Stock Market Volatility in the Philippines

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Abstract

Regime-switching-ARCH regression was used on weekly aggregate Philippine stock return data from February 1987 to October 2000 to estimate its conditional variance. The estimated volatility was then related to major political/economic events and to fluctuations in economic activity as measured by real GDP growth. Four high volatility episodes were observed for the period under study. It was seen that high stock return volatility preceded a bust cycle, defined as a sequence of low growth periods. The study showed the sensitivity of the Philippine stock market to drastic changes in the political environment as well. This was observed twice during the late 1980s when a series of military coup attempts led to large fluctuations in the stock price index. In the 1990s, high return volatility was also observed twice. The lifting of the remaining foreign exchange and capital account restrictions in 1993 led to the third high volatility episode. In 1997, the start of the fourth volatility episode preceded the onset of the Asian financial crisis by a few months.

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I. INTRODUCTION

Since the article of Schwert (1989), a significant portion of research in the stock market has been directed towards examining aggregate return volatility. The main interest is on why stock market volatility is high during certain periods and how this is related to the level and volatility of other macroeconomic variables. The recent attention given to volatility in stock markets is understandable in the light of rapid developments in world financial markets and the occurrence of the Asian financial crisis in 1997. This short article reports the result of an empirical research on the nature of stock market volatility in the Philippines. Unlike mature stock markets of advanced economies, the stock markets of less developed economies like the Philippines began to develop rapidly only in the last two decades and are sensitive not only to economic activity levels but also to changes in the political as well as international economic environment.

This article benefits from developments in the measurement of volatility through econometric techniques. Here, the regime-switching-ARCH method developed by Hamilton and Susmel (1994) is used to estimate the conditional variance of Philippine weekly stock return from February 1987 to October 2000. The method allows for an objective determination of high and low volatility states. The result of estimates of stock return volatility is then related to major political and economic events and the boom-bust cycles observed by Philippine researchers (See Fabella, 1994, De Dios, 1998 and De Dios, 2000).

II. EMPIRICAL FRAMEWORK

In this study, it is assumed that the stock return follows a first-order autoregressive scheme of the form:

$$r_t = \phi_0 + \phi_1 r_{t-1} + e_t \tag{1}$$

where r_t is the stock return. One of the first models of stock prices posits that the ϕ parameters are zero. This view of serial independence of returns is effectively a hypothesis that the (log of) stock price follows a random walk if e_t is stationary with zero mean and constant variance. Most empirical studies however have not validated this as serial correlation has been detected in various indexes and evidence of changing variances abound.[1] The ARCH family of models assumes a non-constant conditional variance for stock returns. ARCH techniques differ on how the error process, e_t, is modeled, that is, how volatility is measured. In the switching-ARCH framework, the error process is described by the following equations:

$$\begin{aligned} e_t &= u_t \sqrt{g(s_t)} \\ u_t &= \sigma_t v_t \qquad ; \qquad v_t \sim N(0,1) \\ \sigma_t^2 &= \alpha_0 + \sum_{i=1}^{q} \alpha_i u_{t-i}^2 \end{aligned} \tag{2}$$

where $g(s_t)$ is a constant variance factor that serves to scale the ARCH process. This factor depends on the state variable, $s_t = 1, 2, \ldots, K$, that indexes the "volatility regime." The move from one state to another represents a change in the scale of the volatility process. In this specification, a normalization is imposed such that $g(1) = 1$ and $g(s_t) \geq 1$ for $s_t = 2, \ldots, K$. Hence, state 1 may be viewed as the low volatility state. For $s_t \neq 1$, $g(s_t)$ therefore indicates the magnitude of volatility at s_t relative to the low volatility state. Equation (2) describes a regime-switching-ARCH(K, q) model. Notice that when $K = 1$, the model reduces to the plain ARCH(q) model.

The volatility state is assumed to be the outcome of an unobserved first-order K-state Markov process, which can be described by transition probabilities, $P(s_t = j | s_{t-1} = i) = p_{ij}$. Each probability number, p_{ij}, is the probability that state i is followed by state j. In this study, it is assumed that there are only two volatility states: low volatility (state 1) and high volatility (state 2). Hence, the transition probability matrix simplifies to:

$$\mathbf{P} = \begin{bmatrix} p_{11} & p_{21} \\ p_{12} & p_{22} \end{bmatrix}$$

where $\sum_{j=1}^{2} p_{ij} = 1$. One of the objectives of switching-ARCH estimation is to predict the probability of occurrence of a state for each period. This is obtained using a non-linear Markov-switching filter. A detailed discussion of Markov-switching techniques can be seen in Hamilton (1989) and Hamilton and Susmel (1994).

III. DATA AND ESTIMATION RESULTS

The Philippine Stock Exchange makes available to the public, daily stock price index data from 1987 to the present. Weekly aggregate stock return is computed from this data set and covers the period from a week's Thursday beginning price to the following week's Wednesday closing price. Stock return is computed as 100 times the first difference of the logarithm of the stock price: $r_t = 100 \cdot (\ln p_t - \ln p_{t-1})$. The estimation period is from February 18, 1987 to October 25, 2000 for a total of 715 observations.[2]

Table 1 presents the results of maximum likelihood estimates of a switching-ARCH(2, 3) model. As shown in the Table, the slope coefficient estimates as well as estimates of the transition probabilities are statistically significant.[3] From the estimates, one can compute for the expected duration of each volatility state as $1/(1-p_{ii})$. The expected duration of the low volatility state is 77 weeks, while for the high volatility state it is 53 weeks.[4] The estimated variance factor is also statistically significant. This result means that the second state is 3.8 times more volatile than state 1.

One of the attractive features of regime-switching analysis is that it permits the researcher to get a glimpse of the state of the variable through time. The main output of the Markov-switching filter is the probability of occurrence of a state conditional on information available at time t (filtered probability) and the probability conditional on the full sample (smoothed probability). Figure 1 presents a graphical description of the weekly stock return and the smoothed probability of a high volatility state obtained from the switching-ARCH(2, 3) model. This diagram is useful in trying to explain quantitatively, historical events associated with the variable and relate it to some previously known and recorded events. The study adopts this line of analysis, which was also followed by Lahiri and Wang (1996) who related movements in interest rate spreads to U.S. business cycle dates determined by the NBER using a univariate two-state Markov-switching variance model. In the absence of an agency that dates business cycles in the Philippines, this study relies on previous studies on the Philippine boom-bust cycle for estimates of dates of economic downturns.

The bottom panel of Figure 1 is shaded to mark bust period dates that were determined in Bautista (2000) using a three-state Markov regime-switching regression on quarterly GDP growth. In that study, a boom period is a sequence of moderate growth states while a bust period is a sequence of low growth periods that may include crisis states. The relevant bust period dates are from April 1990 to September 1993 and from July 1997 to March 1999. As can be seen in the bottom panel of Figure 1, four high volatility episodes can be observed. It is interesting to note that the second and fourth high volatility episodes began prior to the bust periods and are indications that to a certain extent, stock return volatility may be a good leading indicator of an economic downturn.

The first high volatility episode in the time period under consideration covered the full year of 1987 — the year when the economy was just recovering from the worst BOP crisis in its history (1983 –1985). It was also a transition period — the economy was moving away from a centralized form of government under martial rule to a decentralized and democratic government.[5] More significantly, it was also the year when a series of failed military coup attempts took place. This political instability was what caused the uncertainty in the environment and the large fluctuations in the prices of equity assets. The following year, 1988, was a quiet year until another coup attempt in December 1989 that likewise failed, disturbed the tranquility. This last coup attempt marked the beginning of the second high volatility period of the study.

The first bust period from April 1990 to September 1993 covered many events and crisis states and was preceded by the second high volatility state. The major events were the last coup attempt in 1989 mentioned above, the gulf war, the fiscal crisis of 1990 and the power crisis of 1992. The renewed political instability, the anticipation of a slowdown because of an observed overheating of the economy and the uncertainty in world affairs that lead to the gulf war were mainly responsible for the high volatility states that began as early as the last week of September 1989. The bleak prospects due to a bulging deficit and the resulting cutbacks in spending prolonged the high volatility period, reflecting the uncertain political and economic environment. Stock market activity declined by the first quarter of 1992 as the anticipation of continued low growth due to natural calamities (Mt. Pinatubo eruption) and the power shortage was being realized.

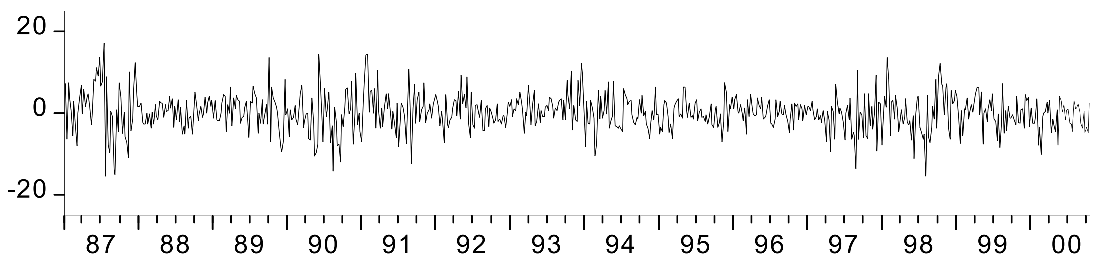
The relaxation of restrictions on the capital account was mainly responsible for the third high volatility episode that began in the last quarter of 1993. This liberalization effort began in the middle of 1991 when the Foreign Investments Act was signed into law. This law removed restrictions on foreign investments gradually over a span of three years. This was followed by the relaxation of the rules on foreign exchange transactions by the Central Bank in the first quarter of 1992. In the third quarter of the same year, the government removed all the remaining restrictions, thus allowing foreign investors to freely repatriate their capital (See Bekaert and Harvey, 1998). By the start of the second quarter of 1993, repatriation of cash dividends without Central Bank approval was allowed by the government. In the middle of 1993, the stock price index climbed rapidly because of foreign demand. In the diagram, the high volatility episode began in the third quarter of 1993, reflecting both increased market activity and heightened uncertainty brought about by the inflow of foreign portfolio funds. The stock market boom continued until the middle of 1994. It is interesting to note that the stock market did not react to the Mexican crisis of December 1994.

The fourth high volatility episode seemed to have been triggered by events that led to the Asian currency crisis of 1997. The first clear sign of the crisis appeared during the first week of May 1997 when Japanese policy makers contemplated on raising interest rates to prop up the Yen that has been declining. While this was not implemented, it triggered a sell-off of East Asian currencies by global investors that affected the local stock markets. By the middle of this month, the Philippine authorities raised overnight rates and sold dollars to defend the exchange rate. Foreign capital moved out as quickly as it came in during the third high volatility episode. Ultimately, the pressure led the Philippines to devalue its currency. Notice in the diagram that this fourth high volatility period began in the second week of April 1997 while the bust period began in July 1997, which coincided with the formal commencement of the Asian crisis. Thus, the start of the fourth high volatility period was ahead of the crisis by three months.

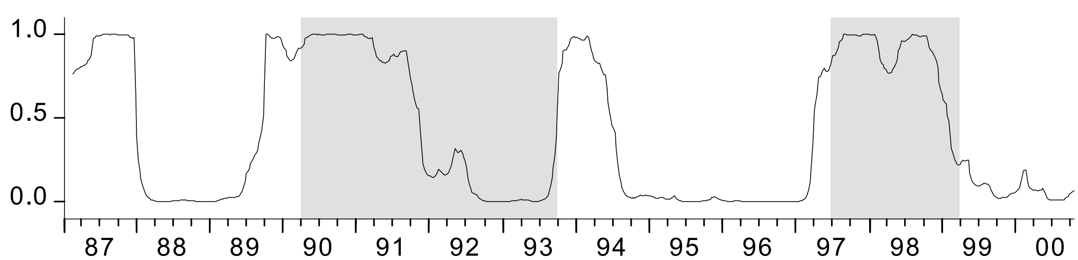
Table 1
Parameter estimates of switching-ARCH(2, 3)
2-18-1987 to 10-25-2000

	ϕ_0	ϕ_1	α_0	α_1	α_2	α_3	p_{11}	p_{22}	$g(2)$
Estimate	0.179	0.107	5.974	0.084	0.162	0.121	0.987	0.981	3.817
Std. error	(0.136)	(0.037)	(0.944)	(0.047)	(0.058)	(0.058)	(0.007)	(0.011)	(0.637)

Figure 1
Stock return and
smoothed probability of a high volatility state from switching-ARCH model



Weekly stock return



Probability of a high volatility state

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Endnotes

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[1] See for example, Kim and Kon (1994) and the references cited therein.

[2] Lagrange multiplier tests on the residuals of OLS estimates of equation (1) showed the presence of ARCH effects. ARCH estimation in this study makes use of the first 5 observations to implement Hamilton's non-linear filter.

[3] A switching-ARCH(2, 4) model was estimated but yielded an insignificant coefficient at lag 4 in the variance equation; estimation at higher lags was discontinued because of this.

[4] Note that while the states themselves are highly persistent, the effects of volatility as revealed by the switching-ARCH estimates are not. This is reflected in estimates of the decay parameter, λ, of the ARCH processes. A GARCH(1, 1) specification was fitted to the data and persistence effects compared with the switching-ARCH estimates. The volatility effects for the switching-ARCH model die out in 2 months ($\lambda^8 = 0.027$) while those of the GARCH model persist for more than a year ($\lambda^{52} = 0.091$). The details of the computation of the GARCH coefficients and the decay parameters are not reported in the study but can however be seen in Hamilton and Susmel (1994).

[5] Bekaert and Harvey's (1998) Appendix A provides a listing of major political and economic events in various countries including the Philippines from 1980 to 1997.