Exchange Rate Risk and Philippine Stock Returns:
Before and after the Asian financial crisis

Rodolfo Q. Aquino

Abstract

This paper examines whether the Philippine stock market prices exchange rate risk during the period 1992-2001; specifically, before and after the onset of the Asian financial crisis. Using a two-factor arbitrage pricing theory model, the evidence presented in the paper suggests that stock returns did not react significantly to foreign exchange rate fluctuations before the period of the crisis. After the onset of the crisis, however, Philippine firms started to exhibit cross-sectional differences in their reaction to exchange rate movements. Furthermore, during the post-crisis period, investors began to expect a risk premium on their investments for their perceived added exposure to exchange rate risk. In the larger, macroeconomic sense, this implies market inefficiencies in the foreign exchange or stock market or both and inadequate hedging by local firms for foreign exchange risk.

Correspondence:

Rodolfo Q. Aquino
College of Business Administration
University of the Philippines
Diliman, Quezon City
PHILIPPINES

E-mail: rodolfo.aquino@up.edu.ph

I. Introduction

Foreign exchange rate fluctuations under a floating or flexible exchange rate system are a major concern to Philippine companies whether they are engaged in foreign trade and finance or not. Exchange rate fluctuations affect firms through their direct effects on the firms' net foreign monetary and real domestic assets and indirectly through effects on aggregate and industry demand, on the cost of traded inputs, on competing imported goods, and on inflationary expectations. However, these fluctuations can in theory be considered to be a source of risk that can be diversified or hedged away in a well-developed financial market. In particular, modern portfolio theory postulates that only risks that cannot be diversified away, also called systematic risks, should be priced by the capital market in the sense that shareholders should be paid a premium for being the residual bearers of these risks. If foreign exchange risks are not significant or are diversified away through hedging, then this source of risk should not be priced and therefore not add to the cost of capital of firms.

The period covered by this study is from 1992-2001. The year 1992 saw the deregulation of the foreign exchange market. Although the foreign exchange rate was officially under a floating rate system, up to mid-1997, the Philippine peso like many other Asian currencies was generally considered to be under a "de facto" peg. Thus, to the extent that the peg held, foreign exchange risk could be considered as non-existent or insignificant. The onset of the Asian financial crisis, however, changed this perception. The peso was allowed to float freely and in fact the peso-dollar (U.S.) rate fluctuated wildly after the onset of the crisis (see Graph 1). In contrast, the volatility in stock market returns (with the market proxied by the Philippine Stock Exchange (PSE) composite index or Phisix) had been fairly stable except for a brief period during the crisis (see Graph 2). The use of financial derivatives to hedge major foreign exchange risks, among others, also started to be significantly employed by financial managers of the larger firms (see for example Cao, 2003 and Agcaoili and Ang, 2003). In reasonably efficient foreign exchange and stock markets where arbitrage forces should enforce consistent pricing of risks between the two markets, the transaction cost of hedging and the elimination or reduction of foreign exchange risk are offsetting forces that should leave the firm cost of capital unchanged (see for example Adler and Dumas, 1983). Furthermore, more primitive macroeconomic shocks may impact on firms differently. However, to the extent that these shocks are reflected in the same way and to the same extent on stock returns and exchange rate movements, then stock returns may not show any sensitivity to exchange rate movements, after accounting for movements in the aggregate stock market (Jorion, 1991) Thus, in both instances, foreign exchange fluctuations should not be a separately priced source of risk.

This study seeks to empirically verify the hypotheses that the exchange rate risk is not priced first during the entire 1992-2001 period and then separately for the pre-crisis and post-crisis periods. Resolution of this issue should contribute toward our further understanding of the factors that affect stock prices and the effects of the Asian financial crisis on one sector of the capital market. The framework for testing these hypotheses is a two-factor arbitrage pricing theory (APT) model in the spirit of

Chen, Roll and Ross (1986) with market excess returns and changes in the peso-dollar exchange rate as factors.

The rest of the paper is organized as follows. Section II presents the model to be tested. Section III discusses the data and testing methodology to be used. Section IV reviews the empirical results. Section V concludes.

II. Model

As discussed above, if exchange rate fluctuations are not considered a major source of risk or if both stock returns and exchange rates are generated by the same original factors, then individual stock returns may not exhibit any sensitivity to exchange rate fluctuations after accounting for the effects of the original factors channeled through their effects on aggregate market returns. Thus, in the model to be tested, exchange rate movements will be orthogonal by construction to market returns in accordance with the assumptions of Ross' (1976) original APT formulation[1].

The following two-factor APT model following Jorion is used[2].

$$E(\widetilde{R}_i) = \delta_0 + \delta_1\beta_i^m + \delta_s\beta_i^s \tag{1}$$

where $\widetilde{R}_i$ is the ith stock's return over the riskfree rate (proxied by the 91-day Treasury Bill rate), β_i^m denotes the ith stock's sensitivity to market movements and β_i^s denotes its sensitivity to exchange rate movements. The "~" on top denotes that the variable is a random variable. In this model, market excess return could be interpreted as a transformation of the original factors which are not observable anyway. Since the market's sensitivity to exchange rate movements $\beta_m^s = 0$ by construction, this implies

$$E(\tilde{R}_i) = \delta_0 + [E(\tilde{R}_m) - \delta_0]\beta_i^m + \delta_s\beta_i^s, \qquad (2)$$

where $\tilde{R}_m$ is the return on the market portfolio in excess of the riskfree rate. If $\delta_0 = \delta_s = 0$, this is the Sharp-Lintner capital asset pricing model or CAPM. The test equation is developed as follows. Assuming stationarity, time series returns can be expressed as:

$$\tilde{R}_{it} = E(\tilde{R}_{it}) + \beta_i^m[\tilde{R}_{mt} - E(\tilde{R}_{mt})] + \beta_i^s\tilde{F}_{st} + \tilde{\varepsilon}_{it} \qquad (3)$$

where $\tilde{F}_{st}$'s are the residuals of the regression of exchange rate movements against $\tilde{R}_{mt}$. Note that the mean of $\tilde{F}_{st}$ is zero by construction.

Under rational expectations, substituting (2) into (3) yields

$$\tilde{R}_{it} = [\delta_0(1 - \beta_i^m) + \delta_s\beta_i^s] + \beta_i^m\tilde{R}_{mt} + \beta_i^s\tilde{F}_{st} + \tilde{\varepsilon}_{it} \qquad (4)$$

Equation (4) is the restricted equation to be tested.

III. Data and Testing Methodology

As mentioned, the aggregate stock market is proxied by the Phisix which, despite its limitations, is the only stock market index which has a long enough history for use in the study. The Phisix is a market-value-weighted index of 30 representative companies from different sectors of the local bourse. Each industry is represented by a company with the highest market capitalization within the industry. The remaining 15 of the 30 companies that compose the index were also chosen based on the market capitalization. The other, broader index, which is the all shares index, includes all shares traded in the PSE. However, this index only started to be reported in November 1996[3].

Monthly data on the Phisix, stock prices, and cash and stock dividends for 1992-2001 are from the PSE. Let P_{it} denote end-of-month prices of the ith stock, D_{it} the cash dividends per beginning share, and SDV_{it} the stock dividends as proportion of existing shareholdings, monthly simple returns for stock i are computed as follows:

$$R_{it} = \frac{P_{it} \cdot (1 + SDV_{it}) + D_{it} - P_{it-1}}{P_{it-1}} . \tag{5}$$

If cash dividends are declared after the payment of stock dividends, the appropriate adjustments are made. End-of-month nominal exchange rates and returns on the 91-day treasury bill are from the Philippine Institute of Development Studies website. Monthly excess returns are computed by deducting from the gross returns the monthly riskfree rate computed as

$$R_{ft} = (1 + TB_t)^{1/12} - 1 \tag{6}$$

where R_{ft} is the estimated riskfree rate per month and TB_t is the treasury bill rate reported at the start of month t. Both the market excess return and change in exchange rate series are tested for stationarity[4]

Sixteen equally weighted portfolios are formed from 58 stocks with continuous trading for 1992-2001. The portfolios are formed using the first two-digit industry classification code of Neda (National Economic and Development Authority, the Philippine economic planning agency) as reported by Philippine Business Profiles (1998-1999). This is similar to Sweeney and Warga (1986) and Jorion except that holding companies not classified in any particular industry code are grouped together.

The parameters δ_0, δ_s, β_i^m's, and β_i^s's in equation (4) are estimated simultaneously using generalized least squares seemingly unrelated regression (SUR) estimation. The unrestricted equation is given by

$$\widetilde{R}_{it} = \alpha_i + \beta_i^m \widetilde{R}_{mt} + \beta_i^s \widetilde{F}_{st} + \widetilde{\varepsilon}_{it} \,. \tag{7}$$

Given the restricted and unrestricted models, the cross-section restriction $\alpha_i = \delta_0(1-\beta_i^m) + \delta_s \beta_i^s$ is tested by a likelihood ratio test. The likelihood ratio test statistic is

$$\mathrm{LR}(k) = T \cdot \mathrm{Ln}\left(\frac{|\Sigma_R|}{|\Sigma_U|}\right) \tag{8}$$

which is distributed as a χ^2 with k degrees of freedom equal to the difference between the number of parameters estimated in the two models. The values $|\Sigma_R|$ and $|\Sigma_U|$ are the determinants of the residual covariance matrices of the restricted and unrestricted equations, respectively, and T is the number of observations.

IV. Empirical Results

Table 1 shows the beta coefficients representing the exposure of the 16 industry portfolios to market and exchange rate fluctuations as a result of the SUR of restricted equation (4) for the entire period 1992-2001. At the bottom of the table, the results of a Wald test on the equality of the betas across portfolios are reported. The statistics indicate that the null hypothesis of equal beta coefficients is rejected for the market return but not for exchange rate exposure. Tables 2 and 3 show the results for the two periods: 1992 to mid-1997 representing the period before the onset of the Asian financial crisis and mid-1997 to 2001 representing the period after. The result for the sub-period before the crisis is very similar to that for the entire period 1992-2001. The lack of variability in sensitivity to exchange rate fluctuations reflects the relative stability in exchange rate during that period. The Asian financial crisis changed the situation. For the period after the start of the crisis, the null hypothesis of equal coefficients for both risks is strongly rejected by the data.

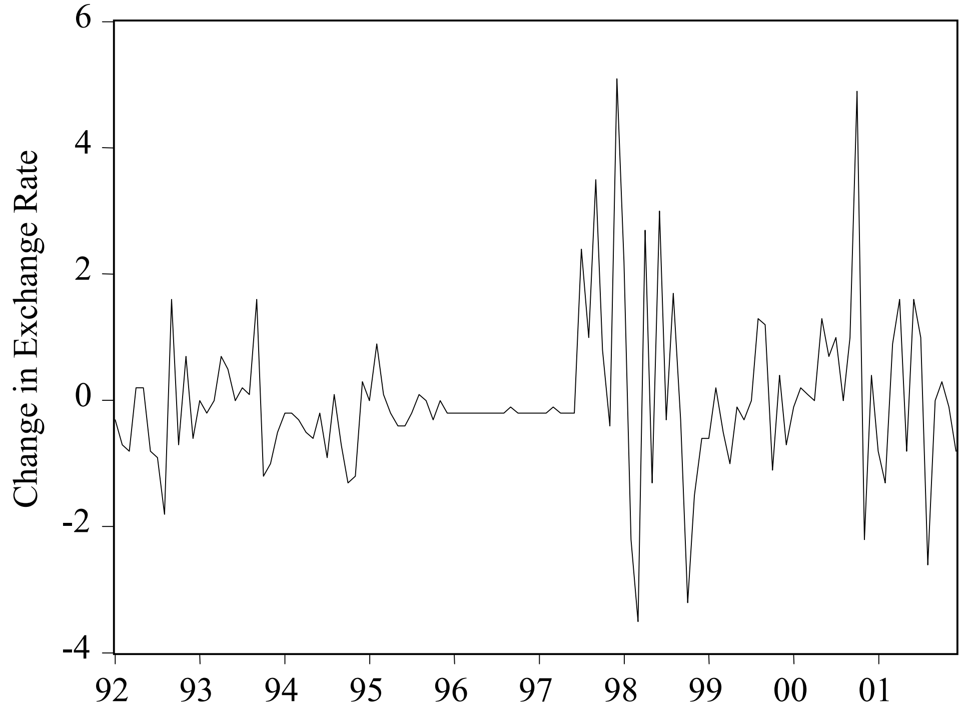
Table 4 shows the factor prices in the first two columns. The null hypothesis that $\delta_0 = 0$ is not rejected for the entire period and the two sub-periods. This implies that the model used accounts for the total differential in excess return across the test portfolios. The null hypothesis that $\delta_s = 0$ is rejected (at 0.01 significance level) for the entire period and the second sub-period. However, the null hypothesis that $\delta_s = 0$ is accepted for the first sub-period indicating that exchange rate fluctuation is not a priced risk during that period of relative exchange rate stability. After the onset of the financial crisis and as exchange rate fluctuations become more pronounced, however, investors started demanding extra return for firms' foreign exchange rate exposure. To put some economic context into the statistical picture, the factor price in Table 4 for the second sub-period is –0.7705 and the betas of all industry portfolios with significant coefficients (at significant level of 0.05 or better) are negative. The industries are oil and gas exploration, paper and paper products, non-metallic products manufacturing, non-bank financial intermediaries, real estate, and holding companies. These implies that firms in these industries are perceived to have direct or indirect foreign exchange exposures that are not fully hedged either through ownership of risk-offsetting assets or the use of derivatives. Negative betas mean that a positive change in the exchange rate representing currency depreciation decreases returns for all portfolios. However, the negative factor price implies that a premium is expected from stocks with negative exposure to currency depreciation risk. The average beta for all industries in Table 3 is -0.0189 implying an average 1.46% monthly risk premium for the average portfolio.

To test model fit, the regressions for the unrestricted model (7) are also run for the entire period and the two sub-periods and the likelihood ratios computed. The likelihood statistics as shown in the last column of Table 4 should be interpreted together with the significance of the pricing coefficients. For the entire period 1992-2001, the likelihood ratio statistic is significant at the 0.05 level but not at the 0.01 level indicating moderately good fit. The fit is much better for the sub-period before the crisis. Furthermore, the pricing coefficients are individually not significant for this sub-period. Taken together, these results imply support for the one-factor CAPM which is consistent with the result of Yu (2002) for the same period. For the second period, the model fit is also good. Moreover, the pricing coefficient for exchange risk δ_s is statistically non-zero. These together with the non-rejection of the null hypothesis that $\delta_0 = 0$ imply that the two-factor APT model with market excess return and exchange rate fluctuations as risk factors is capable of fully explaining the cross-sectional difference in the returns of the industry portfolios during the post-financial crisis period.

V. Conclusion

Especially after the onset of the Asian financial crisis, the impact of foreign exchange fluctuations on stock returns has become an important issue to investors, government policy-makers and financial managers. This evidenced by the fact that the two most-reported statistics in media are the exchange rate and stock price movements. This paper examines the exposure of Philippine firms to foreign exchange fluctuations both during the pre-crisis and post-crisis periods within the framework of a two-factor APT model. The empirical results show that foreign exchange fluctuations was not a risk factor taken seriously by the market before the start of the financial crisis. However, after the onset of the crisis, Philippine firms started to exhibit cross-sectional differences in their reaction to exchange rate movements either because the nature of their operations involved different risk exposures or they have chosen different ways of addressing risk. Furthermore, exchange rate risk is priced by the market meaning that investors expect a risk premium on their investment for their added exposure to exchange rate risk. In the larger, macroeconomic sense, this implies market inefficiencies in the foreign exchange or stock market or both and inadequate hedging by local firms for foreign exchange risk.

Graph 1: Exchange Rate Fluctuations. 1992-2001



Graph 2: Market Excess Returns. 1992-2001

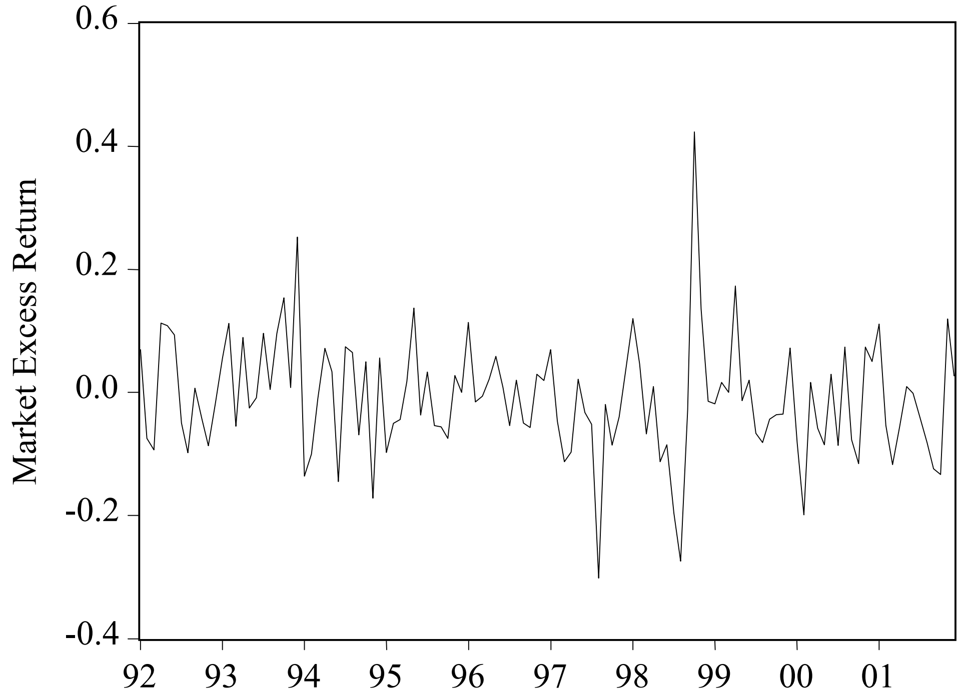


Table 1: Beta Coefficients of Restricted Equation: Jan 1992 to Dec 2001

NEDA		β_m			β_s		
Code	Industry	Coeff	t-stat	p-value	Coeff	t-stat	p-value
21	Metallic ore mining	0.7830	6.3606	**0.0000**	-0.0066	-1.1703	0.2420
22	Oil and gas exploration	0.9023	7.3983	**0.0000**	-0.0064	-1.1529	0.2491
31	Food manufacturing	0.5028	6.9970	**0.0000**	-0.0058	-1.4239	0.1546
34	Paper and paper products	1.6723	6.9563	**0.0000**	-0.0301	-2.3589	**0.0184**
35	Chemical products	0.1710	0.9280	0.3535	0.0041	0.4557	0.6487
36	Non-metallic mineral products	0.8165	2.9577	**0.0031**	-0.0361	-2.5239	**0.0117**
38	Fabricated metal products	0.1347	1.3237	0.1858	-0.0010	-0.1641	0.8696
41	Electricity	1.0049	10.1485	**0.0000**	-0.0088	-1.8706	**0.0616**
50	Construction	1.4561	7.6219	**0.0000**	-0.0163	-1.7467	**0.0808**
73	Communication	1.1662	8.7237	**0.0000**	-0.0057	-0.9441	0.3452
81	Banking institutions	0.9105	1.7768	**0.0758**	-0.0459	-1.8795	**0.0603**
82	Non-bank financial institutions	0.8223	8.5258	**0.0000**	-0.0160	-2.9250	**0.0035**
84	Real estate	-0.0953	-0.0431	0.9656	-0.1767	-1.7047	**0.0884**
93	Private education services	0.2571	0.1248	0.9007	-0.3058	-2.7555	**0.0059**
96	Recreational and cultural svcs.	0.1494	0.6486	0.5167	-0.0153	-1.3565	0.1751
-	Holding companies	-2.5478	-0.7306	0.4651	-0.1513	-0.9676	0.3334
Test of equal Betas							
χ^2 – statistic				97.0022			13.6014
p-value				**0.0000**			0.5560

Table 2: Beta Coefficients of Restricted Equation: Jan 1992 to Jun 1997

NEDA Code	Industry	β_m Coeff	β_m t-stat	β_m p-value	β_s Coeff	β_s t-stat	β_s p-value
21	Metallic ore mining	0.6218	2.6261	**0.0088**	0.0045	0.3650	0.7152
22	Oil and gas exploration	0.6365	3.7941	**0.0002**	0.0159	1.8149	**0.0698**
31	Food manufacturing	0.6805	5.0000	**0.0000**	-0.0002	-0.0161	0.9871
34	Paper and paper products	1.3372	3.5227	**0.0004**	-0.0190	-1.1096	0.2674
35	Chemical products	0.7064	3.3876	**0.0007**	0.0036	0.3486	0.7275
36	Non-metallic mineral products	1.1042	2.4670	**0.0138**	-0.0203	-0.9212	0.3572
38	Fabricated metal products	0.0001	0.0008	0.9993	0.0319	2.1457	**0.0321**
41	Electricity	1.4664	7.8100	**0.0000**	-0.0298	-2.1202	**0.0342**
50	Construction	1.4990	6.3979	0.0000	-0.0229	-1.8416	0.0658
73	Communication	1.7994	6.7429	0.0000	-0.0335	-2.1159	0.0346
81	Banking institutions	1.5696	1.3193	0.1874	-0.0773	-1.1977	0.2313
82	Non-bank financial institutions	1.1959	7.9360	0.0000	-0.0166	-1.6968	0.0900
84	Real estate	-2.5218	-0.4816	0.6302	-0.1548	-0.5278	0.5977
93	Private education services	0.9259	0.1943	0.8460	-0.4342	-1.1841	0.2366
96	Recreational and cultural svcs.	0.2653	0.5530	0.5804	-0.0041	-0.1374	0.8907
-	Holding companies	-10.8859	-1.3209	0.1868	0.1365	0.3279	0.7431
	Test of equal Betas						
	χ^2 – statistic			59.8264			7.4587
	p-value			**0.0000**			0.7609

Table 3: Beta Coefficients of Restricted Equation: Jul 1997 to Dec 2001

NEDA		β_m			β_s		
Code	Industry	Coeff	t-stat	p-value	Coeff	t-stat	p-value
21	Metallic ore mining	0.7944	5.3036	**0.0000**	-0.0081	-0.8180	0.4136
22	Oil and gas exploration	0.9474	4.8181	**0.0000**	-0.0318	-2.4341	**0.0152**
31	Food manufacturing	0.3849	4.3945	**0.0000**	0.0019	0.3145	0.7532
34	Paper and paper products	1.9240	5.4773	**0.0000**	-0.0685	-2.9276	**0.0035**
35	Chemical products	-0.1885	-0.6179	0.5369	0.0215	1.0573	0.2908
36	Non-metallic mineral products	0.4492	1.0538	0.2924	-0.0912	-3.2081	**0.0014**
38	Fabricated metal products	0.0318	0.2081	0.8352	-0.0108	-1.0552	0.2917
41	Electricity	0.7192	7.0737	**0.0000**	0.0055	0.8100	0.4183
50	Construction	1.2823	3.5940	**0.0004**	-0.0262	-1.1045	0.2698
73	Communication	0.7744	5.6450	**0.0000**	0.0050	0.5459	0.5853
81	Banking institutions	0.4782	1.8732	**0.0615**	-0.0127	-0.7488	0.4542
82	Non-bank financial institutions	0.5665	3.7829	**0.0002**	-0.0307	-3.0692	**0.0022**
84	Real estate	0.8829	6.3242	**0.0000**	-0.0215	-2.3127	**0.0211**
93	Private education services	-0.3678	-0.5529	0.5805	-0.0209	-0.4731	0.6363
96	Recreational and cultural svcs.	0.0691	0.3961	0.6922	0.0118	1.0096	0.3131
-	Holding companies	1.3064	7.2546	**0.0000**	-0.0252	-2.1014	**0.0360**
Test of equal Betas							
χ^2 - statistic				53.3703			41.6630
p-value				**0.0000**			**0.0000**

Table 4: Pricing of Exchange Rate Risk

	Factor Prices (t-statistic)		Test of Fit (p-value)
Period	δ_0	δ_s	χ^2_{14}
1992-2001	0.0081	-1.3681*	25.106**
	(0.4293)	(-6.3758)	(0.0336)
1992-1997	0.0712	-2.7955	15.106
	(0.9891)	(-1.2167)	(0.3708)
1997-2001	-0.0063	-0.7705*	20.2900
	(-0.8015)	(-4.6225)	(0.1213)

* significant at the 0.01 level
** significant at the 0.05 level

REFERENCES

Adler, M. and Dumas B. (1983) International portfolio choice and corporation finance: A synthesis, *The Journal of Finance,* **38**, 925-984.

Agcaoili, D. M. and Ang C. S. (2003) Forwards and swaps: A study of risk management in the Philippines, *Unpublished Manuscript*.

Aquino, R. Q. (2002-2003) Macroeconomic factors and Philippine stock returns, *Philippine Management Review,* **10**, 24-40.

Cao, S. S. (2002) Use of financial derivatives by Philippine companies, *Unpublished Manuscript*.

Chan, L. K. C., Karceski J. and Lakonishok, J. (1998) The risk and return from factors, *Journal of Financial and Quantitative Analysis,* **33,** 159-188.

Chen, Nai-fu, Roll, R and Ross, S. (1986) Economic forces and the stock market, *Journal of Business,* **59**, 583-403.

Jorion, P. (1991) The pricing of exchange rate risk in the stock market, *Journal of Financial and Quantitative Analysis,* **26**, 363-376.

Philippine Business Profiles & Perspectives, Inc., *Top 7,000 corporations, 1998-1999*.

Ross, S. (1976) The arbitrage theory of capital asset pricing, *Journal of Economic Theory,* **13**, 341-360.

Sweeney, R. and Warga, A. (1986) The pricing of interest rate risk: Evidence from the stock market, *The Journal of Finance,* **41**, 393-410.

Yu, J. (2002) A test of the CAPM on Philippine common stocks, *The Philippine Review of Economics,* **24,** 121-141.

ENDNOTES

[1] Orthogonality of factors is not really necessary for most forms of the APT. Furthermore, enforcing orthogonality may be innocuous by itself since the R^2 between the two factors is 0.0503 which has a p-value under a t-test of 0.0138.

[2] Jorion also used a six-factor model based on Chen, Roll and Ross. The factors were changes in exchange rate, industrial production, expected and unexpected inflation risk premium, term structure, and market excess return. The other factors are not used in this study based on the results of Aquino (2002-2003) that these other factors do not appear to be separately priced in the stock market.

[3] Both the Phisix and the all shares index are market capitalization weighted based on all outstanding shares. Within 2004, the PSE plans to replace the weights by "free-float market capitalization" or the amount of shares that can actually be traded in the market.

[4] Using the Augmented Dickey-Fuller test, the unit root hypothesis for both series is rejected at 0.01 level of significance.