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Dr. Mouawiya M. Al-Awad

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Abstract:

This paper provides a measure of the expected inflation rate for the United Arab Emirates using the nominal term structure of interest rate. This measure is superior to other measures of expected inflation in two main aspects: it is consistent with economic theory and it incorporates all information available to the investor at the time of forecasting. Two term structures of the interest rates are used in the paper using monthly nominal interest rates in the UAE. They provide an identical measure of expected inflation rate in the long run. It seems that the public over-predicted inflation during the period 1996(1) to 1997(6) but under-predicted inflation for the period 1997 (7) to 1998 (12).

I. Introduction and Literature Review:

Effort to find a suitable measure of expected inflation dates back to Irving Fisher (1930) when he proposed the use of an autoregressive measure of expected inflation that depends on current and past values of the actual inflation rates. Then, Cagan (1956) developed the adaptive expectation hypothesis in which the expected inflation is equal to a weighted average of the current and the most recent expectation of the inflation rate. Throop (1988) evaluated the performance of three alternative measures of inflationary expectations: a purely autoregressive measure that depends only on past and current values of inflation: an augmented autoregressive measure that depends on current and past values of inflation and on current and past values of other variables that

* Assistant Professor Department of Economics, UAE University.

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determine inflation, and a survey-based measure of expected inflation. He found that the purely autoregressive measure appears to do better than the other two models. However, these methods, in addition to many other regression methods to measure expected inflation [for example, Roll (1972) and Hamilton (1985)] are criticized on the basis that agents are backward looking and may not incorporate all available information to form their expectations of inflation and, therefore, they may systematically overestimate or underestimate inflation [see Ragan (1995)].

Some researchers and institutions started to survey economic agents to extract measures of expected inflation such as the Livingston Survey in the US [for example, Lahin (1976), Bomberger and Frazer (1981), and Makin (1983)]. It is true that this method is forward-looking in detecting expected inflation but it is widely believed that these estimates are rarely consistent with the actual future movements of inflation and are not consistent with rational expectations [see for example Pearce (1979), Evans and Gulamani (1984), Pesrans (1985) and Pearce (1987)].

Another line of research began using the nominal interest rates of different maturities to infer agents' expectations of inflation. Frankel (1982) proposed a technique for extracting a measure of expected inflation from the interest rate term structure by assuming that the real interest rate is constant in the long run. He used monthly interest rates for different maturities for the US and showed that his measure of expected inflation was superior to the measures obtained using survey data in predicting actual inflation. Ragan (1995) used the term structure of interest rates to construct estimates of agents' expectations of inflation in the US and Canada without the assumption that the real interest rate converges to a constant in the long run. His results suggested that agents' expectations of inflation are heavily influenced by the current inflation rate, concluding that people may be naive in the way they forecast inflation or that they expect low inflation when they are exposed to low inflation for a good amount of time. St-Amant (1996) decomposed the 1-year and 10-year US government bond rates into an expected inflation component and an ex ante real interest rate component using the structural VAR methodology. He assumed that nominal interest rates and expected inflation rates are cointegrated and concluded that both the expected real interest rates and the expected inflation rates are important in explaining fluctuations in nominal interest rates. However, the author pointed out that there is a significant amount of uncertainty about his estimates. These methods are forward-looking since all new information is used in forming inflation expectations as it is incorporated in changes in the nominal interest rates. However, Kozicki (1998) questioned the predictive power of the term structure in estimating inflation for countries where authorities have strong reputation of keeping the inflation rate stable for a long time. For these countries, he suggested the use of the nominal interest rate itself rather than the term structure to predict inflation since the nominal interest rate provides a clearer measure of the stance of economic policies. For the UAE authorities, there is no evidence that they conduct monetary policies to target a lore rate of inflation. Therefore, the model proposed below is appropriate for the UAE economy.

Here we use Frankel's (1982) methodology to extract a measure of expected inflation rates for the UAE. This measure is superior to previous measures of expected inflation rates because it uses variables available to economic agents at the start of each period, it is consistent with economic theory, and it is suitable for the data available for the UAE. This method has been used in a number of research papers to extract agents' expectations of inflation in the industrialized countries, [see for example, Day and Lange (1997), Alles.and Bhar (1997) and Rozicki (1998)], but has never been used in a small non-industrialized country as this paper offers.

Section II provides a brief overview of inflation and monetary policy in the UAE. Section III explains the methodology of extracting the expected inflation measure used in this paper. Section IV explains the data and reports the empirical results, and section V concludes.

II. Inflation and Monetary Policy in the UAE:

The main objective of monetary policy of the Central Bank in the UAE is to maintain fixed peg of the UAE dirham to the US dollar. Although it has had a significant impact on banking in the UAE since its foundation in December 1980, "the instruments available to the central bank to exercise monetary control and influence short-term movements of the monetary aggregates are few and of limited effectiveness," [see IMF Report Page 51].

In the UAE economy, movements in the CPI inflation rate are affected largely by movements of improt prices, house rents, and related housing items. Inflation in 1974-77 rose to about 30% due to the excess demand in the economy caused by accelerated economic growth that followed the increase in world oil prices [see Asad Rizvi (1993)]. In the period 1993-95, inflation decreased to around 4.5-5% and then to around 3% in 1996-97 due to stabilization in demand for residential units and to decrease in import prices [see IMF Report page 31].

III. Methodology:

Frankel (1982) suggested a model to extract a measure of expected inflation from the interest rate term structure. He showed that his model is consistent with a wide variety of macroeconomic models with sticky prices. Frankel’s procedure depends on the idea that, for a given term to maturity, the interest rate can be regarded as a weighted average of a short-term interest rate and a long-term interest rate that reflects only the expected inflation rate. These weights depend upon the speed at which the system converges to the steady-state inflation rate and upon the length of maturity of the bond in question. Therefore, one can examine two maturities to extract a long-term inflation rate measure, at least up to a constant. The constant reflects a risk (term) permium that drives a wedge between real rates of interest of differennt maturities.

Let’s assume that the real interest rate in the absence of future disturbances converges to its steady-state value at a speed of δ:

$$\frac{\partial i_t}{\partial t} = -\delta \left(i_t - \pi_0^e - r^* \right) \quad (1)$$

Where i_t is a short-term interest rate, π_0^e is the long-term expected inflation fromed at time zero, and r^* is the steady-state (constant) real interest rate. This equation implies that at time zero, the public expects i_t to be a weighted average of the long run interest rate $(\pi_0^e + r^*)$ and the current short-term interest rate (i_0). Therefore, we can write

$$i_t = (1 - e^{-\delta_t})(\pi_0^e + r^*) + (e^{-\delta_t})\, i_0 \qquad (2)$$

Equation (2) says that in the absence of new disturbances, i_t approaches $(\pi_0^e + r^*)$ in the long run since $e^{-\delta_t}$ approaches zero as t increases.

Let i_0^τ be the interest rate on a τ-maturity bond issued at time 0. We assume that i_0^τ is the average of the expected short-term rates between 0 and τ plus a possible term premium (λ_t):

$$i_0^\tau = \frac{1}{\tau}\int_0^\tau i_t\, dt + \lambda_t \qquad (3)$$

Substituting from equation (2) and integrating equation (3) we get:

$$i_0^\tau = (1 - \omega_\tau)(\pi_0^e + r^*) + (\omega_\tau)\, i_0 + \lambda_t \qquad (4)$$

where $\omega_\tau = \dfrac{1 - e^{-\delta\tau}}{\delta\tau}$

Equation (4) says that the interest rate is a weighted average of the long-term interest rate $(\pi_0^e + r^*)$ and the short-term interest rate (i_0) plus a possible term premium. The weights (ω_τ) and $(1 - \omega_\tau)$ depend on the speed (δ) at which the system converges to its steady state value and on the maturity of the bond (τ).

Now, if we pick any two maturities (τ_1 and τ_2) and substitute into equation (4) we can solve for the expected inflation rate π^e:

$$\pi^e = \frac{\omega_{\tau 1} i^{\tau 2} - \omega_{\tau 2} i^{\tau 1}}{\omega_{\tau 1} - \omega_{\tau 2}} - \frac{\omega_{\tau 1}\lambda_{\tau 2} - \omega_{\tau 2}\lambda_{\tau 1}}{\omega_{\tau 1} - \omega_{\tau 2}} - r^* \qquad (5)$$

Therefore, a measure of expected inflation (up to a constant) is given by:

$$\pi_c^e \;=\; \pi^e \;+\; \frac{\omega_{\tau 1}\lambda_{\tau 2} \;-\; \omega_{\tau 2}\lambda_{\tau 1}}{\omega_{\tau 1} \;-\; \omega_{\tau 2}} \;+\; r^* \tag{6}$$

$$\text{where} \quad \pi_c^e \;=\; \frac{\omega_{\tau 1} i^{\tau 2} \;-\; \omega_{\tau 2} i^{\tau 1}}{\omega_{\tau 1} \;-\; \omega_{\tau 2}}$$

Thus, $\pi_c \;=\; \pi^e$ + constant. Then, the real interest rate is given by:

$$i \;-\; \pi^e \;=\; r^* \;+\; \frac{(i^{\tau 1} \;-\; \lambda_{\tau 1}) \;-\; (i^{\tau 2} \;-\; \lambda_{\tau 2})}{\omega_{\tau 1} \;-\; \omega_{\tau 2}} \tag{7}$$

To compute the expected inflation series in equation (6) we need to estimate δ (and thus $\omega_{\tau 1}$ and $\omega_{\tau 2}$). To do that we assume that agents' expectations of δ are, on average, equal to the true δ, and, therefore, we can regress the real interest rate $(i - \pi^e)$ against its own lagged values to estimate the speed at which the system tends to the steady state, i.e.,

$$(i \;-\; \pi^e)_t \;=\; \alpha \;+\; \beta(i \;-\; \pi^e)_{t-1} \;+\; u_t \tag{8}$$

However, the right-hand-side of equation (7) implies that regressing $i^{\tau 1} \;-\; i^{\tau 2}$ on its own lagged values is sufficient to estimate β (and so δ) and so we can use the following regression:

$$(i^{\tau 1} - i_t^{\tau 2} \;=\; \alpha \;+\; \beta\;(i^{\tau 1} \;-\; i^{\tau 2})_{t-1} + u_t$$

The slope coefficient (β) from the regression in (9) is equivalent to $e^{-\delta/n}$, where (1/n) is the length of the observation interval. Moreover, the estimates of β and δ represent the speed (in discrete and continuous times respectively) at which the real interest rate adjusts to its long-run value.

Finally, to estimate the constant term in equation (6) we could assume that agents' expectations of inflation are, on average, correct during this period and we could calculate an approximation of the constant as the average of $(\pi_c^e - \pi)$, where π is the actual rate of inflation calculated as in $(P_t) - 1n(P_{t-12})$ where P is the monthly consumer price index. However, it is worth noting that the value of the constant will have no bearing on the use of the expected inflation measure in empirical research such as in regressions since the constant is captured by the intercept terms.

IV. Discussion of Data and Empirical Results

The nominal interest rates are monthly rates on 1-month, 2-month, 3-month 6-month, and 12-month deposits. They are taken from the Statistical Bulletin of the Central Bank of the UAE and cover the period January 1996 to March 1999. The monthly consumer price indices (CPI) do not cover the whole sample period in the Statistical Bulletin; therefore, the annual rates for the remaining period are converted to the monthly frequency interval by fitting cubic spline curves to the CPI values to form continuous-time approximations, which were then used to interpolate the monthly data. The spline method is proven to do well in non-noisy data such as the CPI [see de Boor (1978)].

Table (1) reports the parameter estimates of equation (9) using four pairs of nominal interest rates: 1 and 12-month, 2 and 12-month. 3 and 12-month, and 6 and 12-months maturities. In theory, the estimated β should be the same if we use any term structure of interest rate in equation (9) since it represents the speed at which the real interest rate converges to its long run value. Any pairs of interest rates that represent the return on the same security but with different maturities can do the job of estimating this speed. We notice from table (1) that the estimated speed of adjustment is very close in all regressions. Moreover, table (I) shows that all regressions indicate the absence of the problems of serial correlation at up to 4 lags and of heteroscedasticity. However, the last two regressions, namely the 3 and 12month and 6 and 12-month maturities, indicate that the residuals are not normal.

Therefore, the pairs 1 and 12-month and 2 and 12-month maturities are used to calculate the expected inflation rate measure.

"Equation (9) is estimated using least square estimation. The method is valid even if the regressors are nonstationary since no inference is carried out from the estimated coefficients. Therefore, we do not provide unit root testing even though we believe that the nominal interest differentials in equation (9) are stationary."

Table (1)

Regression Results for Different Term Structures

τ_1	τ_2	$\alpha^{(a)}$	β	R^2	B-G Test[(b)]	J-B Test[(c)]	W Test[(d)]
1	12	0.0772 (0.0207)	0.8262 (0.0000)	0.77	9.2389 (0.0554)	1.1120 (0.5735)	1.0528 (0.3601)
2	12	0.0521 (0.0404)	0.8478 (0.0000)	0.79	9.4257 (0.0513)	0.9842 (0.6114)	0.6820 (0.5112)
3	12	0.0546 (0.0485)	0.7930 (0.0000)	0.67	3.9340 (0.4150)	8.2166 (0.0164)	0.7167 (0.4954)
6	12	0.0333 (0.0642)	0.8149 (0.0000)	0.70	4.4856 (0.3449)	8.3808 (0.0001)	0.5361 (0.5898)

(a) The numbers in brackets are the p-values.

(b) The B-G test is the Breusch-Godfrey serial correlation LM test with the null of no serial correlation

(c) The J-B test is the Jarque-Bera test of normality with the null of normality.

(d) The W test is the White heteroscedasticity test that has the null of no heteroscedasticity.

Table (2) reports the estimates of the speed of adjustment in discrete (β) and continuous (δ) times for the selected two pairs of interest rates along with resulting weights for each maturity as given in equation (4). The estimates of β as the speed of adjustment indicate that between 83% to 85% of the effect of a shock to the short term interest rate will remain one month later and around 11% (0.83^{12}) to 14% (0.85^{12}) of the shock will remain one year later. The estimates of the weights indicate that for the pairs of 1 and 12-month maturities the short-trem 1-month rate has a weight of around 4% of the interest rate while the long-term rate has around 96% weight of the interest rate which is regarded as a weighted average of observed short-term rate and the unobserved long-term rate. For the 12-month rate, the weight of the short-trem rate is close to 40% leaving around 60% for the weight of the long-term rate. For the pair of 2 and 12-month matunties the weights are around 4% and 96% for the 2-month rate of the short-term and the long-term interest rates respectively, and around 25% and 75% for the 12-month interest rate.

Table (2)
Estimation of the Weights

τ_1	τ_2	β	δ	$\omega_{\tau 1}$	$\omega_{\tau 2}$
12	1	0.8262	2.2907	0.0364	0.3924
12	2	0.8478	1.9809	0.0421	0.2476

Table (3) reports the resulting expected inflation rate series using the pair 1 and 12-month interest rates (series 1) and 2 and 12-month interest rates (series 2) along with the annualized monthly actual inflation rates. It is clear that the two expected inflation series are identical except for around 4 values. This is better observed in figure (1) where the two measures of expected inflation almost form one line. Moreover, figure (1) shows that the public underpredicted inflation during the period 1996(1) to 1997(6) while overpredicted inflation until the end of 1998. However, the actual and the expected inflation rates move closely for most of the sample period.

V. Conclusion

In this paper, we provide a measure of the expected inflation rate that depends on the term structure of interest rate. Two pairs of interest rates with different maturities are used: 1- and 12-month and 2- and 12-month. The two measures provide identical expected inflation series. This method is very useful especially in countries where an accurate price index measure is difficult to obtain. In that case, all measures of expected inflation rates are questionable. Even in the presence of a correct price index, it is still questionable that measures of expected inflation, which depend entirely on some statistical techniques that are far from economic theory, are the correct ones to use in empirical economic research. A suggestion for further empirical research is to check how the measure of expected inflation provided in this paper performs in emperical work compared to other measures of expected inflation in the UAE or in similar countries.

Table (3)
Actual and Expected Inflation Rates for the UAE

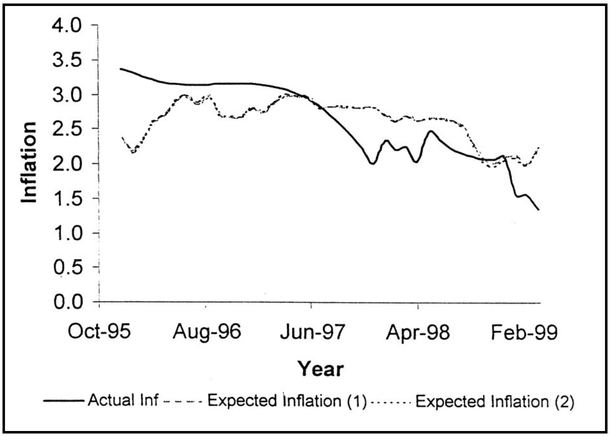
YEAR	MONTH	Actual Inflation	Expected Series1	Inflation[(a)] Series2
1996	JAN	3.4	2.4	2.4
1996	FEB	3.3	2.2	2.2
1996	MAR	3.2	2.3	2.3
1996	APR	3.2	2.6	2.6
1996	MAY	3.2	2.7	2.7
1996	JUN	3.1	2.9	2.9
1996	JUL	3.1	3.0	3.0
1996	AUG	3.1	2.9	2.9
1996	SEP	3.1	2.9	3.0
1996	OCT	3.1	2.7	2.7
1996	NOV	3.1.	2.7	2.7
1996	DEC	3.1	2.7	2.7
1997	JAN	3.1	2.8	2.8
1997	FEB	3.1	2.7	2.8
1997	MAR	3.1	2.9	2.9
1997	APR	3.1	3.0	3.0
1997	MAY	3.0	3.0	3.0
1997	JUN	2.9	2.9	3.0
1997	JUL	2.8	2.8	2.8
1997	AUG	2.7	2.8	2.8
1997	SEP	2.6	2.8	jl 2.8
1997	OCT	2.4	2.8	2.8
1997	NOV	2.2	2.8	2.8
1997	DEC	2.0	2.8	2.8
1998	JAN	2.3	2.7	2.7

Table (3) con't

YEAR	MONTH	Actual Inflation	Expected Series1	Inflation[a] Series2
1998	FEB	2.2	2.6	2.6
1998	MAR	2.2	2.7	2.7
1998	APR	2.0	2.6	2.6
1998	MAY	2.5	2.7	2.7
1998	JUN	2.3	2.7	2.7
1998	JUL	2.2	2.6	2.6
1998	AUG	2.2	2.6	2.6
1998	SEP	2.1	2.3	2.3
1998	OCT	2.1	2.1	2.0
1998	NOV	2.1	2.0	2.0
1998	DEC	2.1	2.1	2.1
1999	JAN	1.6	2.1	2.1
1999	FEB	1.6	2.0	2.0
1999	MAR	1.4	2.2	i 2.2

(a) Series (1) is based on 1 and 12-month interest rate spread and series (2) is based on 2 and 12-month interest rate spread.

Figure (1)
Actual and Expected Inflation Rates in the UAE



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