange rates. The relationship between the spot and futures (forward) prices, both in the securities and foreign exchange markets has been extensively studied in the literature. See, for example, Baillie and Bollerslev (1989) and Barnhart and Szakmary (1991), on the cointegration of spot and future exchange rates. Brenner and Kroner (1995) provide an excellent theoretical framework against which this body of empirical literature can be viewed.

Using the cost of carry relationship,

\[ \text{Ln} f_{it+k} = \text{Ln} S_t + k(r_d^{it} - r_f^{it+k}) \]

where \( S_t \) is the spot rate at time \( t \), \( f_{it+k} \) the future price at time \( t \) of a contract expiring at time \( t+k \), and \( r_d^{it} \) and \( r_f^{it+k} \) the domestic and foreign, \( k \) period interest rates at time \( t \). It can be seen that the spot and futures will be cointegrated if the interest rates are either stationary or if they share a common stochastic trend. The overwhelming empirical evidence shows the spot and future prices in the major currencies (Sterling, Deutsche Mark, Yen, Swiss Franc, Franc, Canadian dollar) to be cointegrated, implying a stationary representation of the interest differential. This is not surprising, as most of these studies have focused on the currencies of the major industrial economies, and as pointed out by Brenner and Kroner (1995), “the same sets of underlying economic forces likely drive interest rates in both countries.”

The focus of this paper however is to examine the structure of the relationship in the short term interest rates, in a fixed exchange rate regime and as in the current case where the two economies are very dissimilar—the US, which is the world’s largest industrial economy and Saudi Arabia, a small but important oil dependent economy. Thus there is little a priori reason to believe in a shared common stochastic trend in the two interest rates.

In an idealized world where the pegged exchange rate policy is fully credible, the domestic interest rate must match the interest in the intervention currency to preclude riskless arbitrage.

Specifically [Eq. (1)],

\[ e_{t+k} = e_t, \]  

(1)

The left hand side—the exchange rate to prevail at \( k \) time periods into the future—equals the fixed exchange rate at time \( t \). This implies that the \( k \) period interest differential in the two currencies must be identically zero. However, given the current information set \( \Phi_t \), agents will assign a non-zero probability to the set of events under which the central bank is unable to defend the current policy. Future expectations will therefore deviate from the current pegged rate:

\[ E_t (e_{t+k} | \Phi_t) = e_t (1 + \Sigma_i P_i d_i) \]

(2)

where \( P \) is a probability measure defined over a state space, each state identified with a policy \( i \), and \( d_i \) the proportional change in the pegged rate under policy \( i \). Speculative
trading induced by these expectations will now drive a wedge between the relative interest rates. As the parameters in the information set $\Phi$ are revised based on randomly arriving information, the relative interest rates could drift apart.

To see this more clearly combine now a version of the International Fisher Effect:

$$
\ln E(e_{t+k} \mid \Phi_t) = \ln(e_t) + k(r_{t+k}^d - r_{t+k}^f)
$$

(3)

From Eqs. (2) and (3), it can be seen that the expected future exchange could drift away from the spot exchange rate, inducing non-stationarity in the interest rate differential. To place this in context with the extant literature on cointegration in the Spot-Forward exchange rates, note that the observed cointegration in the Spot-Forward system in a floating rate regime is, as argued by Brenner and Kroner (1995), driven by a stationary interest rate differential. In the case of fixed exchange rates, however, the arrow of causality is reversed running from expectations about the future fixed rate rule to interest rates.

The dynamic properties of interest rates (and, by symmetry, bond prices) in general has received considerable attention in the literature, particularly in the area of contingent claim pricing. A variety of stochastic characterizations have been proposed, including those by Vaicek (1977), Brennan and Schwartz (1979) and Cox, Ingersoll, and Ross (1985). Spot rate processes need to take into account factors such as mean reversion and more importantly since zero coupon bonds have a fixed value at maturity, time dependent volatilities. In a recent development Heath, Jarrow and Morton (1992), propose a new methodology that models the forward rate process rather than the spot rate process itself, where a constant forward rate volatility is consistent with fixed par values for bonds. In keeping with this, tests conducted in this paper therefore use implied forward rates computed from the observed term structure of interest rates, rather than the level of interest rates.3

3. Statistical model

In the first stage of the analysis, I test for stationarity of the implied forward rate process obtained from the level of interest rates in each currency. Specifically I test whether the forward process $f_t$ has a stationary $I(1)$ (integrated of order 1) ARMA representation, implemented through a unit root test using the Augmented Dickey Fuller methodology for each of the two currencies indexed by $j$.

$$
D(f^j_t) = \alpha_0 + \alpha_1 f^{j-1}_t + \alpha_2 D(f^{j-1}_t) + \epsilon, \quad j = 1,2
$$

The presence of a unit root is implied by the coefficient on the lagged value of the series ($\alpha_1$) being zero.

In the second part of the analysis, I test whether the two forward rates, which may be independently non-stationary, can be viewed as a cointegrated system, equivalently, examining whether there exists a linear combination of the two series which is stationary. If the central bank policy is credible, one should expect to find a stable relationship between the two forward rate processes, however, if agents perceive that the current exchange rate policy to be unsustainable, speculative activity should cause the forward
Table 1
Unit root test in the forward rate process

<table>
<thead>
<tr>
<th>Currency</th>
<th>Coeff. Value ($\alpha_i$)</th>
<th>ADF T-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eurodollar</td>
<td>-0.0035</td>
<td>-0.2689</td>
</tr>
<tr>
<td>Saudi Riyal</td>
<td>-0.0089</td>
<td>-0.5564</td>
</tr>
</tbody>
</table>

* This table provides the results of unit root tests using the Augmented Dickey Fuller (ADF) test. The model tested is:

$$D(f_t) = \alpha_0 + \alpha_1 f_{t-1} + \alpha_2 D(f_{t-1}) + \alpha_3 D(f_{t-2}) + \epsilon_t$$

Where $D$ is a difference operator, $f_t$ the forward interest rate at time $t$, $\epsilon_t$ is a white noise process, and $\alpha_0, \alpha_1, \alpha_2, \alpha_3$ are parameters.

Mackinnon Critical values are -3.5213, -2.9012, and -2.5875 at the 1%, 5%, and 10% respectively.

rate processes to drift apart. The Johansen (1988) maximum likelihood estimator is used to test for the presence of cointegrating vectors in the interest rate processes. The Johansen methodology is essentially a multivariate extension of the univariate Dickey-Fuller test. Specifically, consider the following simple VAR representation for the two implied forward rates.

$$f_t = \Theta f_{t-1} + \epsilon_t$$

where, $f_t$, $f_{t-1}$, and $\epsilon_t$ are $2 \times 1$ vectors and $\Theta$ a $2 \times 2$ coefficient matrix. Rewriting in terms of the differences, we have

$$\Delta f_t = (\Theta - I)f_{t-1} + \epsilon_t.$$ 

The rank of $(\Theta - I)$, measured by the number of non-zero characteristic roots, determines whether the two series are cointegrated. A rank of zero implies that the two series are unit root processes with no cointegrating vector.

If we cannot reject the null hypothesis that the rank is zero, we are unable to attribute a stable relationship between the two time series, suggesting therefore the existence of speculative activity, stemming from a lack of credibility in the central bank’s posture.

3.1. Data, estimation and results

Monthly data on one month and three month gulf currency interest rates and corresponding rates on eurodollar deposits were collected from the Money and Banking Statistics, published quarterly by the Saudi Arabian Monetary Agency. Data collected covered the period January 1988 to March 1994, from which implied forward rates were computed.

As a first step in the analysis, I test if the forward rate processes follow a random walk, that is, if the differenced system is fully stationary and thus is consistent with a martingale representation. Table 1 reports the results using the Augmented Dickey Fuller methodology, which tests the coefficient on the lagged value of the forward rate series. The results reported are robust to different choices of the number of lagged difference terms used to induce residual white noise in the regression. Details
Table 2
Johansen cointegration test for forward interest rates

<table>
<thead>
<tr>
<th>Sample period</th>
<th>Likelihood ratio</th>
<th>5% Critical value</th>
<th>1% Critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan 88–Mar 94</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH1</td>
<td>10.16</td>
<td>19.96</td>
<td>24.60</td>
</tr>
<tr>
<td>NH2</td>
<td>0.93</td>
<td>9.24</td>
<td>12.97</td>
</tr>
<tr>
<td>Jan 88–Dec 92</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH1</td>
<td>10.38</td>
<td>19.96</td>
<td>24.60</td>
</tr>
<tr>
<td>NH2</td>
<td>1.01</td>
<td>9.24</td>
<td>12.97</td>
</tr>
<tr>
<td>Jan 88–Dec 91</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>NH1</td>
<td>8.18</td>
<td>19.96</td>
<td>24.60</td>
</tr>
<tr>
<td>NH2</td>
<td>0.81</td>
<td>9.24</td>
<td>12.97</td>
</tr>
</tbody>
</table>

The table gives the results for the number of non-zero characteristic roots (rank) of the coefficient matrix $\pi_2$ in the following VAR model in differences. Results presented are for a lag of period two.

\[
D_f = \pi_1 D_f_{t-1} + \pi_2 f_{t-2} + \epsilon_t
\]

where $D$ is a difference operator.

Two null hypotheses are tested:

- NH1: The $\pi_2$ matrix has rank zero (i.e., both series are stationary and that the series are not cointegrated).
- NH2: The $\pi_2$ matrix has at most rank 1 (i.e., that the matrix is not full rank, implying that the series are individually stationary).

are therefore provided only for an AR(2) representation. Critical values are taken from Mackinnon’s tables.

It is apparent from the results presented that the forward rates, as expected, are non-stationary, and appear to follow a random walk, a reasonable finding from the efficient markets perspective and consistent with the consensus opinion in the literature. This follows, as the existence of a unit root cannot be rejected even at the mild 10% significance level for either series.

In the second step of the analysis, I investigate the structure of the relationship between the two forward interest rate processes which comprises the principal contribution of the paper. The results of the cointegration tests are provided in Table 2. Two nulls are examined. The first, labeled NH1, is that there is no cointegrating equation for the two series, and the second, labeled NH2, that each series is individually stationary. As in the earlier case, the conclusions are invariant to the choice of the number of lagged first differences used, suggesting the robustness of the results provided. Since our objective is to determine the credibility of the central bank’s policy under differing economic conditions, test results are provided for the entire sample period and for sub-periods.

It is evident from the results provided in Table 2 that we cannot reject the null hypothesis (NH1) that each series is individually non-stationary and that there is no linear combination of the variables which is stationary for any of the periods examined.
Cast in terms of the underlying forward interest rates, one cannot therefore attribute an equilibrium cointegrating association between the two time series. This is at the same time both a surprising result and yet one which strikes a familiar chord of intuition. It is intuitive, since as shown by Diebold, Gardeazabal, and Yilmaz, nominal exchange rates across economies tend to be not cointegrated, and thus attempts to force parity through a fixed exchange rule must be reflected in the absence of cointegration in nominal interest rates. On the other hand, this is a surprising result, since as in the present case the central bank has demonstrated its resolve and ability to defend the stated exchange policy over a sustained period of time (nine years)—with the singular advantage of hindsight, speculative attacks on the fixed rule could be executed, de-facto, only at a loss. With respect to the second null (NH2), as expected one cannot reject the null that the individual series are non-stationary, confirming the results from Table 1. Not surprisingly, these findings generally support the notion of market efficiency, to the extent that information on the relative strengths and weaknesses in the currency exchange rate are revealed through the medium of interest rates, even though the exchange rate is fixed by the central bank as in this case.

4. Conclusions

Considerable work has been done on the dynamics of exchange rate for the post-1973 floating period. In a freely floating system, information flow is impounded directly in the observed traded prices of currency exchange rates. The empirical evidence in the literature points towards an absence of a linear equilibrium relationship between currency rates, corroborating the appeal of efficient markets. I show in this paper that informational efficiency is achieved in a fixed exchange rate system, through the mechanism of interest rates—that there does not exist a linear equilibrium cointegrating relationship in intercurrency interest rates. This is shown to be the case even where the central bank has demonstrably shown itself capable and determined to pursue its stated policy over a long and sustained period of calendar time.

The success of this fixed rate regime of course hinges on a number of critical factors. Any long-term deterioration in the economic fundamentals (such as a permanent decrease in export earnings from falling oil prices) will make sustaining the fixed rate extremely difficult, and as has been shown recently in the case of Mexico and Thailand, simply bad policy. The influence of the central bank (SAMA) over the activities of commercial banks is also important, to the extent that speculative destabilization not based on economic fundamentals can be reduced if not averted.

Acknowledgments

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Notes

1. The principal reason for using the US dollar as the intervention currency has been because oil exports (the major source of export earnings) are priced and paid for in dollars, and most investments are biased in favor of the dollar.

2. For an excellent discussion on the Saudi Arabian Monetary System, see Banafe (1993).

3. To address concerns that systematic differences in liquidity premiums may be driving the results, all tests were replicated using spot interest rates which yielded identical conclusions.

4. Data on interest rates were available starting in January of 1988. It is fortuitous that the data series begins after a sustained period of exchange rate stability over which the central bank had the opportunity to demonstrate its resolve to maintain the pegged rate. The last change in the pegged rate was in July of 1986.

5. The annualized implied forward interest rate \( f \) is the break even rate computed from the following: \( (1 + r_3/4) = (1 + r_3/12)(1 + f/6) \).

References


