A NOTE ON THE EQUILIBRIUM RELATIONSHIPS BETWEEN ISSUERS IN THE ASIA PACIFIC REGION

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ABSTRACT

We investigate the relationships between the sovereign bonds issued in international markets by major Asia-Pacific issuers (China, Korea, Malaysia, Philippines and Thailand) and various benchmark US Treasury bonds (2, 5, 10 and 30 year maturities). The results suggest that the equilibrium relationship holds only between pairs of bonds of equivalent credit status. The dynamics of these processes highlight aggregation issues for portfolio managers constructing portfolios of sovereign Asian bonds of different credit ratings.

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1. INTRODUCTION

Following the Asian Financial Crisis in the late 1990s there has been a considerable deterioration in the levels of foreign bank lending, while debt issues in international markets have increased. Pricing in these offshore markets is usually based on a spread, which reflects the premium for default risk, above a riskless ‘‘benchmark’’ curve; in practice, generally the term structure of US government securities (De Almeida, Duarte, & Fernandes, 1998).

The objective of this note is to apply simple empirical techniques to investigate the relationships between sovereign bonds issued within the Asia-Pacific region and the underlying US Treasury benchmark[1] bonds with a maturity of 2, 5, 10 and 30 years. Such an analysis is essential to pricing and managing the risks of sovereign debt in international markets, while also providing an insight into the equilibrium relationship between different maturity classes of sovereign bonds and US Government benchmark bonds. Historically, studies investigating long-term equilibrium relationships have been restricted to securities of developed countries (for example, see Hiraki, Shiraishi, & Takezawa, 1996).

These issues are investigated using empirical models based on Batten, Hogan, and Pynnonen (2000) for the equilibrium relationships. The paper is set out as follows. In the next section, a brief discussion is provided on data and method employed in this study. The results are then presented and the final section allows for some concluding remarks (see Table 1).

2. DATA AND METHOD

Daily bond data was obtained from the Reuters Fixed Income Database for the period from 30 December 1999 to 28 November 2002 (749 daily observations). All bonds were fixed rate, semi-annual coupons priced on a 30/360-day basis. The yield to maturity (YTM) was calculated as the ISMA yield to maturity, with indicative daily bids provided by market practitioners at the close of trading. To overcome potential distortions in yield due to illiquidity and the time path effects due to the bond approaching maturity, only liquid bonds and those with a modified duration of greater than 1 year were included in the final group of bonds. Only nine bonds issued by the governments of China (3 bonds), Korea (1 bond), Malaysia (1 bond), Philippines (3 bonds) and Thailand (1 bond) passed these simple tests and also

Table 1. Information on the Sovereign Bonds of Asian Issuers as at the 28 November 2002.

Issuer	Code	Coupon	Issued	Maturity	Rating	Price	YTM	Modified Duration
People's Republic of China	CHG08	7.3	12/9/1998	12/15/2008	BBB	118.41	3.928	5.017
People's Republic of China	CHU06	7.75	7/1/1996	7/5/2006	BBB	115.52	3.327	3.266
People's Republic of China	CHU04	6.5	2/2/1994	2/17/2004	BBB^{+}	105.43	2.472	1.319
Federation of Malaysia	MYG09	8.75	5/27/1999	6/1/2009	BBB^{-}	123	4.692	5.116
Republic of Korea	KOG08	8.875	4/7/1998	4/15/2008	A^{-}	124.14	3.978	4.385
Republic of Philippines	PHU24	9.5	10/14/1999	10/21/2024	BB^{+}	108.8	8.602	9.286
Republic of Philippines	PHG19	9.875	1/6/1999	1/15/2019	BB^{+}	99.25	9.965	7.834
Republic of Philippines	PHG08	8.875	4/2/1998	4/15/2008	BB^{+}	105.3	7.681	4.197
Kingdom of Thailand	THU07	7.75	4/10/1997	4/15/2007	BBB^{-}	115.46	3.994	3.772

Note: YTM is the ISMA yield to maturity of the bond. The designation "G" or "U" in the bond code refers to whether the bond was a global bond (G), or a Yankee bond (U).*Source:* Reuters Fixed Income Database had a complete set of price data. Table 1 reports this information as well as information on the issue date of each bond and its maturity. The price and yield to maturity of the bond at the end of the sample period (28 November 2002) are also reported. The correlations between the bond pairs, reported in Table 2, are generally low and are below 0.5. The highest correlation was between the US30 and US10 with a value 0.473. The correlations between the nearest maturity Asian international bonds are higher than between bonds of differing maturity.

Batten et al. (2000) denote the continuously compounded yield to maturity of a k period pure discount bond as $R^{*}(k,t),(k=1,2,\ldots)$. Using their notation, a general relationship between maturities of pure discount bonds is

$$R^{*}(k,t)=\frac{1}{k}\sum_{j=1}^{k}E_{t}[R^{*}(1,\ t+j-1)]+A(k,t) \tag{1}$$

where $A(k,t)$ is a risk premium, with traditional theories of the term structure (Hall et al., 1992) focusing on the properties of the premium. The QA :2 pure expectation hypothesis asserts that $A(k,t)$is zero and the expectation hypothesis that the premiums are constants. In our case of Asian sovereign bonds, there is a risk premium over an otherwise similar "risk-free" government bond, generally considered the equivalent US Treasury bond by the financial markets. Let $D(k,t)$ denote the risk premium for the Asian sovereign bond over the US government bond, and then from (1) we get the following model for the yield of the Asian sovereign bond

$$R(k,t)=R^{*}(k,t)+D(k,t) \tag{2}$$

Thus, using (4) we can write QA :3

$$\begin{aligned}R(k,t)-R(1,t)&=R^{*}(k,t)-R^{*}(1,t)+D(k,t)-D(1,t)\\&=\frac{1}{k}\sum_{j=1}^{k}E_{t}[R^{*}(1,t+j-1)]-E_{t}[R^{*}(1,t)]+A(K,t)\\&\quad+D(k,t)-D(1,t)\\&=\frac{1}{k}\sum_{j-1}^{k-1}\sum_{i=1}^{j}E_{t}[\Delta R^{*}(1,t+i)]+A(k,t)+D(k,t)-D(1,t)\end{aligned} \tag{3}$$

where $\Delta R^{*}(1,t+i)=R^{*}(1,t+i)-R^{*}(1,t+i-1)$

Given that $R^{*}(1,t+i)$ is $I(1)$ (integrated of order one), the differenc-es$\Delta R^{*}(1,t+i)$ are therefore stationary implying that the (double) summa-

Table 2. Correlations between Changes in Yields on Asian International Bonds and US Treasury Benchmark Bonds.

	CHU04	CHU06	CHG08	KOG08	MYG09	PHG08	PHG19	PHU24	THU07	US2	US5	US10
CHU06	0.295											
CHG08	0.081	0.119										
KOG08	0.073	0.204	0.222									
MYG09	0.103	0.144	0.091	0.292								
PHG08	0.042	0.111	0.049	0.172	0.237							
PHG19	−0.021	0.022	0.024	0.061	0.017	0.123						
PHU24	0.064	0.118	0.038	0.033	0.044	0.181	0.127					
THU07	0.084	0.200	0.157	0.131	0.054	−0.023	−0.032	0.010				
US2	0.083	0.117	0.078	0.128	0.095	0.016	−0.023	−0.007	0.036			
US5	0.187	0.285	0.196	0.154	0.082	0.090	0.012	0.055	0.203	0.238		
US10	0.148	0.270	0.100	0.109	0.091	0.057	−0.020	0.009	0.104	0.460	0.388	
US30	0.105	0.231	0.113	0.131	0.103	0.057	−0.037	0.042	0.075	0.341	0.279	0.473

tion term in the last line of (3) is stationary. Therefore, the important result predicted from the theory is that the yield spread $R(k,t) - R(1,t)$ is stationary since the maturity premiums $A(k,t)$and default risk premiums $D(k,t) - D(1,t)$ are stationary. The next section reports the results from the correlation and cointegration analysis.

3. RESULTS

Given that the risk premiums, $D(k,t)$ defined in Section 2, can be assumed stationary, theory predicts that the series should be cointegrated with a cointegration vector $(1, -1)$. To establish these relationships, Johansen unrestricted cointegration analysis was conducted using the daily bond data over the sample period. These tests have been applied by other authors on a daily yield time-series to determine the presence of a cointegrating relationship (Batten & Bae, 2003). Table 3 reports the corresponding likelihood QA :4 ratio for various combinations of bond pairs between the various bonds. The Augmented Dickey-Fuller tests for stationarity of the spreads and the yields were also calculated but in the interest of brevity are not reported. The full sample test statistics show no evidence against the null hypothesis that there was a unit root in yield levels, but the data clearly rejects the null hypothesis that there was a unit root in the difference. A reasonable conclusion from these results is that each yield to maturity is integrated at order one (i.e. they are an $I(1)$ process) with all tests supporting the unit root hypothesis at the 1% level of significance for all the data series. However, all combinations of spread (levels) are non-stationarity, which suggests the spreads also follow $I(1)$ processes, or equivalently, that the stochastic trends which play the dominating role in the behaviour of the yields are independent of one another. The five lags proved to be sufficient to ensure that the residuals were not serially correlated.

There were 78 (13 by 12/2) possible combinations comprising six different pairs of US benchmark bonds, 36 pairs of bonds between US bonds and Asian bonds, and 36 different pairs of Asian bonds. Of the 78 possible bond pairs, only 34 (43.5%) were cointegrated at the 5% level. Of these 34 cointegrating pairs, 3 were between different pairs of US benchmark bonds (3/6 or 50%), a result which is inconsistent with the Expectations Hypothesis; 13 were between Asian bonds and US bonds (13/36 or 36.1% of all possible combinations) and 18 were between pairs of Asian bonds (18/36 or 50.0% of all possible combinations). The highest number of pairwise combinations was between the US 2-year benchmark (US2), which was cointegrated with

Table 3. Bivariate Cointegration between Pairs of Bonds Comprising Asian International Bonds and US Treasury Benchmark Bonds.

	CHU04	CHU06	CHG08	KOG08	MYG09	PHG08	PHG19	PHU24	THU07	US2	US5	US10
CHU06	25.50**											
CHG08	29.28**	36.75**										
KOG08	35.40**	24.86	28.81*									
MYG09	30.45**	38.11**	40.81**	27.81*								
PHG08	22.26	16.43	17.42	21.60	20.24							
PHG19	23.49	16.67	18.09	20.08	19.71	34.81**						
PHU24	25.65*	18.02	19.09	23.01	22.31	39.73**	26.97*					
THU07	32.93*	28.41*	53.08**	38.00**	41.82**	19.28	17.42	20.87				
US2	61.35**	60.44**	56.78**	57.64**	61.87**	48.39**	49.20**	50.32**	51.66**			
US5	25.76*	19.76	24.69	22.32	21.79	15.82	17.11	19.46	17.45	53.99**		
US10	33.17**	23.86	24.41	28.47*	29.13*	20.46	20.49	22.55	22.39	56.36**	15.89	
US30	24.02	17.88	17.78	22.04	23.16	17.07	15.92	19.22	17.42	53.99**	12.40	16.63

Note: Johansen Cointegration Test at four lags.
*Critical level 5% (25.32);
**Critical level 1% (30.45).

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all 12 other bonds. The other US bonds were generally not consistently cointegrated with any particular class or group of bonds.

Of those pairs of Asian bonds, it is interesting to note that with one exception the Philippines bonds were only cointegrated with one another and with the US 2-year benchmark bond. In fact the three pairwise combinations of China bonds and the three pairwise combinations of Philippines bonds were both 100% cointgerated – a result consistent with Expectations Theory. If one excluded from the set of all pairs of Asian bonds, those pairs between with the same issuer (36–6), then the within group cointegrating pairs of Asian bonds was only 40%((18–6)/30). The reason for this result is that with one exception, the Philippines bonds were not cointegrated with the other Asian bonds. This is an important result for financial market participants since bundling groups of Asian issues into a portfolio of bonds may result in complex portfolio dynamics and difficulty in risk management.

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To illustrate this complex behaviour, Figs. 1 and 2 plot the spread between two pairs of bonds: the PHG08-CHG08 and the KOG08THU07. Even though these bonds have equivalent maturity, the first pair is not cointegrated, while the second pair is cointegrated. The property of mean reversion expected from a cointegrating pair of bonds is evident in Fig. 2 (KOG08THU07), but not in Fig. 1 (PHG08-CHG08). In fact, in Fig. 1 the

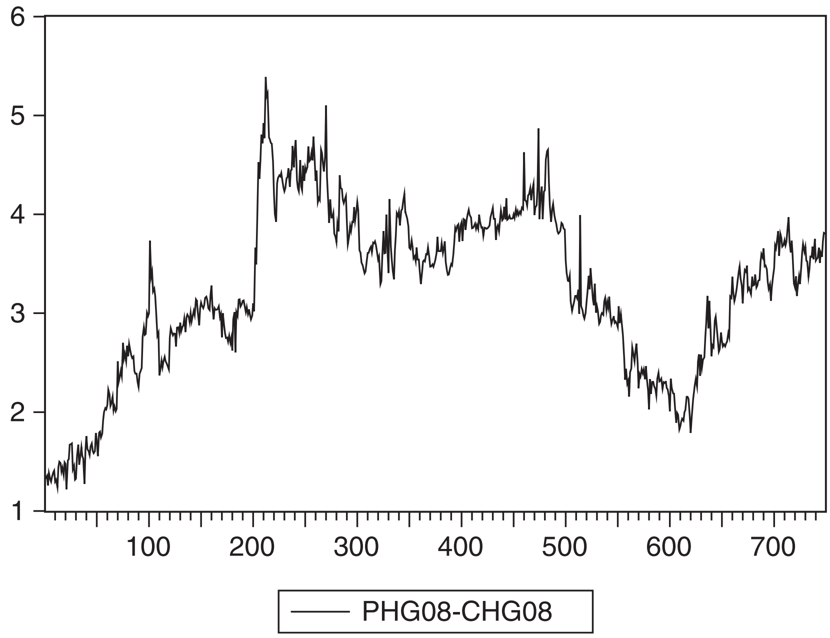

Fig. 1. Plot of the Spread between the Philippines and China Global 2008 Maturity Bond.

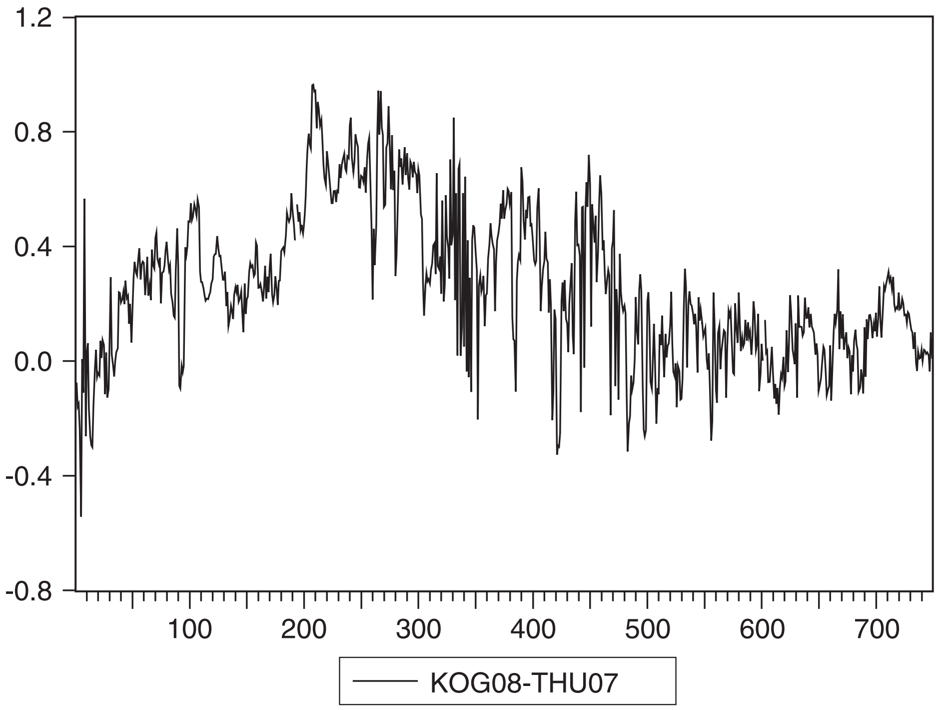

Fig. 2. Plot of the Spread between the Korea and Thailand Global 2008 Maturity Bond.

spread rose significantly from observation 1 to 460, then, declined to observation 620, and then, subsequently rose. Over the sample period the spread increased overall.

4. CONCLUSION

The objective of this note was to report the results of an examination of the equilibrium dynamics of Asian international bonds within a cointegration framework. The results from cointegration analysis suggest that the equilibrium relationship holds between pairs of bond of similar credit rating. The implication of this result is that there are definite limitations to the market approach for pricing and managing the risk of Asian bonds in international portfolios.

5. UNCITED REFERENCES

Batten & Kim (2001), Kim, Moon, & Lee (1998).

NOTES

1. Benchmark bonds of a specific maturity are interpolated from yields of selected on-the-run bonds using splining or other techniques (Kim, Moon, & Lee, 1998). Industry associations usually specify bonds, which are the most liquid, for this purpose.

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