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EFFICIENCY OF THE PHILIPPINE STOCK EXCHANGE USING SERIAL CORRELATION AND VARIANCE RATIO TESTS

BY

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DISSERTATION

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Economics

MENTOR

READER

READER

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Finally, to the Philippines' investing public, who suffer most in moments of crisis and speculative attacks, and credited least in times of expansion and development; I dedicate this to you.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

Literature regarding the efficiency of the Philippine stock markets is limited because most writers take it as a fact that the market is inefficient. Dumlao-Arceo (1999), Dela Pena (1999), Vercasion (1999), Redulde (1989), Constantino (1990), Bueno (1992) and Adad (1982), among others, are examples. Now that the Philippine Stock Exchange (PSE) is fresh from its latest scandal, the 1999 BW Resource, Inc. controversy, the perception of its inefficiency is as strong as ever. This further justifies researchers' tendency to either rationalize the market's inefficiency or simply jump to the topic of profitability using technical trading rules, without actual quantitative proof of the market's inefficiency (or efficiency).

This paper quantitatively tests the degree of efficiency of the market using serial correlation[1] and variance ratio[2] tests. In so doing, this paper figures the number of firms considered efficient and otherwise. Based on these results, one may figure the degree of efficiency of the PSE. By degree of efficiency, the test will specifically point as to which stocks are considered efficient. It will show the percentage of stocks that are inefficient.

On the more technical aspect, the serial correlation test, popularized by Fama (1965), checks the degree of market's efficiency. Specifically, no serial correlation

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[1] Kolb and Rodriguez (1995) provide an introductory discussion on how serial correlation may be used to test for efficiency. Fama (1970) provides more rigorous discussion on serial correlation testing. LeRoy (1989) has a more up to date discussion on using serial correlation in general.

[2] I got the idea of using variance ratio test from Parantap Basu.

accepts the efficient market hypothesis. This rule goes consistently with a martingale sequence, supposedly having a "fair game" rate of return as introduced by Samuelson (1965).

The presence of serial correlation only rejects the random walk sequence but does not necessarily indicate inefficiency. Fama (1970) proposes that by using a less restrictive condition of submartingale sequence, low serial correlation may persist in an efficient market. The Lucasian efficient market valuation (1978) may also be used to show for the possibility of serial correlation under efficient market. Returns' serial correlation may also exist resulting from diminishing returns, as proposed by Basu and Vinod (1994).

To test whether the serial correlation warrants inefficiency, this paper uses a simplified Alexander (1961) filter rule to figure whether the technical trading rule can beat the buy and hold strategy. Consistent with Fama's (1970) argument, if technical trading rule beats the buy and hold strategy, then the stock is inefficient. Otherwise, the stock is considered efficient.

Obviously, the simplified filter rule that will be employed represents only one of infinite number of technical trading rules possible. For instance, one may use either a more sophisticated Alexander filter rule (1961), moving averages used by Brock, Lakonishok, and LeBaron (1992), support and resistance by Wyckoff (1910), channel breakouts using Dow Theory,[3] and on-balance volume (OBV) averages used by Granville (1963).[4] This necessitates for a more restrictive test for efficiency: the random walk test.

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[3] Hamilton (1922) and Rhea (1932) gives rigorous explanation of the Dow line.
[4] Sullivan, Timmermann and White (1999) provide short discussion explaining how these mentioned technical trading rules work.

This paper uses the variance ratio test popularized by Lo and MacKinlay (1988) and used by Fama and French (1986) to indicate whether stock returns' behave consistently with random walk. A variance ratio equal to one accepts the efficient market hypothesis and that the particular stock follows a random walk. A variance ratio not equal to one does not necessarily reject the efficient market hypothesis due to the probable presence of a submartingale sequence. However, it automatically rejects the random walk process.

To check the validity of the tests, this paper compares the PSE's performance relative to its ASEAN neighbors' equities markets and the U.S. who supposedly has the most efficient market. If the tests are proper, the most developed, greatest market capitalization and best credit rating countries should have the most efficient equities market. This argument goes consistently with intuition, also expressed by Harvey (1995). The most open, as proposed by Basu and Morey (2000), should also be the most efficient.

It will also check the validity of the tests by comparing each stock's efficiency with its value of stocks traded and market capitalization. If the tests are proper, firms with the greatest value of stocks traded and greatest market capitalization should tend to be the most efficient. Again, this goes consistently with Harvey's (1995) intuition.

Finally, it will check the validity of the tests by comparing the results of the serial correlation and variance ratio test results. If the tests work well, they should not contradict each other. For example, an efficient stock using variance ratio test must also be efficient using serial correlation test.

This chapter serves as introduction. Chapter 2 briefly covers the literature discussion regarding the inefficiency of the Philippine stock markets. Chapter 3 provides

the literature on theoretical discussion on serial correlation, variance ratio, random walk and efficient market hypothesis. Chapter 4 describes the methodology of testing the efficiency and randomness of the Philippine Stock Exchange. Chapter 5 shows the tests and observations, and discusses the implications. Chapter 6 concludes.

CHAPTER 2

LITERATURE REGARDING THE EFFICIENCY OF THE PHILIPPINE STOCK MARKETS

2.1 Introduction

The chapter briefly discusses the common perception, recent events and quantitative researches regarding the inefficiency of the Philippine stock markets.

2.2 Academic researches

Literature regarding the efficiency of the Philippine stock markets is limited because most writers take it as a fact that the market is inefficient. Usually, either research works rationalize the market's inefficiency or simply jump to the topic of profitability using technical trading rules, without actual quantitative proof for the market's inefficiency (or efficiency). Such works include those of Redulde (1989), Constantino (1990), Bueno (1992) and Adad (1982).

Redulde assumes the Philippine stock markets' inefficiency as common knowledge. She reasons the assumption due to the "government's inability to effect and enforce rules and regulations in the stock market as unscrupulous brokers trade stocks of corporations where they are also directors and officers." Constantino provides discussion on how one can profit from the stock exchange. However, his discussion is purely theoretical and does not discuss whether this holds true empirically.

Bueno (1992) introduces her paper stating that Philippine traders and investors do not often use technical trading analysis because either they are not familiar with the approach or they doubt the accuracy. Thus, she rules out the possibility that traders and investors do not use technical analysis because they think the market is efficient. As will be discussed later, technical trading strategies cannot beat a buy-and-hold strategy in an efficient market. Thus, if the market is efficient, investors might as well do away with technical trading strategies.

In addition, using pricing patterns and graphical trends, she concludes that there is sufficient way to make profit in the Philippine stock markets. Although her analysis is graphically rigorous enough, it still remains graphical in nature and lacks quantitative merit. And even if it is true that there is sufficient way to profit using such analysis, she does not cover whether the profit is enough to beat the buy-and-hold strategy.

Adad discusses the usefulness of technical analysis as tool to time when a stock should be sold or bought. Here, she uses weekly data to track graphical trends to prove her point. However, she does not attempt to rationalize for the existence of such trends. She does not cover whether these trends happen by chance or these trends occur as reflection of market inefficiency. Like Bueno, the author does not discuss whether the use of technical analysis can result to profits greater than a usual buy-and-hold strategy.

2.3 Recent events

Recent press releases that suggest market inefficiency include those of Dumlao-Arceo (1999), Dela Pena (1999) and Vercasion (1999). Dumlao-Arceo justifies market inefficiency by discussing the case of Asia Pacific Equity Corp. (APEC), which the

market perceives as a crony chip. A crony chip refers to stocks of companies owned by someone close to President Estrada. Given APEC and Lucio Tan's[1] Tanduay Distillers, Inc.'s financial positions, a capital infusion of the latter to the former will increase APEC's stock price. However, as price of APEC stocks went up before the announcement of capital infusion, she concludes that some investors must have known the move in advance and took advantage to their own benefit. While it is probably true that insider trading persisted in APEC, she assumes without quantitative proof that APEC is the rule rather than the exception.

She also implies market inefficiency by going through basic facts that make the Philippine Stock Exchange (PSE) vulnerable to insider trading. For example, she quoted Liboro, research head of Orion-Square Capital, Inc., about the ease to affect market prices. Liboro indicated that P600 million a day is all it takes to manipulate the market.[2] She also quoted Ackerman of I.Ackerman and Co., Inc. who estimates that 20% to 30% of all trades are based on rumors. Some basic facts also include the following.

1. Admittance of the Philippine Securities and Exchange Commission (SEC) of the difficulty to enforce laws regarding insider trading.
2. The ease to manipulate the market through block sales.[3]
3. The concentration of ownership of stocks by a few elite
4. Board membership of brokers in particular listed companies; etc.

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[1] The market perceives Lucio Tan to be one of the biggest cronies under President Estrada.
[2] At the exchange rate of P40/$, P600 million is equivalent to $15 million.
[3] Block sales refer to privately negotiated deals involving stocks worth more than P5 million or $125,000. The price band of 50% up and 40% does not cover the price of "block sales" down. The law requires suspension of trade of a particular stock whose price increases by 50% up or 40% down until the company explains the fluctuation to the SEC.

These facts undoubtedly make the PSE vulnerable to inefficiency. However, this does not mean that some actually take advantage enough to consider the market inefficient.

Dela Pena covers the recent findings of the Brokers and Exchange Department (BED), the SEC unit that oversees the equities market. These include the following.

1. Some recent block sales were executed even without approval from the PSE floor trading arbitration committee.
2. In some cases, transacting parties deviated from the prices approved by PSE.
3. There were cases where shares purchased through block sales were sold a day after at a profit.

While these hold true, BED also fails to indicate whether this is the rule rather the exception.

Finally, Vercasion reports the latest survey by the Makati Business Club.[4] As indicated, 43.3% of respondents think that cronyism is the most critical issue facing the Estrada administration. This result remains a function of perception and perception does not have to be true always.

With such negative sentiment of the stock market comes the BW Resource, Inc. scandal. The alleged manipulation supposedly started in March 1999 when the stock's price steadily went up 900% from P2.50 to about P25 by mid June 1999. Just as the price settled to early September 1999, the price went up again about 300% from P25 to P97 in less than two months before it went down again to about P25 in about two weeks.

As to how this happened, many suspected that volatility occurred when company executives and stock brokerages, who have advanced knowledge of probable capital

[4] Makati City is the financial capital of the Philippines.

infusion by Stanley Ho, started buying and selling the stocks.[5] This prompted PSE's compliance and surveillance department and the Philippines' Securities and Exchange Commission (SEC) to investigate the matter.

When the PSE's compliance and surveillance unit finished its preliminary investigation, it recommended indictment of several member brokers. Such brokers allegedly include those associated or owned by some members of the PSE's board of directors. Just as soon as the report was submitted, the PSE's board of directors decided to lift the recommendation.

This resulted to the compliance and surveillance unit's mass resignation, including that of its head Ruben Almadro. Specifically, Almadro stated that the "structural defect of the stock exchange" results from the fact that the market is broker controlled which makes the PSE a "den of manipulators". With that, he concludes that some cover up must have occurred in the process (Associated Filipino Press, 2000). Whether there is truth to such statement, this remains an allegation and is still subject to legal investigation.

With all the turmoil going on within the PSE, the SEC continued its own investigation of the alleged anomaly. Adding to the negative sentiment came when SEC's then Chairman Perfecto Yasay claimed to have received phone calls from President Estrada who asked him to clear the BW Resource, Inc.'s majority stockholder, Dante Tan, for insider trading. Dante Tan is said to be a friend of President Estrada.[6]

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[5] Stanley Ho is supposedly one of the richest casino tycoons in Asia. As to what really happened, many specific explanations remain as accusations.

[6] President Estrada denies ever asking then Chairman Yasay to clear Dante Tan.

On 7 March 2000, the SEC suspended the PSE's self-regulatory organization (SRO) status until it met several changes. An SRO refers to companies who may independently operate and police its own ranks, without much interference from the SEC. For example, before the scandal, the PSE had SRO status in that it set much of its trading rules and investigated possible illegal trading within.

Before the PSE could gain its SRO status, it needed to do among others the following. First, the PSE was supposed to increase its non-broker members of the board to majority, or at least eight out of fifteen members. Second condition represents an approved plan of demutualization of the PSE. This means a conversion of the PSE from a broker controlled company to a publicly listed and owned company. Third, the PSE must reinstate and regroup the PSE's compliance and surveillance group. Apparently, these requirements have been met as the PSE regained its SRO status on 8 September 2000 (Diaz, 8 September 2000). Whether this will make the bourse more efficient (or inefficient), time will tell.

More importantly, the scandal prompted the Philippine government to include in the new Securities Regulation Code a law barring a broker to act as dealer, and vice versa. A dealer is one who buys and sells stocks for the account of the company he or she is working for. A broker is one who buys and sells stocks in behalf of his clients. If this law takes in effect on 1 January 2001, theoretically, a broker may still be a board member of a listed stock but may still buy and sell stocks only through a dealer (Diaz, 31 August 2000). Hence, a broker and a board member may still have advance information and trade, but at a cost that must be paid to a dealer.

2.4 Quantitative researches

Quantitative researches include those of Basu and Morey (1997) and Basu, Kawakatsu and Morey (2000). Both use autocorrelation and variance ratio to test the efficiency of several emerging markets including the Philippines. The former includes monthly returns from January 1988 to October 1997, and concludes in favor of market efficiency. The latter include monthly returns from January 1988 to August 1999, and conclude against market efficiency at least at 10% level of significance.[7]

However, the study uses only one index on a monthly basis.[8] For this reason, it does not go as far as testing specific stocks.[9] In addition, the fact that the study involves monthly returns opens the possibility that such result may have failed to capture price manipulation on a daily basis.

For example, consider BW Resource, Inc., which is currently under investigation by the Philippine Securities and Exchange Commission for alleged insider trading.[10] Figure 2.1 includes three time series data. The most volatile represents the daily price while the two smoother lines represent the average of the month and beginning of the month prices. Suppose that insider trading actually took place between the middle of May to the end of June. The monthly average and beginning of the month data will most likely fail to capture the upward trend that went on for one and a half months. While the daily data will have at least thirty observations to capture the trend, the monthly data will have

---

[7] The second paper also tests for the stationary property of stock prices using Elliot, Rothenberg and Stock (1996) efficient autoregressive unit root test.

[8] Though not specified, this is supposedly the Composite Index.

[9] With all fairness, Basu and Morey conducted the study for several emerging markets, not particularly for the Philippines only. For this reason, they did not get as much involved with the Philippines as much as this paper is.

only as much as two. Suppose now that insider trading actually took place between 23 September to 18 October. In this short period of time, the price "bubbled" from about P20 to P100 and "burst" from about P100 back to P20 in less than a month. Again, the monthly figures will most likely fail to capture the manipulation. While the daily data will have at least fifteen numbers to capture the trend, the monthly data will have only one.

2.5 Closing remarks

The preceding qualitative researches and press releases imply a consensus that the Philippine stock markets are inefficient. This paper tests this, however quantitatively. The preceding quantitative researches indicate mixed conclusions regarding the PSE's efficiency. This paper will check this by more rigorously testing whether the Philippine Stock Exchange is efficient or otherwise. [11]

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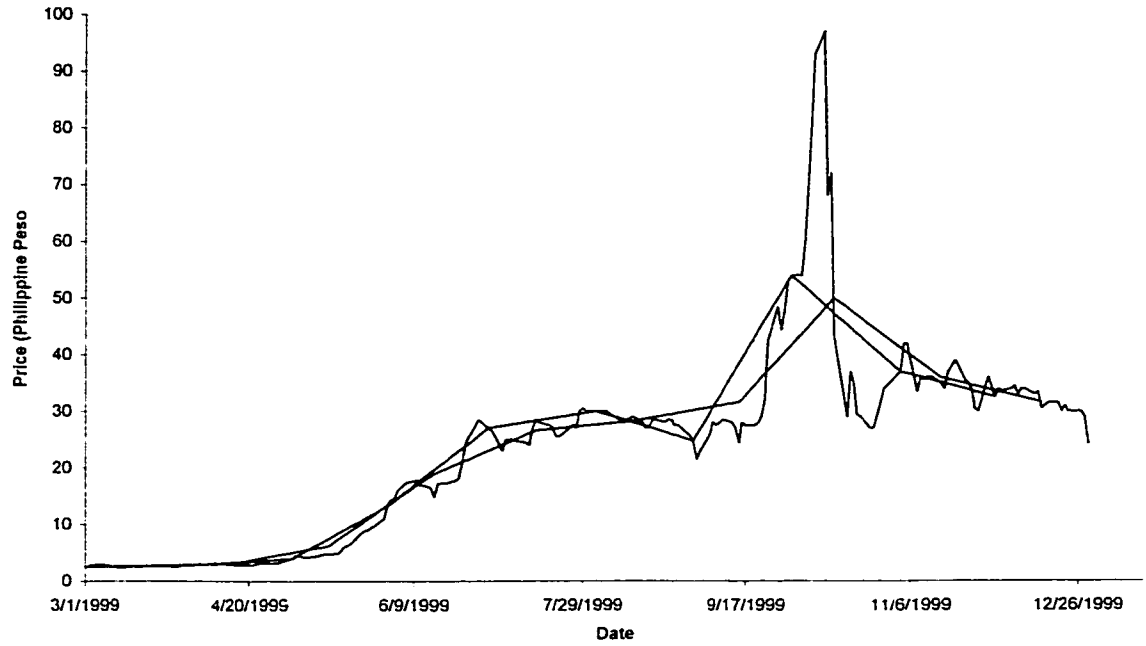
[10] The SEC and the Philippine Senate has just started the investigation. Whether this will lead to conviction, time will tell.

[11] With all fairness, all researches discussed cover time periods that are not as updated as this paper covers, and some intentionally did not write their articles as rigorous.

FIGURE 2.1
BW Resource, Inc. - 1 March 1999 - 29 December 1999



CHAPTER 3

EFFICIENT MARKET HYPOTHESIS, RANDOM WALK PROCESS, SERIAL CORRELATION AND VARIANCE RATIO

3.1 Introduction

This chapter discusses the theoretical characteristics of the efficient market hypothesis, random walk process, serial correlation and variance ratio. It covers the implication of the random walk process on the efficient market hypothesis. Then, it shows how serial correlation and variance ratio may be used to test market efficiency and the random walk process.

3.2 Efficient market hypothesis

When economists say that the security market is efficient, two conditions hold. First, investors easily have access to information. Second, security prices already reflect all relevant and ascertainable information.[1] Such information includes past returns, recent publications and dividend payments.

More specifically, a weak-form efficient market is a market where prices reflect all historical data. Consistent with Fama (1991) and Roberts (1967), and discussed by LeRoy (1989), historical data includes variables as prices, dividends and interest rates. A semi-strong-form efficient market is a market where prices reflect all historical data and all readily available information. Finally, a strong-form efficient market is a market where

[1] Brealy and Myers (1991) provide short and simple definition of efficient market.

no specific investor has relevant information not available to the public and that allows him or her to earn profit greater than the rest of the market.

Suppose the market is efficient and new information continuously comes. It follows that security prices continuously change so as to incorporate the new information. Good news and bad news, by its nature, randomly comes. If they do not come randomly, then they cannot be new. Thus, price changes randomly as new information dictates (Black, 1971). Such statement goes consistently with equation 3.1.

$$P_{t+n} = P_t + e_{t+n} \qquad 3.1$$

Note that "P_{t+n}" represents the price at period t+n, where "n" is a number greater than zero; "P_t" represents the current price; and "e_{t+n}" represents a serially uncorrelated error term. In such case, the price at period t+n equals the current price plus some random error (or random information) that nobody can predict.

Rearranging relation 3.1 results to relation 3.2.

$$P_{t+n} - P_t = e_{t+n} \qquad 3.2$$

Relation 3.2 states that the difference between the price at t+n and the current price equals the random error. In other words, the return from now to period t+n equals some random error. Since the returns come randomly, then the return on a specific period is independent of the return on another period.

In contrast to an efficient market, an inefficient market's stock prices do not fluctuate randomly at all. For example, suppose that investors do not have equal access to new information. Also suppose that new information indicates that a particular security is over priced. As a result, price goes down one day so as to reflect the changing supply and demand of those investors with advance access to information. The next day, price goes

down again so as to reflect the changing supply and demand of those with one-day delayed access. The next day, the same happens due to those investors with two-day delayed access. Thus, price changes follow a certain pattern. In this case, price tends to go down for three consecutive days.

Another example of market inefficiency takes place when everyone has equal access to information, except that investors systematically misinterpret any new information given. Case in point, when new information dictates the price to supposedly go down, everyone reacts so as to affect prices to go up. The next day, the economic agents correct its previous reaction causing prices to go down. Thus, new information that supposedly decreases the price of a stock results to a decrease-increase sequence of daily prices. Likewise, new information that supposedly increases the price of a stock results to an opposite sequence. Thus, price changes and rates of return follow a certain pattern again.

3.3 Random walk process

Suppose that for a constant n and for any given t, the variance of the error term, e_{t+n}, is constant.[2] Then, the market behaves consistently with a random walk process. The random walk process has two conditions.[3] First, it asserts that successive returns are independent. Thus, the correlation between one period's return and the next equals zero.

---

[2] Note that the variance may change as n changes.

[3] Kolb and Rodriguez provide short and simple discussion of a random walk process.

Second, the probability distribution of returns is the same every period. This implies that the expected rate or return is constant.[4]

Numerous tossing of a coin presents an example of a random walk. First, the outcome of a toss has nothing to do with the outcome of previous tosses. Second, for every toss, the probability of getting a head or a tail remains the same. Applying the same example for a stock, its rate of return on Tuesday has nothing to do with the same stock's rate of return on Monday. Also, if a stock has 50% chance of having a 5% daily rate or return on Monday, the same holds true on Tuesday, Wednesday, etc.

Take note that an efficient market needs only the first condition of the random walk process. That is in an efficient market, prices fluctuate randomly but the variation of fluctuation does not have to be constant. In this sense, the random walk process is a sufficient but not necessary condition of an efficient market.

3.4 Serial correlation

3.4.1 Definition

Serial correlation refers to the relationship between the returns in different periods for the same stock.[5] In an efficient market, a stock's return today is independent of the same stock's return on any other day. Thus, returns cannot have serial correlation. For example, suppose the stock of Ayala Corp. has serial correlation, then its return on a specific trading day has relationship with its return on some other trading day. If the difference between the days is one trading day, the stock has correlation between one day

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[4] This does not mean that the variance takes a finite value. In fact Granger and Newbold (1986, p. 40) finds that the variance of a random walk takes an infinite value.

[5] Kolb and Rodriguez (1995) provide short and simple textbook discussion.

and another of "lag 1." If the difference between the days is two trading days, the stock has correlation between one day and another of "lag 2." If the difference is "q" trading days, it has correlation between one day and another of "lag q."

If no serial correlation persists, then the sign of the return today has no bearing on tomorrow's return. Figure 3.1 shows what appears to have no correlation, where points of occurrences lie randomly around the origin. This may follow a random walk process. If positive correlation persists, then a positive rate of return today will tend to be followed by a positive rate of return tomorrow. Inversely, a negative rate of return today will tend to be followed by a negative rate of return tomorrow. Figure 3.2 shows what a positive correlation might appear. As shown, most dots lie on the southwest and northeast of the quadrant.[6] If negative correlation persists, the opposite of a positive correlation persists.

[6] The fact that most dots lie on the southwest and northeast quadrants is not too obvious, visually. However, when tested, Banks and Financial Index will have a positive serial correlation greater than twice its standard error.

FIGURE 3.1
Universal Rightfield Prop. Hldgs., 3 August 1998 to 30 July 1999

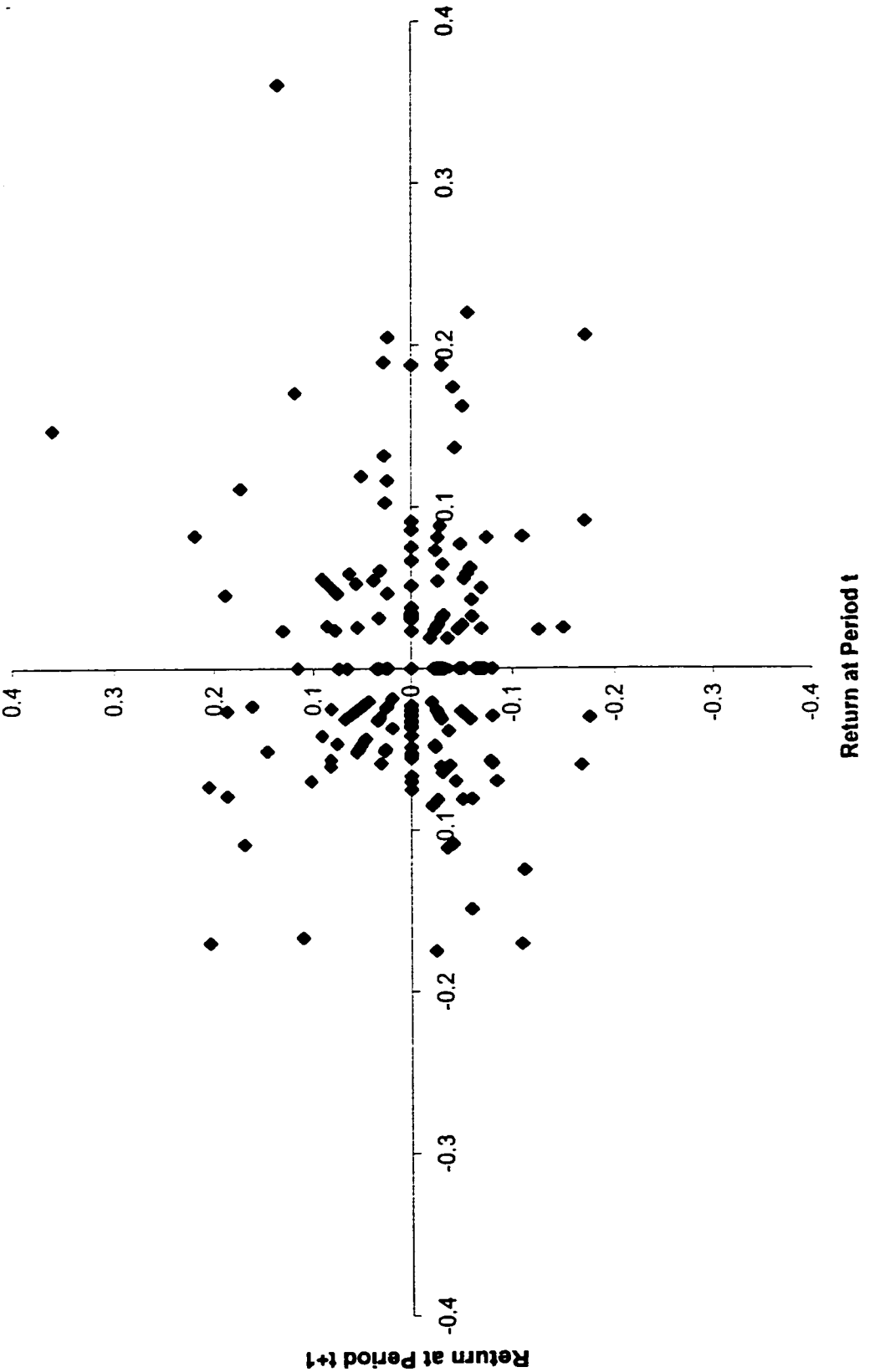
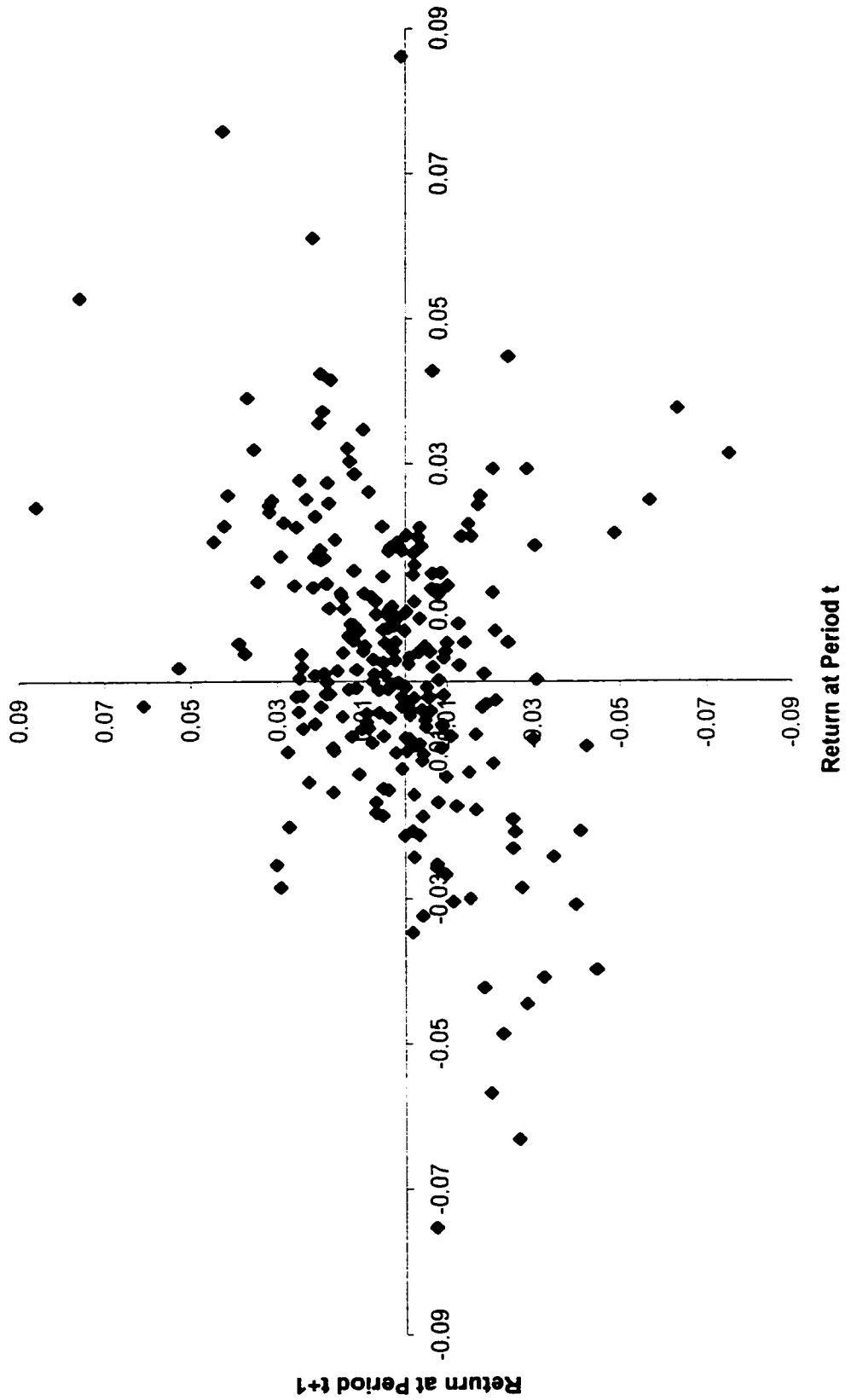


FIGURE 3.2
Banks and Financial Index, 3 August 1998 to 30 July 1999



When serial correlation persists, a technical trading strategy becomes possible. For example, suppose the serial correlation is 0.1. If a stock has a return today of 20%, the stock will likely have a return of 2% tomorrow.[7] Thus, one can buy the stock today for a probable return of 2% tomorrow.

3.4.2 Martingale sequence

The non-stochastic version of equation 3.1 follows.

$$E(P_{t+n} \mid \phi_t) = P_t \qquad 3.3.a$$

Note the following notations. "E" equals the expectation parameter, and "ϕ_t" equals the information sequence at period t. Relation 3.3.a states that the expected price of a stock on period t+n, as projected on the basis of the current information (ϕ_t), is equal to the current price.

Rearranging equation 3.3.a results to equation 3.4.a.

$$E(P_{t+n} \mid \phi_t) - P_t = 0 \qquad 3.4.a$$

Equation 3.4.a states that the expected return from period t to period t+n, as projected on the basis of the current information, equals zero. When equation 3.4.a holds, economists describe the price sequence as martingale. Thus, an efficient market may follow a martingale sequence.

Dividing both sides of equation 3.4.a by the current price results to equation 3.5.a.

$$\frac{E(P_{t+n} \mid \phi_t) - P_t}{P_t} = \frac{0}{P_t} \qquad 3.5.a$$

[7] 0.1 of 20% is 2%.

The left side represents the expected rate of return, as projected on the basis of the current information. The right side equals zero. Equation 3.6.a alternatively represents equation 3.5.a.

$$E(R_{t+n} \mid \phi_t) = \frac{E(P_{t+n} \mid \phi_t) - P_t}{P_t} = 0 \qquad 3.6.a$$

Here, "R_{t+n}" equals the rate of return from period t to t+n. Equation 3.6.a states that the expected rate of return as projected on the basis of current information equals the "fair game" rate of return of zero (Samuelson, 1965). Since the expected rate of return is subject to random error, then it should fluctuate randomly around zero. Thus, the serial correlation should equal zero.

3.4.3 Sub-martingale sequence

Fama (1970) relaxes equation 3.3.a to equation 3.3.b as necessary condition of an efficient market.

$$E(P_{t+n} \mid \phi_t) \geq P_t \qquad 3.3.b$$

Relation 3.3.b states that the expected price of a stock on period t+n, as projected on the basis of the current information (ϕ_t), is greater than or equal to the current price. If the expected price is less than the current price, the market anticipates an expected loss.[8] When current information indicates an expected loss, rational economic agents will stay away from buying the stock. By law of supply and demand, the current price of the stock will fall until it equals the opportunity cost of buying the stock.

---

[8] For example, suppose the current price of a stock is P8 and the expected future price is P5. Then the expected loss is P5-P8=-P3.

Thus, if the opportunity cost is zero, the current price will go down until it equals the expected future price. If the opportunity cost is greater than zero, then current price will go down until it is less than the expected future price, where the expected profit equals the opportunity cost.[9] Note that under normal conditions, the minimum opportunity cost is zero. Even if all stocks reflect negative expected returns, rational economic agents will not invest and hold on to their funds in cash, gold or treasury bills, which have at least zero expected profit.

Rearranging equation 3.3.b results to equation 3.4.b.

$$E(P_{t+n} \mid \phi_t) - P_t \geq 0 \qquad 3.4.b$$

Equation 3.4.b states that the expected return from period t to period t+n, as projected on the basis of the current information, is greater than or equal to zero. When equation 3.4.b holds, economists describe the price sequence as sub-martingale. Thus, an efficient market may follow a sub-martingale sequence.

Dividing both sides of equation 3.4.b by the current price results to equation 3.5.b.

$$\frac{E(P_{t+n} \mid \phi_t) - P_t}{P_t} \geq \frac{0}{P_t} \qquad 3.5.b$$

Equation 3.6.b alternatively represents equation 3.5.b.

$$E(R_{t+n} \mid \phi_t) = \frac{E(P_{t+n} \mid \phi_t) - P_t}{P_t} \geq 0 \qquad 3.6.b$$

Equation 3.6.b states that the expected rate of return as projected on the basis of current information is greater than or equal to zero. Though the expected rate of return is subject

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[9] For example, suppose the current price of a stock is P8, the expected future price is P5 and the opportunity cost is P1. Then the current price will go down to P4 where the expected profit is P5-P4=P1.

to random error, it remains positive. If the expected rate of return persistently stays at a certain range not equal to zero, testing for the relationship between successive rates of return may result to serial correlation.

The Lucasian efficient market valuation (1978) presents an alternative explanation why the expected rate of return exceeds zero. The derivation of such starts with the Keynes-Ramsey First Order Condition as given.[10]

$$U'(C_t) = \frac{U'(C_{t+1})(1 + R_{t+n})}{1 + \rho}$$

Note that U equals the utility function. C_t and C_{t+1} represent consumption, and ρ is the rate of time preference. In other words, the foregone satisfaction from consumption today equals the present value of tomorrow's satisfaction from consumption.

Finally, solving for the rate of return results to the following.

$$(1 + \rho)\frac{U'(C_t)}{U'(C_{t+1})} - 1 = R_{t+n}$$

Since the left side of the equation does not have to be zero, then the rate of return does not necessarily equal zero.[11]

Returns' serial correlation may also exist resulting from diminishing returns (Basu and Vinod, 1994). Suppose the return from period t to period t+1 is 5%. Now, suppose a favorable technological break-through occurs from period t+1 to t+2, resulting to an increase return of say 10%. The 10% return consequently increases capital accumulation

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[10] One may review the derivation of the Keynes-Ramsey Intertemporal Efficiency Condition in Dumlao (2000).

[11] In fact, under risk neutrality; the marginal utilities equal. This results to a rate of return that exactly equals the rate of time preference. The rate of time preference happens to be positive most of the time, if not all the time.

towards t+3. With diminishing marginal returns, the additional capital accumulation results to lower return, say 6%. Given (R_{t+1},R_t), the data collected is (10%,5%) and (6%,10%). Plotting the two data and connecting them results to a line that is negatively sloped. In respect to this paper's thesis, the sequence of returns from 5% to 10% then to 6% results to negative serial correlation.

3.4.4. When does a serial correlation constitute inefficiency?

The natural question now becomes "when does a serial correlation constitute inefficiency?" The answer to this goes back to equation 3.6.b's implication as mentioned by Fama (1970). Specifically, the relation states that the expected rate of return by buying and holding a security for an extended period of time is greater than or equal to the expected rate of return by adopting a technical trading rule of "buying, selling, holding cash, buying, selling, holding cash, etc." The reason for this lies in the fact that holding cash always results to a zero rate of return.

Although Fama does not specifically explain how this holds true, one may see the intuition by comparing the expected returns using each strategy. Whenever one holds cash, the investor loses the opportunity of earning a possible greater than zero expected rate of return.

Table 3.1 illustrates a hypothetical example comparing the expected profitability between the usual "buy and hold" strategy and a technical trading rule. Suppose that current information projects that the expected rate of return from period t to t+4 equals 8%. In essence, the market expects an 8% rate of return after four periods or an

approximately 2% expected rate of return from one period to the next.[12] As indicated, the buy-and-hold strategy ultimately beats the technical trading strategy of 8% compared to 4%.

Table 3.1

Period	t+0	t+1	t+2	t+3	t+4	$E(R_{t+4}\|\phi_t)$
Buy-and-hold	Buy stocks worth P1	Hold stocks worth P1.02	Hold stocks worth P1.04	Hold stocks worth P1.06	Hold stocks worth P1.08	8%
Buy-sell-hold cash-buy-sell-hold cash-etc.	Buy stocks worth P1	Sell stocks worth P1.02	Hold cash worth P1.02	Buy stocks worth P1.02	Sell stocks worth P1.04	4%

Now, suppose that the serial correlation of lag 1 is 0.01 and the one-year expected rate of return is 25%. If today's price change results to 5% rate of return today, one may buy a stock now and sell it tomorrow for a likely rate of return of 0.05%.[13] This means that the buy and sell strategy will exceed the one-year buy and hold strategy after this occurs about 446[14] times! Thus, even if the serial correlation persists in the rates of return, the serial correlation must be high enough relative to the rate of return to warrant

[12] $(1+0.02)^4 \approx 1.08$

[13] 0.01 of 5% is 0.05%.

[14] $1.005^t = 1.25$; $t = \ln(1.25) / \ln(1.0005) \approx 446$.

an expected return greater than the return using the conventional buy-and-hold strategy before one can fully contradict the efficient market hypothesis.

3.4.5 Serial correlation summary

A strict condition of market efficiency follows a martingale sequence. A martingale sequence results to zero serial correlation. In this sense, zero serial correlation represents a sufficient but not necessary condition for the market to be efficient.

The most relaxed condition of market efficiency follows a sub-martingale sequence. A sub-martingale sequence may result to serial correlation. For the market to be efficient, the serial correlation should not be high enough relative to the rate of return to "predict the future in a way which makes expected profits greater than they would be under a naïve buy-and-hold model, (Fama, 1965)." Thus, a low serial correlation represents a sufficient and necessary condition for the market to be efficient.

Thus, when using serial correlation to test market efficiency, no serial correlation accepts the efficient market hypothesis and supports the possibility that the market follows a random walk process. Second, a low serial correlation still accepts the efficient market hypothesis, but rejects the random walk process. Third, high serial correlation rejects both the efficient market hypothesis and the random walk process. Table 3.2 summarizes the results.

Table 3.2			
Serial correlation test result →	No serial correlation	Low serial correlation	High serial correlation
	Accept efficient market hypothesis Accept possibility of random walk process	Accept efficient market hypothesis Reject random walk process	Reject efficient market hypothesis Reject random walk process

3.5 Variance ratio

3.5.1 Definition

Variance ratio procedure, popularized by Lo and MacKinlay (1988) and used by Fama and French (1986), serves to test whether market returns follow a random walk process.[15] Equation 3.2 implies equation 3.7.

$$P_t - P_{t-1} = e_t \qquad 3.7$$

Equation 3.7 implies that the variance of the difference between today's price and yesterday's price equals the variance of the error term. As mentioned, the random walk variance of the error term is constant for any time period. Thus, the variance of the difference between today's price and the price two days ago equals twice the variance of the error term. Likewise, the variance of the difference between today's price and the

[15] The preceding explanation comes from Basu and Morey (1998, 1997); Campbell, Lo and MacKinlay (1997); and Lo and MacKinlay (1988).

price four days ago equals four times the variance of the error term. More generally, the variance between the difference between today's price and the price q days ago equals q times the variance of the error term. Relation 3.8 generalizes the relationship mathematically.

$$\mathrm{Var}(P_t - P_{t-q}) = q\mathrm{Var}(P_t - P_{t-1}) = q\mathrm{Var}(e_t) \qquad 3.8$$

Rearranging relation 3.8 results to 3.9.

$$\frac{\mathrm{Var}(P_t - P_{t-q})}{q\mathrm{Var}(P_t - P_{t-1})} = 1 \qquad 3.9$$

This paper refers to the left side of the equality of relation 3.9 as the variance ratio.

The relation states that the ratio between $\mathrm{Var}(P_t\text{-}P_{t-q})$ and $q\mathrm{Var}(P_t\text{-}P_{t-1})$ equals 1. If this holds true, then the market must follow a random walk. This also implies that the market must follow a martingale sequence and consequently accepts the efficient market hypothesis. If relation 3.9 does not hold true, then the test rejects the random walk process. Using Fama's logic, this does not necessarily prove an inefficient market because of the possibility of a sub-martingale sequence. Thus, the result cannot lead to acceptance or rejection of market efficiency.

3.5.2 Variance ratio summary

The preceding discussion leads to the following implications. First, a variance ratio equal to one accepts the efficient market hypothesis and the random walk process. Second, a variance ratio not equal to one rejects the random walk process. Table 3.3 results.

Table 3.3	
Variance ratio test results ↓	
Variance ratio = 1	Accept efficient market hypothesis Accept random walk process
Variance ratio ≠ 1	Reject random walk process

3.6 Comparing the serial correlation and variance ratio tests

One may compare the results of the two tests whether the tests reinforce, contradict, or say nothing about each other. Table 3.4 illustrates such by combining tables 3.2 and 3.3. In this case, those boxes containing words without underline reinforce the results of the tests. For example, no serial correlation complements a variance ratio of 1 because of two reasons. First, both accept the efficient market hypothesis. Second, while the former accepts the possibility of a random walk process, the latter accepts the same process. Those boxes containing double underline words denote some contradiction. For example, low serial correlation contradicts a variance ratio of one. While the former rejects the random walk sequence, the latter accepts. Finally, those boxes containing single underline words does not denote reinforcement or contradiction. Specifically, no serial correlation does not complement or contradict a variance ratio not equal to one. While the former indicates that random walk is possible but not necessary, the latter rejects random walk.

Table 3.4			
Serial correlation → Variance ratio ↓	No serial correlation	Low serial correlation	High serial correlation
VR = 1	Accept EMH Possible RW	Accept EMH Reject RW	Reject EMH Reject RW
	Accept EMH Accept RW	Accept EMH Accept RW	Accept EMH Accept RW
VR ≠ 1	Accept EMH Possible RW	Accept EMH Reject RW	Reject EMH Reject RW
	Reject RW	Reject RW	Reject RW
Note: VR, EMH and RW mean variance ratio, efficient market hypothesis and random walk, respectively.			

3.7 Summary

No serial correlation accepts both the efficient market hypothesis and the possibility of a random walk process. Low serial correlation still accepts the efficient market hypothesis and rejects the random walk process. High serial correlation rejects both the efficient market hypothesis and the random walk process.

A variance ratio of 1 accepts both the efficient market hypothesis and the random walk process. A variance ratio not equal to 1 does not say much about market efficiency but rejects the random walk process.

Combining the two tests results to Table 3.4. The table shows whether the results of the tests reinforce or contradict each other.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter goes through the mechanics of determining the daily rates of return. It discusses the coverage of the data. Then, brief discussions on the serial correlation and variance ratio follow. It will also discuss the method of checking for the validity of the tests. Particularly, it discusses how the Philippine market will compare with that of its ASEAN neighbors and the United States. It covers how individual stocks' efficiency will compare to value of stocks traded and market capitalization. Then, it shows how the results of the two tests complement or contradict. The chapter closes by discussing other basic facts about the Philippine Stock Exchange.

4.2 Stock prices

This paper discusses prices in terms of the Philippine Peso. The strike price refers to the price in which a buyer and a seller agree to trade a stock. This paper determines the market price of a particular stock as the strike price for a particular transaction. For that reason, it picks up data or actual price of a particular stock only when transaction occurs. Thus, when no transaction occurs on a particular day, one cannot actually realize the specific market price of a stock. This limits the number of observations to the number of days that transactions occur.

The closing price and the opening price refer to the strike price of the last and first transactions in a specific trading day, respectively. The "high" and "low" prices refer to the highest and lowest strike prices during the trading day, respectively. This paper uses the closing price. In currency markets, the best indicator of the foreign exchange rate is the weighted average and not the closing exchange rate.[1] The same probably holds true with the equities market. However, the weighted average of strike prices during the day is not readily available. Among those available include the opening price, high price, low price and the closing price. This paper assumes that the closing price most closely reflects the market price of the day.

In addition, this paper does not strictly use the closing price. Rather, it uses the "adjusted" closing price to take account of possible change of par. For example, the unadjusted prices for a share of Gotesco Land, Inc. – A on 21 July 1997 and 22 July 1997 are P0.0625 and P6, respectively. The company also changed its par value from P0.01 to P1 on 22 July 1997. Without adjusting the prices, the one-day return equals 9500%.[2] This distorts the data. After all, a change of par value say from P0.01 to P1 only combines an investors 100 shares at P0.01 each to 1 share at P100 each. Thus the real equity does not change. To adjust, this divides all prices before the change in par by its original par. For example, this divides all prices before 22 July 1997 by 0.01. The adjusted 21 July 1997 price becomes P6.25.[3] Thus, the one-day rate of return equals –4%.[4]

This paper picks up the most actively traded stocks in the PSE. "Most actively" traded stocks arbitrarily include those stocks traded 9 out of 10 days the market is open.

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[1] The closing foreign exchange rate is the foreign exchange rate of the last transaction of the day.
[2] (P6-P0.0625)/P0.0625 = 95 = 9500%.
[3] P0.0625/.01 ≈ P6.25.

Thus, it picks up those traded at least 225 times, or 90% of the possible 250 trading days in the period the data covers. The idea is to get the stocks traded almost every day so that differences in prices between closing dates almost always reflect "lag 1."

4.3 Dividends

A cash dividend refers to dividends in form of cash. For example, when Philippine National Bank announces a P0.50 cash dividend, a stockholder is entitled to receive P0.50 per share holding. A stock dividend refers to dividends in form of stock. For example, when Jollibee Foods Corp. announces a 20% stock dividend, a stockholder is entitled to receive 20% of a stock per share holding or one additional stock per five shares holding. A stock right refers to special privileges to stockholders to buy additional share per specific number of share holding at a specific price. For example, if SPI Technology offers a stock right of two shares per five share holdings at a price of P19, a stockholder is entitled to buy two stocks at the price of P19 each per five share holding. Keep in mind that in a stock right, the stockholder gets rewarded only if the price is less than the market price and if he or she chooses to exercise the right.

The ex-date is the cut off date of holding a stock that gets particular cash dividend, stock dividend or stock right. For example, suppose the ex-date is 4 August 1998. Any investor who holds a share on 4 August 1998 is entitled to a dividend payment. Any person who buys a share on that day and after is not entitled to a dividend payment. If the stock is sold on 4 August, the seller gets the dividend while the buyer does not get any.

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[4] (P6-P6.25)/P6.25 = 0.04 = 4%.

Suppose t+1 and t equal transaction dates. Also, suppose that t+1 equals the ex-date. Stock's return from period t to t+1 (R_{t+1}) equals the change of price from period t to t+1 (P_{t+1}-P_t) plus the cash dividend paid on t+1. Divide the stock by the price at period t, the daily rate of return between transaction dates results. Equation 4.1 states the rate of return mathematically.

$$R_{t+1} = \frac{(P_{t+1} - P_t) + D_{t+1}}{P_t} \qquad 4.1$$

Apparently, dividend stocks and stocks rights are not in the form of cash. For that reason, relation 4.1 does not apply in measuring the rate of return. This necessitates dividend stocks and stock rights converted to their cash dividend equivalence. The cash dividend equivalence of stock dividends and rights follows. The formula for expressing a stock dividend in terms of cash dividend follows.

$$D_t = (\text{Stock Dividend at } t+1)P_{t+1} \qquad 4.2$$

For example, suppose the firm announces a 20% stock dividend.[5] This goes to say that the firm is giving stockholders 20 additional stocks per 100 stocks owned. The only way to figure the market price of a stock after a stock dividend is to take the strike price after the dividend's occurrence. Suppose the said price equals P1 per stock. Then, the 20% stock dividend equals 20 additional stocks worth P1 each. This equates to giving stockholders P20 per P100 stocks owned, or P0.20 per P1 stock owned. Thus, the cash dividend equivalent equals the product of the market price and the stock dividend.[6]

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[5] Stock dividends are usually expressed in %.

[6] Kell, Kieso and Weygandt (1993) provide textbook explanation of the nature of cash dividends, stock dividends and rights.

The formula for expressing a stock right in terms of cash dividend follows. Given "X:Y@Z," the management basically offers to sell X number of stocks per Y number of stocks owned at a price of Z. Equation 4.3 results.

$$D_t = \frac{X}{Y}(P_{t+1} - Z) \qquad 4.3$$

For example, suppose the firm announces a 3:4@P30 stock right on period t+1. This goes to say that the firm is offering to sell 3 shares at P30 each per 4 shares stockholders own. Suppose, that on ex-date, the market price equals P50 per stock. Thus, the offer equates to a P20 discount per stock.[7] Since one can take advantage of this by buying 3 for every 4 stocks owned, the cash dividend equivalence follows.[8]

$$D_t = \frac{3}{4}(P50 - P30) = P15$$

4.4 Coverage of the data

This paper uses data from August 1998 to July 1999, which covers a year of data. The test avoids the pre-Asian currency crisis regime and fall of the equities market as a result of the Asian currency crisis. Technically speaking, the Asian currency crisis started on 11 July 1997. Although the Asian currency crisis arguably started before 11 July 1997, the date marks the time the Philippine central bank, called the "Bangko Sentral ng Pilipinas" or BSP allowed the peso to float. Figure 4.1 shows this to be true. Before 11 July 1997, the foreign exchange remains relatively fixed at around P26.3/US$. The

[7] P50-P30 = P20 or P_{t+1}–Z = discount.

[8] I hard coded the cash dividends, stock dividends and rights by listed companies taken either directly from PSE, or indirectly through Bloomberg as published by the Philippine Daily Inquirer, The Manila Times and The Philippine Star. About 90% of the data were taken from The

fluctuation only started after the said date. This paper avoids including the data before 11 July 1997 because the market probably behaves differently now that the foreign exchange floats more freely in comparison to a fixed exchange rate regime.

This paper avoids the one-year data after July 1997 for two reasons. Such period represents the midst of the Asian currency crisis when most stocks fell. Table 4.1 shows this to be true. First, as noted by a sub-martingale process, the expected rate of return is greater than or equal to zero. Given the negative returns of most stocks in the said period, if the market is efficient, the investing sector cannot expect the sub-martingale sequence that Fama describes. Second, which is related to the first reason, the year does not represent a period where one can adopt a "buy and hold" strategy to profit. Instead, it represents a period where one should "sell and hold cash" or "sell and get out of the Philippine market" to save losses.[9]

Manila Times. I did not print them because of its size. However, I may share the data if the reader wishes to obtain it.

[9] I hard coded the raw data and calculated the adjusted data in a file. The data comes from either directly from PSE, or indirectly through Bloomberg as published by the Philippine Daily Inquirer, The Manila Times and The Philippine Star. About 90% of the data were taken from The Manila Times. I did not print them because of its size. However, I may share the data if the reader wishes to obtain it.

FIGURE 4.1

It also excludes data after July 1999. The reason for this lies on the fact that BSP Governor Singson stepped down and replaced by Governor Buenaventura on 6 July 1999. Although the current governor claims to have no significant policy changes, nevertheless it is a change of regime. Thus, the possibility that the market behaves differently still remains.[10]

[10] Lucas (1981) indicates the danger of econometric testing between different conditions particularly when policy parameters change.

Table 4.1 - Rate of Return from 14 July 1997 to 31 July 1998			
1 1ST PHIL. HLDGS. CORP. - A	-33.04%	31 JOLLIBEE FOODS CORP.	-36.48%
2 1ST PHIL. HLDGS. CORP. - B	-11.89%	32 JOLLIBEE FOODS CORP. - WARRANTS	-30.77%
3 ABOITIZ EQUITY VENTURES, INC.	-46.88%	33 LA TONDENA DISTILLERS, INC.	-71.25%
4 ABS-CBN BROADCASTING CORP.	-39.48%	34 MANILA ELECTRIC CO. - A	-16.67%
5 AIR PHILS. INT'L CORP.	-61.33%	35 MANILA ELECTRIC CO. - B	-33.39%
6 ALL SHARES INDEX	-41.30%	36 MEGAWORLD PROP. & HLDGS., INC.	-80.00%
7 ALSONS CEMENT CORP.	-54.75%	37 METRO PACIFIC CORP.	-62.52%
8 AYALA CORP.	-6.84%	38 METROPOLITAN BANK & TRUST CO.	-50.31%
9 AYALA LAND, INC.	-39.30%	39 MINING INDEX	-49.28%
10 BANK OF THE PHIL. ISLANDS	-40.33%	40 MONDRAGON INT'L PHILS., INC.	-89.39%
11 BANKS AND FINANCIAL SVCS. INDEX	-47.63%	41 MUSIC SEMICONDUCTORS CORP.	-69.82%
12 BELLE CORP.	-84.79%	42 OIL INDEX	-67.93%
13 BENPRES HLDGS. CORP.	-34.38%	43 PETRON CORP.	-50.00%
14 C & P HOMES, INC.	-86.22%	44 PHIL. COMMERCIAL INT'L BANK, INC.	-55.58%
15 COMMERCIAL - INDUSTRIAL INDEX	-36.55%	45 PHIL. LONG DISTANCE TELEPHONE CO.	-3.77%
16 COMPOSITE INDEX	-40.69%	46 PHIL. NATIONAL BANK	-73.93%
17 COSMOS BOTTLING CORP.	0.95%	47 PILIPINO TELEPHONE CORP.	-75.42%
18 DIGITAL TELECOMMUNICATIONS PHILS., INC	-50.00%	48 PROPERTY INDEX	-49.09%
19 DMCI HLDGS., INC.	-83.42%	49 REYNOLDS PHILS. CORP.	7.41%
20 EEI CORP.	-45.59%	50 RFM CORP.	-18.98%
21 EMPIRE EAST LAND HLDGS., INC.	-77.73%	51 SAN MIGUEL CORP. - A	5.25%
22 EQUITABLE BANKING CORP.	-51.55%	52 SAN MIGUEL CORP. - B	-12.76%
23 FAR EAST BANK & TRUST CO.	-31.68%	53 SECURITY BANK CORP.	-48.28%
24 FIL-ESTATE LAND, INC.	-92.09%	54 SINOPHIL CORP.	-87.62%
25 FILINVEST DEV'T CORP.	-67.54%	55 SM PRIME HLDGS., INC.	-12.86%
26 FILINVEST LAND, INC.	-69.49%	56 SOUTHEAST ASIA CEMENT HLDGS., INC.	-66.67%
27 GLOBE TELECOM GMRC, INC. - A	-32.84%	57 UNIVERSAL RIGHTFIELD PROP. HLDGS., INC.	-86.40%
28 INT'L CONTAINER & TERMINAL SVCS., INC.	-43.86%	58 UNIVERSAL ROBINA CORP.	-61.80%
29 IONICS CIRCUITS, INC.	-45.57%	59 UNIWIDE HLDGS., INC.	-80.84%
30 JG SUMMIT HLDGS., INC.	-48.51%	60 WELLEX INDUSTRIES, INC.	-72.50%

4.5 Serial correlation

This paper uses lag 1. It uses ordinary least square method to test serial correlation amongst returns of lag 1. The stochastic equation follows.

$$R_{t+1} = \alpha R_t + e_{t+1} \qquad 4.4$$

Note that α equals the relationship between R_{t+1} and R_t. In other words, it is the serial correlation. e_{t+1} represents the stochastic error term.

After obtaining the serial correlation, the next series of steps follow. First, this paper figures if the obtained parameters are significant. For simplicity, if the serial correlation is greater than twice the standard error, this takes the parameter as significant at the 5% level of significance. This goes consistently with Fama (1970).

Second, if a specific stock has significant serial correlation, it finds whether the serial correlation is enough to warrant a technical trading strategy that can beat the "buy-and-hold" strategy. By technical trading strategy, this paper refers to a simple filter rule where one buys or hold on to a stock if the expected return is greater than zero.[11] Otherwise, one sells or stays away from the stock. For example, if the serial correlation is 0.10 and the return today is 20%, then the expected rate of return tomorrow is 0.10 of 20% which is 2%. With a positive expected rate of return, one should buy or hold on to that particular stock. If the return today is -20%, then the expected rate of return tomorrow is 0.10 of -20% which is -2%. With a negative expected rate of return, one should sell or stay away from that particular stock.

The simulation of the filter rule that will be employed comes in two different simulations. The first assumes zero transactions cost. The second assumes a typical

transactions cost. This paper uses the two to see if there is substantial difference if one trades as a broker-dealer where the transactions cost is minimal, if any; or if one trades as a small investor where the transactions cost typically includes a 0.75% commission and a 10% value added tax (VAT).[12] This way, the test will see the probable effect on the PSE once it bars brokers from acting as dealers. Finally if the simulation results to a profit greater than the buy-and-hold, the paper will then consider the stock inefficient.

The following exemplifies the simulation to be undertaken. Suppose that the serial correlation is 0.15 and it is significant. For the zero transactions cost simulation, if the current stock has greater than zero rate of return, the investor buys if she does not own the stock yet, or holds on the stock if she already owns the stock. For example, if the rate of return from Monday to Tuesday is 10%, this player will buy or hold on to the stock because it has a positive expected rate of return from Tuesday to Wednesday of 1.5%.[13] If the stock has zero or negative rate of return, the investor sells if she owns the stock, or stays out if she does not own the stock. For example, if the rate of return from Monday to Tuesday is -10%, this player will sell or stay out of the stock because it has a negative expected rate of return from Tuesday to Wednesday of -1.5%. In this sense, 0% represents the threshold whether one should stay out, buy, hold or sell.

For the non-zero transactions cost, this paper assumes a 0.75% of the value of stock commission ($0.75\%P_t$) and a 10% value added tax (VAT) on the commission [$10\%(0.75\%P_t)$]. The commission is consistent with many security firms' commission on

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[11] Fama and Blume (1966) provides a generally standard explanation for a filter rule.
[12] Redulde (1989) implies that brokers do most of the insider trading in Philippine stock markets.
[13] 0.15 of 10% is 1.5%.

small investors like Campos, Lanuza and Co., Inc.; Evergreen Stockbrokerage, Inc.; Standard Securities, Inc.; etc.[14] Thus, the cost of buying a stock worth P_t follows.

$$P_t + (0.0075)P_t + 0.10(0.0075)P_t = 1.00825P_t \qquad 4.5$$

The revenue of selling a stock worth P_{t+n} follows.

$$P_{t+n} - (0.0075)P_{t+n} - 0.10(0.0075)P_{t+n} + \text{Dividend} \qquad 4.6$$

$$= 0.99175P_{t+n} + \text{Dividend}$$

Finally, the rate of return of buying a stock at period t and selling the same at period t+n follows.

$$R_{t+n} = \frac{0.99175P_{t+n} + \text{Dividend} - 1.00825P_t}{1.00825P_t} \qquad 4.7$$

Suppose the dividend payment is zero and that the price at period t is P1. The price at period t+n must equal P1.0166 just to get even.[15] The rate of return from P1 to P1.0166 equals 1.66%. Thus, 1.66% represents the threshold whether one should stay out, buy, hold or sell.

Obviously, other forms of technical trading rule exist. They may be of other filter testing type such as that by Alexander (1961), moving averages stressed by Brock, Lakonishok, and LeBaron (1992), support and resistance by Wyckoff (1910), channel breakouts using the Dow Theory,[16] and on-balance volume (OBV) averages used by Granville (1963).[17] But since the testing for efficiency uses serial correlation, this paper uses the most obvious and applicable technical trading strategy hinted by the serial correlation. Thus, other technical trading rule not tested possibly holds. To assure that no

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[14] For example, Standard Securities, Inc. typically charge 0.75% commission for those buying securities worth P20,000 (P20,000 equates to US$500 at an exchange rate of P40/$).

[15] Setting the Dividend=0, R_{t+n}=0 and P_t=1, then solving for P_{t+n} results to P_{t+n}=1.0166. The rate of return from P1 to P1.0166 is 1.66%.

[16] Hamilton (1922) and Rhea (1932) gives rigorous explanation of the Dow line.

other technical trading strategy may hold, this paper also uses a stricter criteria for market efficiency: the random walk process. Here, the variance ratio test comes in.

4.6 Variance ratio

This paper compares the variance ratio of one-day rate of return with two-days, four-days and eight-days returns. Equation 4.8.a shows the simplest variance ratio formula. Campbell, Lo and MacKinlay (1997) describe the variance ratio in terms of relation 4.8.b.

Equation 4.8.a refers to the change of price between periods. Equation 4.8.b refers to the approximate rate of change of price between periods. This paper uses equation 4.8.c. It uses equation 4.8.c for two reasons. First, equation 4.8.c represents a more comparable variance ratio test to the serial correlation test. For this reason, the serial correlation and variance ratio tests will both be in terms of rate of return.[18] Second, equation 4.8.c represents a more accurate discrete measurement of rate of return compared to the log difference estimation shown in equation 4.8.b.

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[17] Sullivan, Timmermann and White (1999) provides short discussion explaining how these mentioned technical trading rules work.

[18] I casually calculated the variance ratio using the three equations and the results came similar.

$$\frac{\mathrm{Var}(p_t - p_{t-q})}{q\mathrm{Var}(p_t - p_{t-1})} = 1 \qquad 4.8.a$$

$$\frac{\mathrm{Var}(\log p_t - \log p_{t-q})}{q\mathrm{Var}(\log p_t - \log p_{t-1})} = 1 \qquad 4.8.b$$

$$\frac{\mathrm{Var}\left(\frac{p_t - p_{t-q}}{p_{t-q}}\right)}{q\mathrm{Var}\left(\frac{p_t - p_{t-1}}{p_{t-1}}\right)} = 1 \qquad 4.8c$$

It also calculates the homoscedastic-consistent and heteroscedastic-consistent test statistic for Z, following Chow and Denning's (1993) proposal. This accepts the random walk hypothesis at 5% level if the test statistic is less than the Studentized Maximum Modulus (SMM) critical value of 2.49.[19] This goes consistently with Basu and Morey (1998).

4.7 Checking the validity of the tests

Skeptics may be curious whether the results are just coincidental of the Philippine market. To confirm, this paper does the following additional tests. First, it ranks the PSE with other countries' equities market and sees if the ranking agrees with intuition. Second, it compares specific stocks within the PSE and sees if tendency to become

[19] Hahn and Hendrickson (1971), and Stolin and Ury (1979) provide the SMM table.

efficient agrees with intuition. Third, it compares the serial correlation and variance ratio tests whether their results support each other.

On the first check, it will calculate the daily rate of return serial correlation and variance ratio of the United States' Dow Jones Industrial Average (DJIA), Indonesia's Composite Index, Malaysia's Composite Index, Singapore's Straits Times Index, and Thailand's SET Index for the same period, as published by the Asian Wall Street Journal.[20]

It will rank Indonesia, Malaysia, the Philippines, Singapore, Thailand and the U.S. from most to least efficient according to their serial correlation and variance ratio. As far as the serial correlation is concerned, as its absolute value decreases relative to the rate of return, the market becomes more efficient. This paper will rank the most to least efficient according to the ratio of the absolute value of the serial correlation over the rate of return. As far as the variance ratio is concerned, as the variance ratio results close to one, the market becomes closer to the random walk process. The closer the market to the random walk, the market becomes more likely efficient. This paper will rank the most to least efficient according to the average absolute difference from one.

It includes the U.S. because it provides a good benchmark comparison as supposedly the most efficient equity market in the world. The others come in to compare the Philippine market with its neighboring Association of South East Asian Nation (ASEAN) markets. In addition, this uses data for the same period, except for Malaysia. After all, no major event that would have probably affected the behavior of the markets

[20] SET means Stock Exchange of Thailand. I also did not print the data for this because of its size. However, I may share the data with those who might be interested.

occurred for the said markets.[21] The data for Malaysia also covers the same period except that August 1998 is not included. The reason for this comes from the fact that the market might behave differently before 31 August when Mahathir's government has not imposed control on the Malaysian Ringgit.

To show the validity of the tests, the order of efficiency must follow from most developed to the least developed country. This follows the assumption that the more developed a country, the more efficient its equities market tends. Table 4.2 measures development in terms of per capita income. Column B of Table 4.2A shows the actual value and Table 4.2B shows the ranking. As indicated, the ranking from most to least efficient should follow: U.S., Singapore, Malaysia, Thailand, the Philippines, and Indonesia.[22]

The order of efficiency may also follow from the most to the least open economy, as proposed by Basu and Morey (1997). In that paper, the authors theoretically show that the more open an economy, the more efficient its equities market should be. Table 4.2 measures openness in terms of the ratio of import per GDP. Columns C, D and E of Table 4.2A show the calculation and actual degree of openness and Table 4.2B shows the ranking. The ranking should follow as given: Singapore, Malaysia, Thailand, U.S., the Philippines and Indonesia.

The order of efficiency may also follow in accordance to market capitalization and credit rating as proposed by Harvey (1995). As market capitalization increases, the more expensive for speculators to affect market prices. Thus, the more efficient the market

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[21] I say this based on the daily headlines of the Asian Wall Street Journal.

becomes. Harvey specifically finds a negative relationship between serial correlation and market size. Table 4.2A's column F shows each market's market capitalization as of 1997. Table 4.2B's column F shows the ranking. According to this, the order of efficiency should follow: U.S., Singapore, Malaysia, Philippines, Thailand and Indonesia.

As the credit rating improves, the better the economy. Hence, the efficiency of equities market should increase. Table 4.2A's column G shows Institutional Investor Magazine's (1999) grades for credit rating for the said countries. Table 4.2B shows the ranking. The order follows: U.S., Singapore, Malaysia, Thailand, Philippines and Indonesia.

On the second check, this paper takes the specific stocks' serial correlations' absolute value and variance ratios' absolute difference from one. Then, it tests whether they have relationship with the respective weight of market capitalization and value of stocks traded. The reasons for market capitalization and value of stocks traded have the following intuition. As the two increase, the cost for one to affect the behavior of a particular stock increases. In addition, the greater the attention it gets from the investing public. For this reason, the likelihood that speculators and insider traders will take advantage of the stock decreases. This increases the efficiency. This should result to serial correlation that is closer to zero and variance ratio that tends to be closer to one. The respective calculations of weights appear on Table 4.3 and 4.4, respectively.

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[22] There are many other and arguably better ways of measuring development. This paper takes the per capita income as measurement of development because it is one of the most common and readily available data.

Table 4.2A Value						
A	B	C	D	E = C/D	F	G
	Per Capita Income	Import	GDP	Calculated Import per GDP	Market Capitalization	Credit Rating
Indonesia	2,830	24	602	0.04	29,105	27.9
Malaysia	10,300	59	215	0.28	93,608	51.0
Philippines	3,500	29	271	0.11	31,361	43.3
Singapore	26,300	134 #	92	1.46	106,317	81.3
Thailand	6,100	74 *	369	0.20	23,538	46.9
United States	31,500	912	8,511	0.11	33,308,779	92.2

Table 4.2B Rank						
A	B	C	D	E = C/D	F	G
	Per Capita Income			Calculated Import per GDP	Market Capitalization	Credit Rating
Indonesia	6			6	5	6
Malaysia	3			2	3	3
Philippines	5			5	4	5
Singapore	2			1	2	2
Thailand	4			3	6	4
United States	1			4	1	1

Figures are in purchasing power parity (PPP) in terms of U.S. Dollar.

Columns B, C and D come from WWW.CIA.Gov. They are in 1998 except for # (1997) and * (1996). Column C is in billion US$.

Column E is calculated.

Column F comes from the IFC. They are in 1997 and in million US$.

Column G comes from Institutional Investor Magazine. They are in March 1999. 100 is the perfect score.

Table 4.3 - Market Capitalization in P millions		
		Weight
1 1ST PHIL. HLDGS. CORP. - A	12,682	0.0079
2 1ST PHIL. HLDGS. CORP. - B	6,623	0.0041
3 ABOITIZ EQUITY VENTURES, INC.	11,836	0.0073
4 ABS-CBN BROADCASTING CORP.	27,285	0.0169
5 AIR PHILS. INT'L CORP.	1,379	0.0009
6 ALSONS CEMENT CORP.	2,879	0.0018
7 AYALA CORP.	142,884	0.0886
8 AYALA LAND, INC.	97,988	0.0608
9 BANK OF THE PHIL. ISLANDS	94,031	0.0583
10 BELLE CORP.	9,213	0.0057
11 BENPRES HLDGS. CORP.	38,476	0.0239
12 C & P HOMES, INC.	3,831	0.0024
13 COSMOS BOTTLING CORP.	4,571	0.0028
14 DIGITAL TELECOMMUNICATIONS PHILS., I	11,188	0.0069
15 DMCI HLDGS., INC.	3,970	0.0025
16 EEI CORP.	1,221	0.0008
17 EMPIRE EAST LAND HLDGS., INC.	4,315	0.0027
18 EQUITABLE BANKING CORP.	32,942	0.0204
19 FAR EAST BANK & TRUST CO.	34,020	0.0211
20 FIL-ESTATE LAND, INC.	2,065	0.0013
21 FILINVEST DEV'T CORP.	20,547	0.0127
22 FILINVEST LAND, INC.	15,005	0.0093
23 GLOBE TELECOM GMRC, INC. - A	19,173	0.0119
24 INT'L CONTAINER & TERMINAL SVCS., INC.	9,463	0.0059
25 IONICS CIRCUITS, INC.	5,371	0.0033
26 JG SUMMIT HLDGS., INC.	22,258	0.0138
27 JOLLIBEE FOODS CORP.	18,316	0.0114
28 JOLLIBEE FOODS CORP. - WARRANTS	8,880	0.0055
29 LA TONDENA DISTILLERS, INC.	13,984	0.0087
30 MANILA ELECTRIC CO. - A	50,230	0.0312
31 MANILA ELECTRIC CO. - B	41,188	0.0255
32 MEGAWORLD PROP. & HLDGS., INC.	7,638	0.0047

Source of market capitalization figures: Business World. 3 Jan. 2000.The rest are calculated.
Index numbers are excluded.
MUSIC SEMICONDUCTORS CORP. and RFM CORP. are ommitted due to unavailability of data.
Weight = individual mkt cap. / total mkt cap.

Table 4.3 - Market Capitalization in P millions		
		Weight
33 METRO PACIFIC CORP.	32,556	0.0202
34 METROPOLITAN BANK & TRUST CO.	88,432	0.0548
35 MONDRAGON INT'L PHILS., INC.	1,840	0.0011
36 PETRON CORP.	36,094	0.0224
37 PHIL. COMMERCIAL INT'L BANK. INC.	39,966	0.0248
38 PHIL. LONG DISTANCE TELEPHONE CO.	134,421	0.0834
39 PHIL. NATIONAL BANK	18,835	0.0117
40 PILIPINO TELEPHONE CORP.	5,055	0.0031
41 REYNOLDS PHILS. CORP.	1,060	0.0007
42 SAN MIGUEL CORP. - A	123,432	0.0766
43 SAN MIGUEL CORP. - B	50,904	0.0316
44 SECURITY BANK CORP.	10,409	0.0065
45 SINOPHIL CORP.	4,676	0.0029
46 SM PRIME HLDGS., INC.	72,465	0.0449
47 SOUTHEAST ASIA CEMENT HLDGS., INC.	2,702	0.0017
48 UNIVERSAL RIGHTFIELD PROP. HLDGS., IN	874	0.0005
49 UNIVERSAL ROBINA CORP.	11,159	0.0069
50 UNIWIDE HLDGS., INC.	1,045	0.0006
51 WELLEX INDUSTRIES, INC.	820	0.0005
52 Others	200,129	0.1241
Total	1,612,326	1.0000

Source of market capitalization figures: Business World. 3 Jan. 2000.The rest are calculated.
Index numbers are excluded.
MUSIC SEMICONDUCTORS CORP. and RFM CORP. are ommitted due to unavailability of data.
Weight = individual mkt cap. / total mkt cap.

Table 4.4 - Estimated Value of Stocks Traded						
A	B	C	D = (5/12)*B x (7/12)*C	E	F = D x E	G = Fi / FTotal
	1998 Volume	1999 Volume	Weighed Average of Volume	Average Price	Est. Value of Traded Stocks	Weight
1 1ST PHIL. HLDGS. CORP. - A	14,936,640	84,700,400	55,632,167	23.44	1,303,750,128	0.0038
2 1ST PHIL. HLDGS. CORP. - B	55,894,640	97,894,200	80,394,383	28.40	2,283,490,043	0.0067
3 ABOITIZ EQUITY VENTURES, INC.	700,036,000	1,050,272,000	904,340,333	1.60	1,444,851,845	0.0042
4 ABS-CBN BROADCASTING CORP.	45,862,900	103,962,600	79,754,392	22.85	1,822,323,271	0.0053
5 AIR PHILS. INT'L CORP.	609,570,000	989,720,000	831,324,167	0.44	363,429,505	0.0011
6 ALSONS CEMENT CORP.	108,369,000	36,743,000	66,587,167	3.46	230,147,347	0.0007
7 AYALA CORP.	1,163,993,080	1,316,877,420	1,253,175,612	11.00	13,789,497,955	0.0403
8 AYALA LAND, INC.	1,939,449,120	1,994,361,500	1,971,481,342	10.75	21,200,726,206	0.0619
9 BANK OF THE PHIL. ISLANDS	73,246,375	239,502,030	170,228,840	93.72	15,954,301,786	0.0466
10 BELLE CORP.	7,238,573,000	8,705,749,000	8,094,425,667	1.98	15,991,386,514	0.0467
11 BENPRES HLDGS. CORP.	753,622,000	1,820,761,600	1,376,120,100	6.18	8,500,316,053	0.0248
12 C & P HOMES, INC.	4,388,083,000	3,328,458,000	3,769,968,417	0.87	3,283,299,767	0.0096
13 COSMOS BOTTLING CORP.	211,848,000	358,376,000	297,322,667	3.11	925,339,693	0.0027
14 DIGITAL TELECOMMUNICATIONS PHILS., INC	4,657,564,000	6,229,588,000	5,574,578,000	1.21	6,769,965,331	0.0198
15 DMCI HLDGS., INC.	2,668,841	1,607,107,000	938,591,100	1.65	1,549,625,307	0.0045
16 EEI CORP.	421,419,000	293,129,000	346,583,167	1.22	422,538,988	0.0012
17 EMPIRE EAST LAND HLDGS., INC.	8,053,200,000	13,957,822,000	11,497,562,833	0.62	7,181,481,839	0.0210
18 EQUITABLE BANKING CORP.	58,891,800	100,338,125	83,068,823	65.56	5,446,388,877	0.0159
19 FAR EAST BANK & TRUST CO.	38,882,200	168,731,870	114,627,841	46.79	5,363,488,992	0.0157
20 FIL-ESTATE LAND, INC.	1,215,379,000	969,672,000	1,072,049,917	0.85	914,285,961	0.0027
21 FILINVEST DEV'T CORP.	258,948,000	546,770,000	426,844,167	2.15	918,513,122	0.0027
22 FILINVEST LAND, INC.	3,446,217,000	1,666,711,000	2,408,171,833	2.94	7,081,610,818	0.0207
23 GLOBE TELECOM GMRC, INC. - A	142,579,000	95,004,500	114,827,208	7.42	851,659,051	0.0025
24 INT'L CONTAINER & TERMINAL SVCS., INC.	703,464,000	790,894,000	754,464,833	2.88	2,170,918,668	0.0063
25 IONICS CIRCUITS, INC.	135,827,900	179,148,500	161,098,250	9.99	1,610,109,884	0.0047
26 JOLLIBEE FOODS CORP.	31,310,600	41,125,000	37,035,667	16.13	597,346,318	0.0017

Source of columns B and C: Business World. The rest are calculated.
Index numbers are excluded.
JG SUMMIT HOLDS., INC. and MUSIC SEMICONDUCTORS CORP. are ommited due to unavailability of data.

Table 4.4 - Estimated Value of Stocks Traded						
A	B	C	D = (5/12)*B x (7/12)*C	E	F = D x E	G = Fi / FTotal
	1998 Volume	1999 Volume	Weighed Average of Volume	Average Price	Est. Value of Traded Stocks	Weight
27 JOLLIBEE FOODS CORP. - WARRANTS	134,017,000	179,283,400	160,422,400	17.56	2,816,644,578	0.0082
28 LA TONDENA DISTILLERS, INC.	71,451,800	173,264,300	130,842,425	29.74	3,890,734,588	0.0114
29 MANILA ELECTRIC CO. - A	3,600,100	83,612,150	50,273,796	84.23	4,234,553,714	0.0124
30 MANILA ELECTRIC CO. - B	221,874,860	196,261,920	206,933,978	116.74	24,158,290,354	0.0706
31 MEGAWORLD PROP. & HLDGS., INC.	2,093,584,000	9,173,350,000	6,223,447,500	0.98	6,104,539,929	0.0178
32 METRO PACIFIC CORP.	9,552,181,000	9,124,450,000	9,302,671,250	1.62	15,098,085,396	0.0441
33 METROPOLITAN BANK & TRUST CO.	82,815,568	97,358,948	91,299,206	278.28	25,407,053,630	0.0742
34 MONDRAGON INT'L PHILS., INC.	687,805,000	2,268,567,000	1,609,916,167	0.71	1,140,573,671	0.0033
35 PETRON CORP.	1,531,012,000	1,406,081,000	1,458,135,583	4.08	5,944,665,904	0.0174
36 PHIL. COMMERCIAL INT'L BANK, INC.	18,932,100	16,458,460	17,489,143	177.29	3,100,707,043	0.0091
37 PHIL. LONG DISTANCE TELEPHONE CO.	57,949,130	61,772,620	60,179,499	997.27	60,015,041,021	0.1753
38 PHIL. NATIONAL BANK	67,332,100	85,566,950	77,969,096	67.52	5,264,492,291	0.0154
39 PILIPINO TELEPHONE CORP.	754,019,000	1,665,748,000	1,285,860,917	2.57	3,309,105,571	0.0097
40 REYNOLDS PHILS. CORP.	1,172,290,000	2,391,574,000	1,883,539,000	1.11	2,094,775,564	0.0061
41 RFM CORP.	53,338,000	92,620,000	76,252,500	5.21	397,309,901	0.0012
42 SAN MIGUEL CORP. - A	103,614,300	240,406,540	183,409,773	51.10	9,372,017,551	0.0274
43 SAN MIGUEL CORP. - B	230,035,700	441,173,450	353,199,388	65.12	23,001,398,015	0.0672
44 SECURITY BANK CORP.	20,362,799	61,621,900	44,430,608	19.29	857,125,178	0.0025
45 SINOPHIL CORP.	1,800,700,000	1,209,010,000	1,455,547,500	0.36	517,689,728	0.0015
46 SM PRIME HLDGS., INC.	1,673,829,000	1,847,762,000	1,775,289,917	7.24	12,847,838,878	0.0375
47 SOUTHEAST ASIA CEMENT HLDGS., INC.	1,385,967,000	727,310,000	1,001,750,417	0.49	490,525,173	0.0014
48 UNIVERSAL RIGHTFIELD PROP. HLDGS., INC.	2,022,391,000	3,019,020,000	2,603,757,917	0.35	904,968,611	0.0026
49 UNIVERSAL ROBINA CORP.	316,557,000	238,522,000	271,036,583	4.97	1,347,826,209	0.0039
50 UNIWIDE HLDGS., INC.	1,180,748,000	4,399,710,000	3,058,475,833	0.56	1,699,791,351	0.0050
51 WELLEX INDUSTRIES, INC.	639,980,000	928,577,000	808,328,250	0.51	415,630,279	0.0012
Total					342,402,177,396	1.0000

Source of columns B and C: Business World. The rest are calculated.
Index numbers are excluded.
JG SUMMIT HOLDS., INC. and MUSIC SEMICONDUCTORS CORP. are ommited due to unavailability of data.

It will obtain the relationship via regression. For example, to get the relationship between the serial correlation and market capitalization, the serial correlation's absolute value represents the dependent variable. On the other hand, the stock's market capitalization's weight will be the independent variable.

Note that this paper does not directly use the serial correlation as the dependent variable. Rather, it uses the serial correlation's absolute value. It does so based on the notion that the serial correlation's proximity from zero represents a better measurement of efficiency.

For example, suppose that stocks A and B have significant serial correlations of 0.10 and –0.50, respectively. Just because 0.10 is greater than –0.50 does not make stock A's serial correlation stronger. Thus, it does not make stock A more inefficient. The fact that –0.50 is further from zero gives stock B a stronger serial correlation. This results to greater potential to profit using a technical trading strategy. That makes stock B more inefficient. Thus, this paper uses the absolute value of the serial correlation. Similar reason goes for using the variance ratio's absolute difference from one instead of the pure variance ratio. The further the variance ratio from one, the process becomes less like a random walk.

The third check sees if the results of the serial correlation and variance ratio tests complement or contradict each other. It does so by constructing a table that looks like Table 3.4. If the tests complement each other's results, very few if any should fall inside the boxes where the words are double underlined. As indicated, those boxes containing double underline indicate contradiction of results.

For serial correlation tests, those with insignificant serial correlation will fall on the first column. If the serial correlation is significant and the technical trading strategy does not beat the buy-and-hold strategy, the stock falls on the second column. The rest falls on the third column. For variance ratio tests, those with test statistic less than 2.49 fall on the first row. The rest falls on the second row.

4.8 Basic facts about the PSE

The PSE has the following indices: Composite Index, All Shares Index, Commercial and Industrial Index, Banks and Financial Services Index, Property Index, Mining Index and Oil Index. The Composite Index, which others call the Phisix, represents the most commonly used indicator of the Philippine equities market. It is composed of the thirty most important companies in the Philippines according to the PSE. Many refer to these as "blue chips." Table 4.5 shows the blue chips during the period of analysis. The All Shares Index is composed of all listed shares in the PSE, including those that are traded very rarely. The rest is composed of companies according to sub-industry.

Take note that some companies have so called "A" and "B" shares. Only Filipino citizens may own "A" shares, and everyone may own "B" shares. Filipino citizens and foreigners alike may own companies without "A" and "B" shares. The separation of "A" and "B" shares functions as a barrier to majority control of non-Filipinos of certain protected companies. Usually, "B" shares account for, at most, 50% of all shares. For this reason, even if a non-Filipino owns all "B" shares of a particular company, he or she still does not own the majority shares. For example, only Filipinos may own San Miguel Corporation (SMC) A shares; and everyone may own SMC B shares. Since SMC B takes account of 50% of all stocks, foreigners may own and therefore control only up to 50% of

SMC. On the other hand, foreigners may own up to 100% of companies without "A" and "B" shares. For this reason, they may own the majority of shares and therefore control the company.

4.9 Closing remarks

The preceding discussion shows the steps undertaken to test the market using serial correlation and variance ratio. The next chapter shows the results.

Table 4.5 - PSE Composite Index Companies
1 ABOITIZ EQUITY VENTURES, INC.
2 ABS-CBN BROADCASTING CORP.
3 AYALA CORP.
4 AYALA LAND, INC.
5 BELLE CORP.
6 BENPRES HLDGS. CORP.
7 C & P HOMES, INC.
8 DIGITAL TELECOMMUNICATIONS PHILS., INC
9 DMCI HLDGS., INC.
10 FIL-ESTATE LAND, INC.
11 FILINVEST DEV'T CORP.
12 FILINVEST LAND, INC.
13 INT'L CONTAINER & TERMINAL SVCS., INC.
14 IONICS CIRCUITS, INC.
15 JG SUMMIT HLDGS., INC.
16 JOLLIBEE FOODS CORP.
17 LA TONDENA DISTILLERS, INC.
18 LEPANTO CONS. MINING CO.
19 MANILA ELECTRIC CO.
20 MEGAWORLD PROP. & HLDGS., INC.
21 METRO PACIFIC CORP.
22 METROPOLITAN BANK & TRUST CO.
23 PETRON CORP.
24 PHIL. COMMERCIAL INT'L BANK, INC.
25 PHIL. LONG DISTANCE TELEPHONE CO.
26 PHIL. NATIONAL BANK
27 PILIPINO TELEPHONE CORP.
28 SAN MIGUEL CORP.
29 SM PRIME HLDGS., INC.
30 SOUTHEAST ASIA CEMENT HLDGS., INC.

CHAPTER 5

OBSERVATIONS

5.1 Introduction

This chapter provides the actual observations of the tests. The order of discussion basically follows that described in the previous chapter. Each contains brief generalization of observations.

5.2 Serial correlation test

5.2.1 Results and implication on random walk hypothesis

Table 5.1 shows the results for serial correlation test. It also includes the standard error, the number of observations and the rate of return in the entire period. At the end of each line, some stocks have "*". If "*" appears on the end of the line, the serial correlation is bigger than twice the standard error.

As indicated, most stocks resulted to positive rate of return. Specifically, 54 or 90% have positive gains. This makes the data consistent with Fama's (1970) sub-martingale environment. Note that the maximum number of observations equals 248. From the maximum number of transaction of 250, taking one less to get the rate of return from one period to the other results to 249. Then, taking another for comparing the return next period to the return on the current period results to 248.

Most stocks result to positive serial correlation. Specifically, 13 have negative serial correlation. Of those with negative serial correlation, one is statistically significant.

This company happens to be Reynolds Philippines, Inc., which has a negative rate of return.

Twenty-two or 37% of the 60 stocks have significant serial correlation. Of the seven index numbers, five have significant serial correlation. They include the two most important: the Composite Index and the All Shares Index. Thus, the results show strong evidence that the market does not follow the random walk process.

5.2.2 Implication on efficient market hypothesis

The question now becomes whether the profit from technical trading rule is large enough to beat the buy-and-hold strategy to reject the efficient market hypothesis. Unlike Fama's, the line of acceptance or rejection was easier to determine because the serial correlation results are extremely lower. In fact, none of them exceeds 0.01.

In this study, the results are obviously high enough to allow profitability using technical trading rule. For example, ABS-CBN Broadcasting Corp. has the lowest absolute value serial correlation that is statistically significant, at 0.1283. When the current daily rate of return is 20%, one may buy the stock now for tomorrow's rate of return will most likely be around 2.566%.[1] Likewise, if the current daily rate of return is –20%, one should sell the stock because tomorrow's rate of return will most likely be –2.566%. Thus, the interpretation of the results becomes more difficult to determine.

[1] 0.1283 of 20% is 2.566%.

Table 5.1 - Serial Correlation Test Results

	COMPANY	SERIAL CORR.	STD. ERROR		N	RATE OF RETURN
1	1ST PHIL. HLDGS. CORP. - A	0.1233	0.0641		241	279.18%
2	1ST PHIL. HLDGS. CORP. - B	0.0555	0.0655		234	64.15%
3	ABOITIZ EQUITY VENTURES, INC.	-0.0720	0.0646		240	117.65%
4	ABS-CBN BROADCASTING CORP.	0.1283	0.0635	*	245	111.34%
5	AIR PHILS. INT'L CORP.	0.0908	0.0645		240	200.00%
6	ALL SHARES INDEX	0.2375	0.0617	*	248	57.57%
7	ALSONS CEMENT CORP.	0.1496	0.0657	*	227	45.60%
8	AYALA CORP.	0.0650	0.0639		245	60.32%
9	AYALA LAND, INC.	0.0512	0.0644		241	10.30%
10	BANK OF THE PHIL. ISLANDS	0.1427	0.0633	*	245	45.11%
11	BANKS AND FINANCIAL SVCS. INDEX	0.3152	0.0602	*	248	92.46%
12	BELLE CORP.	0.2088	0.0623	*	246	193.27%
13	BENPRES HLDGS. CORP.	0.1520	0.0632	*	246	56.85%
14	C & P HOMES, INC.	0.2168	0.0631	*	240	-22.03%
15	COMMERCIAL - INDUSTRIAL INDEX	0.1156	0.0632		248	55.69%
16	COMPOSITE INDEX	0.1816	0.0625	*	248	51.83%
17	COSMOS BOTTLING CORP.	0.0406	0.0645		239	-24.79%
18	DIGITAL TELECOMMUNICATIONS PHILS., INC	0.0140	0.0638		246	62.96%
19	DMCI HLDGS., INC.	0.0222	0.0639		245	44.26%
20	EEI CORP.	0.0489	0.0666		235	35.35%
21	EMPIRE EAST LAND HLDGS., INC.	0.1330	0.0640	*	241	137.50%
22	EQUITABLE BANKING CORP.	0.2549	0.0621	*	245	161.42%
23	FAR EAST BANK & TRUST CO.	-0.0065	0.0642		239	78.72%
24	FIL-ESTATE LAND, INC.	0.1518	0.0640	*	234	100.00%
25	FILINVEST DEV'T CORP.	-0.0727	0.0638		244	105.36%
26	FILINVEST LAND, INC.	0.1227	0.0640		241	101.70%
27	GLOBE TELECOM GMRC, INC. - A	0.1247	0.0644		236	118.75%
28	INT'L CONTAINER & TERMINAL SVCS., INC.	-0.0517	0.0641		243	78.26%
29	IONICS CIRCUITS, INC.	0.0406	0.0649		238	21.95%
30	JG SUMMIT HLDGS., INC.	0.1075	0.0651		241	140.00%

* indicates that the serial correlation is greater than twice the standard error.

Table 5.1 - Serial Correlation Test Results

	COMPANY	SERIAL CORR.	STD. ERROR		N	RATE OF RETURN
31	JOLLIBEE FOODS CORP.	0.0256	0.0640		245	49.80%
32	JOLLIBEE FOODS CORP. - WARRANTS	0.1964	0.0636	*	239	39.62%
33	LA TONDENA DISTILLERS, INC.	0.1796	0.0630	*	245	163.64%
34	MANILA ELECTRIC CO. - A	0.0453	0.0640		246	48.55%
35	MANILA ELECTRIC CO. - B	-0.0030	0.0639		246	24.24%
36	MEGAWORLD PROP. & HLDGS., INC.	0.0419	0.0655		233	256.00%
37	METRO PACIFIC CORP.	0.0600	0.0634		246	118.60%
38	METROPOLITAN BANK & TRUST CO.	0.1254	0.0635		245	65.46%
39	MINING INDEX	0.0604	0.0639		248	-0.64%
40	MONDRAGON INT'L PHILS., INC.	0.1506	0.0631	*	246	527.91%
41	MUSIC SEMICONDUCTORS CORP.	0.2596	0.0616	*	245	93.22%
42	OIL INDEX	0.1325	0.0630	*	248	37.36%
43	PETRON CORP.	0.0710	0.0633		246	32.79%
44	PHIL. COMMERCIAL INT'L BANK, INC.	-0.0337	0.0653		235	158.82%
45	PHIL. LONG DISTANCE TELEPHONE CO.	-0.0190	0.0640		245	23.18%
46	PHIL. NATIONAL BANK	0.1667	0.0631	*	245	226.19%
47	PILIPINO TELEPHONE CORP.	0.1418	0.0634	*	244	-11.86%
48	PROPERTY INDEX	0.1809	0.0624	*	248	21.95%
49	REYNOLDS PHILS. CORP.	-0.1449	0.0636	*	240	-7.02%
50	RFM CORP.	0.0223	0.0628		242	4.90%
51	SAN MIGUEL CORP. - A	0.1220	0.0635		246	92.38%
52	SAN MIGUEL CORP. - B	-0.0091	0.0640		246	52.48%
53	SECURITY BANK CORP.	-0.0289	0.0634		240	154.89%
54	SINOPHIL CORP.	-0.0471	0.0646		238	76.00%
55	SM PRIME HLDGS., INC.	-0.0440	0.0647		241	29.30%
56	SOUTHEAST ASIA CEMENT HLDGS., INC.	-0.0918	0.0647		239	39.47%
57	UNIVERSAL RIGHTFIELD PROP. HLDGS., INC.	0.0006	0.0649		238	51.61%
58	UNIVERSAL ROBINA CORP.	0.1771	0.0631	*	243	138.10%
59	UNIWIDE HLDGS., INC.	-0.0499	0.0664		227	-54.95%
60	WELLEX INDUSTRIES, INC.	0.0511	0.0660		225	233.33%
STOCKS WITH SERIAL CORRELATION GREATER THAN TWIC THE STANDARD ERROR			22		or	37% of 60

* indicates that the serial correlation is greater than twice the standard error.

Table 5.2 - Results of Technical Trading Simulation

	Rate of Return			
	With Transactions Cost		Without Transactions Cost	
	Technical Trading	Buy-and-Hold	Technical Trading	Buy-and-Hold
1 ABS-CBN BROADCASTING CORP.	0.00%	109.61%	58.22%	111.34%
2 ALL SHARES INDEX	0.00%	56.28%	101.08%	57.57% *
3 ALSONS CEMENT CORP.	3.84%	44.41%	221.16%	45.60% *
4 BANK OF THE PHIL. ISLANDS	-1.64%	43.92%	107.51%	45.11% *
5 BANKS AND FINANCIAL SVCS. INDEX	1.75%	90.88%	214.30%	92.46% *
6 BELLE CORP.	103.93%	190.87%	257.53%	193.27% *
7 BENPRES HLDGS. CORP.	-15.60%	55.57%	265.96%	56.85% *
8 C & P HOMES, INC.	115.58%	-22.67% *	83.91%	-22.03% *
9 COMPOSITE INDEX	0.00%	50.59%	89.06%	51.83% *
10 EMPIRE EAST LAND HLDGS., INC.	8.68%	135.56%	96.91%	137.50%
11 EQUITABLE BANKING CORP.	32.65%	159.28%	150.35%	161.42%
12 FIL-ESTATE LAND, INC.	11.96%	98.36%	316.31%	100.00% *
13 JOLLIBEE FOODS CORP. - WARRANTS	-5.50%	38.48%	104.09%	39.62% *
14 LA TONDENA DISTILLERS, INC.	87.83%	161.48%	418.90%	163.64% *
15 MONDRAGON INT'L PHILS., INC.	160.73%	522.77%	674.11%	527.91% *
16 MUSIC SEMICONDUCTORS CORP.	198.47%	91.64% *	744.12%	93.22% *
17 OIL INDEX	-4.53%	36.23%	57.85%	37.36% *
18 PHIL. NATIONAL BANK	27.33%	223.52%	358.93%	226.19% *
19 PILIPINO TELEPHONE CORP.	22.36%	-12.59% *	182.30%	-11.86% *
20 PROPERTY INDEX	-9.55%	20.95%	58.25%	21.95% *
21 REYNOLDS PHILS. CORP.	0.00%	-7.78% *	-30.05%	-7.02%
22 UNIVERSAL ROBINA CORP.	-16.32%	136.15%	280.12%	138.10% *
Inefficient	4 or 7% of 60		18 or 30% of 60	

* indicates that the technical trading strategy beats the buy and hold strategy.

However, the companies observed also obtained generally very high rate of returns. For example, Composite Index posted 51.83% rate of return. Those companies with serial correlation greater than twice the standard error obtained an average rate of return of 102.73%. The next question now becomes whether the observed high serial correlation is enough to beat the generally high rate of returns.

Table 5.2 shows the results of the technical trading rule simulation. The right side shows the results that simulate the technical trading profit if one plays as a broker and dealer, where the transaction cost is minimal, if not zero. Of the twenty-two stocks with significant serial correlation; eighteen, or 30% of the sixty, result to technical trading strategy beating the buy-and-hold. The evidence does not support the extreme "black and white" sides of acceptance or rejection. More so, it supports the grayish area in favor more of rejection.

The left side shows the result if there are transactions cost for all market players. The right side shows the result if there is no transactions cost. For the left side, only four or 7% of the 60 end with a technical trading strategy beating the buy-and-hold. This does not take any side whether Almadro (Associated Filipino Press, 2000) and Redulde's (1989) claim is true that the brokers are the ultimate source of inefficiency in the market. However, it at least shows the possible effect of barring brokers from acting as dealers. That is it will make the market from 30% inefficient to 7% inefficient.

5.3 Variance ratio test

Table 5.3 shows the results. For each company, "N" denotes the number of observations, where the maximum number is 250. Under the variance ratio columns, the

first row represents the actual variance ratio. The second and third rows represent the heteroscedastic-consistent and homoscedastic-consistent test statistic for Z, respectively. For example, Belle Corporation has 248 observations. Its variance ratio at q=2 equals 1.3262. The heteroscedastic-consistent test statistic for q=4 is 3.2628. Also, the homoscedastic-consistent test statistic for q=8 is 10.0473.

For each test statistic, the symbol "*" appears on the right side if it indicates a rejection of the random walk at the 5% level using the conventional normal critical value of 1.96. The symbol "**" appears if it indicates a rejection of the random walk at the 5% level using the SMM critical value of 2.49. For example, the VR(4) and VR(8) test statistics for Composite Index indicate acceptance of the random walk. The heteroscedastic-consistent test statistic for VR(2) indicates a rejection of the random walk using the traditional 1.96 test statistic. However, the homoscedastic-consistent test statistic for VR(2) indicates a rejection using the SMM critical value of 2.49.

Twenty-eight or 47% of the sixty stocks have at least one "**". Five of the seven index numbers reject the random walk. The five include two of the most important indices: Composite Index and All Shares Index. This presents strong evidence in favor of the rejection of the random walk process.

Table 5.3 - Variance Ratio Test Results

	N	VR(2)	VR(4)	VR(8)
1 1ST PHIL. HLDGS. CORP. - A	243	1.1118	1.2254	1.2797
		(1.6596)	(1.7006)	(1.3481)
		(1.7386)	(1.8741)	(1.4708)
2 1ST PHIL. HLDGS. CORP. - B	236	1.0409	1.2648	1.3921
		(0.3504)	(1.3720)	(1.3619)
		(0.6267)	(2.1698) *	(2.0320) *
3 ABOITIZ EQUITY VENTURES, INC.	242	0.9343	0.8687	0.8932
		-(1.0171)	-(1.0294)	-(0.4890)
		-(1.0204)	-(1.0897)	-(0.5603)
4 ABS-CBN BROADCASTING CORP.	247	1.1388	1.0444	1.1585
		(1.7156)	(0.2997)	(0.7189)
		(2.1764) *	(0.3719)	(0.8404)
5 AIR PHILS. INT'L CORP.	242	1.3845	1.0558	0.6784
		(1.7092)	(0.1496)	-(0.6850)
		(5.9696) **	(0.4626)	-(1.6878)
6 ALL SHARES INDEX	250	1.2382	1.3284	1.5873
		(2.7308) **	(2.1482) *	(2.5634) **
		(3.7593) **	(2.7703) **	(3.1330) **
7 ALSONS CEMENT CORP.	229	1.1753	1.3499	1.7261
		(2.5915) **	(2.6893) **	(3.5347) **
		(2.6475) **	(2.8238) **	(3.7063) **
8 AYALA CORP.	247	1.1017	1.0968	1.4158
		(1.2645)	(0.6451)	(1.7295)
		(1.5946)	(0.8113)	(2.2049) *
9 AYALA LAND, INC.	243	1.0507	1.1203	1.2765
		(0.7234)	(0.9189)	(1.3203)
		(0.7894)	(1.0007)	(1.4543)
10 BANK OF THE PHIL. ISLANDS	247	1.1483	1.1536	1.3750
		(2.1859) *	(1.2643)	(1.8263)
		(2.3263) *	(1.2877)	(1.9881) *
11 BANKS AND FINANCIAL SVCS. INDEX	250	1.3190	1.5199	1.8746
		(3.7464) **	(3.5091) **	(3.9210) **
		(5.0338) **	(4.3850) **	(4.6655) **

See notes at the end of table.

Table 5.3 - Variance Ratio Test Results

	N	VR(2)	VR(4)	VR(8)
12 BELLE CORP.	248	1.3262	1.9643	2.8911
		(1.9495)	(3.2628) **	(4.5279) **
		(5.1268) **	(8.1010) **	(10.0473) **
13 BENPRES HLDGS. CORP.	248	1.1676	1.4050	1.5543
		(2.1871) *	(2.9851) **	(2.5723) **
		(2.6338) **	(3.4025) **	(2.9449) **
14 C & P HOMES, INC.	242	1.2620	1.8673	2.9130
		(2.5645) **	(4.8647) **	(7.2692) **
		(4.0668) **	(7.1967) **	(10.0397) **
15 COMMERCIAL - INDUSTRIAL INDEX	250	1.1199	1.1249	1.1971
		(1.2157)	(0.7321)	(0.7891)
		(1.8919)	(1.0538)	(1.0513)
16 COMPOSITE INDEX	250	1.1874	1.2294	1.3653
		(2.1053) *	(1.4496)	(1.5300)
		(2.9574) **	(1.9353)	(1.9487)
17 COSMOS BOTTLING CORP.	241	1.0444	0.9603	0.8614
		(0.6298)	-(0.3125)	-(0.6851)
		(0.6880)	-(0.3286)	-(0.7258)
18 DIGITAL TELECOMMUNICATIONS PHILS., INC	248	1.0240	0.9540	0.9763
		(0.2637)	-(0.2945)	-(0.1024)
		(0.3770)	-(0.3862)	-(0.1259)
19 DMCI HLDGS., INC.	247	1.0648	1.1624	1.4470
		(0.5400)	(0.8316)	(1.5437)
		(1.0158)	(1.3618)	(2.3702) *
20 EEI CORP.	237	1.0487	1.2816	1.6539
		(0.5816)	(1.8781)	(2.9702) **
		(0.7475)	(2.3127) *	(3.3960) **
21 EMPIRE EAST LAND HLDGS., INC.	243	1.2173	1.2883	2.3113
		(1.8843)	(1.4866)	(4.3615) **
		(3.3799) **	(2.3976) *	(6.8963) **
22 EQUITABLE BANKING CORP.	247	1.2715	1.4416	1.6193
		(2.7766) **	(2.6534) **	(2.5436) **
		(4.2577) **	(3.7022) **	(3.2839) **

See notes at the end of table.

Table 5.3 - Variance Ratio Test Results

	N	VR(2)	VR(4)	VR(8)
23 FAR EAST BANK & TRUST CO.	241	0.9882	1.0067	0.9017
		-(0.1434)	(0.0476)	-(0.4715)
		-(0.1824)	(0.0555)	-(0.5150)
24 FIL-ESTATE LAND, INC.	236	1.1964	1.3500	1.8281
		(2.2691) *	(2.2990) *	(3.5444) **
		(3.0106) **	(2.8681) **	(4.2917) **
25 FILINVEST DEV'T CORP.	246	0.9331	0.8147	0.7823
		-(0.4193)	-(0.7333)	-(0.6860)
		-(1.0468)	-(1.5507)	-(1.1520)
26 FILINVEST LAND, INC.	243	1.1685	1.2659	1.5168
		(1.9035)	(1.7273)	(2.1945) *
		(2.6209) **	(2.2114) *	(2.7180) **
27 GLOBE TELECOM GMRC, INC. - A	238	1.1559	1.1749	1.4631
		(1.5606)	(1.0278)	(1.8687)
		(2.4001) *	(1.4390)	(2.4100) *
28 INT'L CONTAINER & TERMINAL SVCS., INC.	245	0.9356	1.0366	1.2700
		-(0.6465)	(0.2159)	(1.1601)
		-(1.0058)	(0.3052)	(1.4256)
29 IONICS CIRCUITS, INC.	240	1.0692	1.1920	1.1943
		(0.8975)	(1.3994)	(0.9464)
		(1.0704)	(1.5868)	(1.0152)
30 JG SUMMIT HLDGS., INC.	243	1.1062	1.3309	1.5557
		(1.0630)	(1.9596)	(2.3503) *
		(1.6518)	(2.7511) **	(2.9223) **
31 JOLLIBEE FOODS CORP.	247	1.0351	1.1765	1.3514
		(0.4624)	(1.2530)	(1.5286)
		(0.5498)	(1.4799)	(1.8630)
32 JOLLIBEE FOODS CORP. - WARRANTS	241	1.2303	1.3973	1.6615
		(2.4862) *	(2.6521) **	(2.9613) **
		(3.5679) **	(3.2903) **	(3.4644) **
33 LA TONDENA DISTILLERS, INC.	247	1.1957	1.6225	2.1121
		(2.0759) *	(3.1494) **	(3.7081) **
		(3.0695) **	(5.2186) **	(5.8968) **

See notes at the end of table.

Table 5.3 - Variance Ratio Test Results

	N	VR(2)	VR(4)	VR(8)
34 MANILA ELECTRIC CO. - A	248	1.0336	1.0688	1.0535
		(0.3802)	(0.4452)	(0.2441)
		(0.5281)	(0.5781)	(0.2840)
35 MANILA ELECTRIC CO. - B	248	1.0058	0.8762	0.9819
		(0.0766)	-(0.8901)	-(0.0839)
		(0.0916)	-(1.0397)	-(0.0963)
36 MEGAWORLD PROP. & HLDGS., INC.	235	1.0555	1.1352	1.4695
		(0.7009)	(0.9179)	(2.0475) *
		(0.8495)	(1.1054)	(2.4280) *
37 METRO PACIFIC CORP.	248	1.0749	1.3365	1.9276
		(0.7777)	(1.9090)	(3.1428) **
		(1.1765)	(2.8267) **	(4.9285) **
38 METROPOLITAN BANK & TRUST CO.	247	1.1307	1.2124	1.4013
		(1.4083)	(1.3501)	(1.7873)
		(2.0492) *	(1.7808)	(2.1280) *
39 MINING INDEX	250	1.0616	0.9130	1.0332
		(0.7598)	-(0.5545)	(0.1373)
		(0.9718)	-(0.7335)	(0.1769)
40 MONDRAGON INT'L PHILS., INC.	248	1.2373	1.5044	2.8328
		(2.6884) **	(3.4035) **	(8.2465) **
		(3.7301) **	(4.2373) **	(9.7375) **
41 MUSIC SEMICONDUCTORS CORP.	247	1.3355	1.6373	1.7983
		(2.8809) **	(3.2376) **	(2.9018) **
		(5.2624) **	(5.3427) **	(4.2328) **
42 OIL INDEX	250	1.1526	1.3778	1.5208
		(1.7778)	(2.4361) *	(2.2214) *
		(2.4076) *	(3.1862) **	(2.7781) **
43 PETRON CORP.	248	1.0831	1.0816	1.0131
		(1.0682)	(0.5702)	(0.0578)
		(1.3064)	(0.6854)	(0.0699)
44 PHIL. COMMERCIAL INT'L BANK, INC.	237	0.9709	0.9231	0.9863
		-(0.3954)	-(0.5395)	-(0.0589)
		-(0.4469)	-(0.6316)	-(0.0713)

See notes at the end of table.

Table 5.3 - Variance Ratio Test Results

	N	VR(2)	VR(4)	VR(8)
45 PHIL. LONG DISTANCE TELEPHONE CO.	247	1.0299	0.8561	0.6615
		(0.1512)	-(0.4591)	-(0.8626)
		(0.4692)	-(1.2063)	-(1.7948)
46 PHIL. NATIONAL BANK	247	1.1897	1.4217	1.8364
		(2.0665) *	(2.7161) **	(3.6748) **
		(2.9753) **	(3.5352) **	(4.4351) **
47 PILIPINO TELEPHONE CORP.	246	1.1800	1.5715	2.1742
		(1.9953) *	(3.4504) **	(4.7864) **
		(2.8182) **	(4.7814) **	(6.2130) **
48 PROPERTY INDEX	250	1.1981	1.2722	1.4075
		(2.6417) **	(1.9910) *	(1.8764)
		(3.1264) **	(2.2962) *	(2.1740) *
49 REYNOLDS PHILS. CORP.	242	0.8486	0.6627	0.5673
		-(1.7832)	-(2.2687) *	-(1.9607) *
		-(2.3503) *	-(2.7988) **	-(2.2708) *
50 RFM CORP.	244	1.0060	0.9212	0.9661
		(0.0663)	-(0.5044)	-(0.1499)
		(0.0929)	-(0.6569)	-(0.1786)
51 SAN MIGUEL CORP. - A	248	1.1080	1.1404	1.2304
		(1.6417)	(1.1587)	(1.1862)
		(1.6977)	(1.1794)	(1.2244)
52 SAN MIGUEL CORP. - B	248	0.9916	0.8189	0.7281
		-(0.1044)	-(1.2463)	-(1.2328)
		-(0.1320)	-(1.5212)	-(1.4447)
53 SECURITY BANK CORP.	242	0.9775	0.9614	1.2736
		-(0.2028)	-(0.2003)	(0.9858)
		-(0.3491)	-(0.3201)	(1.4359)
54 SINOPHIL CORP.	241	1.0026	1.3261	2.3289
		(0.0240)	(1.4742)	(3.8086) **
		(0.0410)	(2.7001) **	(6.9600) **
55 SM PRIME HLDGS., INC.	243	0.9615	0.8902	0.7876
		-(0.5059)	-(0.8139)	-(1.0067)
		-(0.5988)	-(0.9128)	-(1.1170)

See notes at the end of table.

Table 5.3 - Variance Ratio Test Results

	N	VR(2)	VR(4)	VR(8)
56 SOUTHEAST ASIA CEMENT HLDGS., INC.	241	0.9145	0.8340	0.7482
		-(1.1417)	-(1.1852)	-(1.1791)
		-(1.3245)	-(1.3749)	-(1.3186)
57 UNIVERSAL RIGHTFIELD PROP. HLDGS., INC.	240	1.0476	1.0147	1.5601
		(0.4919)	(0.0875)	(2.1817) *
		(0.7352)	(0.1216)	(2.9272) **
58 UNIVERSAL ROBINA CORP.	245	1.1736	1.2822	1.2874
		(1.8555)	(1.7557)	(1.1633)
		(2.7111) **	(2.3561) *	(1.5175)
59 UNIWIDE HLDGS., INC.	229	0.9322	0.8463	0.8415
		-(0.9745)	-(1.1024)	-(0.7514)
		-(1.0237)	-(1.2407)	-(0.8090)
60 WELLEX INDUSTRIES, INC.	227	1.1761	0.8762	1.0732
		(0.9979)	-(0.4295)	(0.1988)
		(2.6479) **	-(0.9944)	(0.3718)

Note: The heteroscedaticity-consistent test statistic Z*(q), which tests the null hypothesis that VR(q) equals one, is given in parenthesis immediately below each of the main row entries.
The homoscedaticity-consistent test statistic Z*(q), which tests the null hypothesis that VR(q) equals one, is given also in parenthesis below the heteroscedasticity-consistent test statisitc Z*(q).
* indicates that the variance ratio is statistically different from one at the 5% level (rejection of the random walk) using the conventional normal critical value of 1.96.
** indicates that the variance ratio is statistically different from one at the 5% level (rejection of the random walk) using the Stundentized Maximum Modulus critical value of 2.49.

See notes at the end of table.

5.4 Comparing the results with theory

5.4.1 Comparing the results with other selected countries

Table 5.4 shows the serial correlation test results for the U.S. and selected ASEAN markets. The table ranks them from most to least efficient. The "*" sign indicates if the serial correlation is greater than twice the standard error. As indicated, the four countries with significant serial correlation rank as the four least efficient.

Table 5.4 - Most to Least Efficient Countries According to Serial Correlation

A	B	C	D	E	F
COUNTRY	SERIAL CORR.	STD. ERROR	N	RATE OF RETURN	Abs (B) / E
1 U.S. (DOW JONES INDUSTRIAL AVERAGES)	-0.0021	0.0625	251	21.26%	0.0101
2 MALAYSIA (COMPOSITE INDEX)	0.0646	0.0629	226	192.61%	0.0335
3 THAILAND (SET INDEX)	0.1351	0.0638 *	242	75.10%	0.1798
4 SINGAPORE (STRAITS TIMES INDEX)	0.2114	0.0620 *	249	99.65%	0.2121
5 PHILIPPINES (COMPOSITE INDEX)	0.1816	0.0625 *	248	51.83%	0.3503
6 INDONESIA (COMPOSITE INDEX)	0.2247	0.0626 *	243	25.80%	0.8712

* indicates that the serial correlation is greater than twice the standard error.

Table 5.5 shows the variance ratio test results for the U.S. and selected ASEAN markets. The table ranks them from most to least efficient. Notice the rejection symbols (*) increase as the rank goes down.

Table 5.5 - Most to Least Efficient Countries According to Variance Ratio

Country	VR(q) 2	VR(q) 4	VR(q) 8	Avg. Abs. Diff. From 1
1 MALAYSIA (COMPOSITE INDEX)	1.0093	0.9925	1.0507	0.0225
	(0.0796)	-(0.0307)	(0.1332)	
	(0.1401)	-(0.0604)	(0.2581)	
2 U.S. (DOW JONES INDUSTRIAL AVERAGES)	0.9831	0.9365	0.9194	0.0537
	-(0.1920)	-(0.3879)	-(0.3244)	
	-(0.2677)	-(0.5388)	-(0.4328)	
3 THAILAND (SET INDEX)	1.1528	1.2504	1.2734	0.2255
	(1.9611) *	(1.8012)	(1.3456)	
	(2.3812) *	(2.0861) *	(1.4410)	
4 PHILIPPINES (COMPOSITE INDEX)	1.1874	1.2294	1.3653	0.2607
	(2.1053) *	(1.4496)	(1.5300)	
	(2.9574) **	(1.9353)	(1.9487)	
5 SINGAPORE (STRAITS TIMES INDEX)	1.2093	1.3329	1.3824	0.3082
	(2.7803) **	(2.3773) *	(1.7776)	
	(3.3088) **	(2.8133) **	(2.0441) *	
6 INDONESIA (COMPOSITE INDEX)	1.2451	1.4501	1.4789	0.3913
	(3.2260) **	(3.3107) **	(2.3206) *	
	(3.8278) **	(3.7578) **	(2.5291) **	

Note: The heteroscedaticity-consistent test statistic Z*(q), which tests the null hypothesis that VR(q) equals one, is given in parenthesis immediately below each of the main row entries. The homoscedaticity-consistent test statistic Z*(q), which tests the null hypothesis that VR(q) equals one, is given also in parenthesis below the heteroscedasticity-consistent test statistic Z*(q).

* indicates that the variance ratio is statistically different from one at the 5% level (rejection of the random walk) using the conventional normal critical value of 1.96.

** indicates that the variance ratio is statistically different from one at the 5% level (rejection of the random walk) using the Stundentized Maximum Modulus critical value of 2.49.

Figures 5.1, 5.2, 5.3, and 5.4 show bar graphs relating efficiency measured by the serial correlation's absolute value with development, credit rating, market capitalization and openness. For a perfect fit, the unshaded bars should steadily go down as the shaded ones go up. For development and credit rating, Singapore represents the only exception. In other words, by getting rid of Singapore, the order of efficiency for the rest results to a perfect fit. For market capitalization, Singapore and Thailand are out of order. For openness, Singapore and the United States are out of order.

By ridding off of the United States as a distinctly developed market and Singapore as distinctly developed island (city) country; the rest have relatively similar structures. Specifically Malaysia, Thailand, the Philippines and Indonesia are all ASEAN, developing and have relatively the same size of economy. The ranking of the four agrees in all, except in market capitalization. In market capitalization, the order between Thailand and the Philippines does not agree. The reason for this may result from the fact that Thailand experienced more than its proportionate share of capital flight during the Asian currency crisis. Between Singapore and the United States, the ranking agree in all except in openness. Thus, ranking of efficiency generally agrees with theory.

Figures 5.5, 5.6, 5.7 and 5.8 show whether the variance ratio tests' ranking of efficiency agree with the order according to development, credit rating, market capitalization and openness, respectively. For development, credit rating, and openness; the order fits well for Indonesia, the Philippines, Thailand and Malaysia. The United States and Singapore represent the exceptions. Between the two, the order agrees in development and credit rating. The two disagree in order when compared to openness. This may arise from the fact that Singapore is not a representative and appropriate

comparison with the U.S. because of its extreme reliance on imports, being an island country.

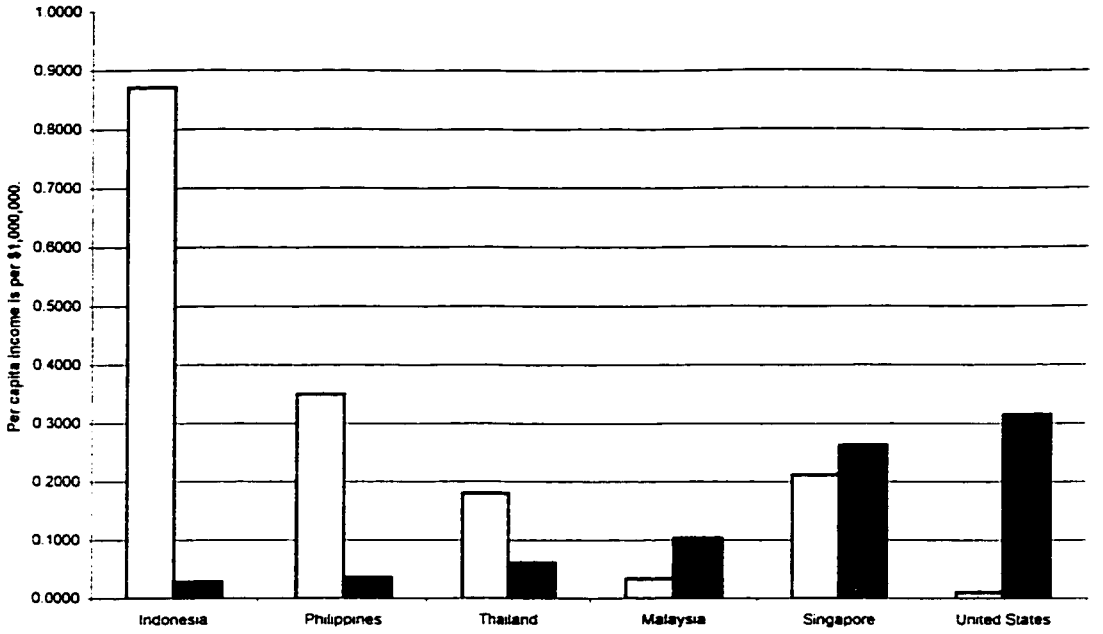
For market capitalization, the United States, Singapore and Thailand do not agree in ranking. The three represent half of the six countries. By ridding off of the United States and Singapore as distinct countries; the ranking agrees, except for Thailand. Again, this probably results from the fact that Thailand experienced greater capital flight relative to the size of its economy during the Asian currency crisis.

Between the serial correlation and variance ratio tests, the former performed better in terms of trying to match efficiency according to theory. This paper conjectures that this happens because the serial correlation test is the better measurement of efficiency. While the former measures the market's efficiency, the latter more specifically measures the market's random walk behavior.

Figures 5.9 shows whether the serial correlation and variance ratio tests' agree in terms of ranking. They agree for Malaysia, Thailand, the Philippines and Indonesia. Between the United States and Singapore only, they agree. More generally, as efficiency measured by serial correlation goes up, so does the variance ratio. The general relationship between the serial correlation and variance ratio indicated in Figure 5.9 goes consistently with Campbell and Mankiw, (1989) and Chow and Denning's (1993) equations relating the two. [2]

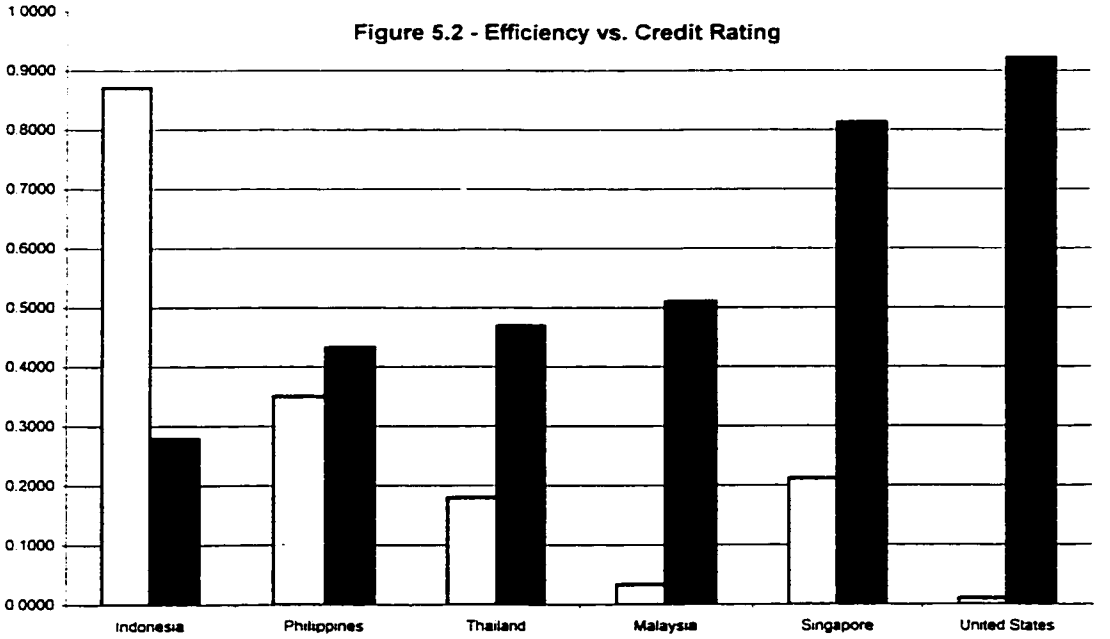
[2] Equation 2 of Campbell and Mankiw (1989) and equation 3 of Chow and Denning (1993) of their paper.

Figure 5.1 - Efficiency vs. Development



Unshaded bar - serial correlation / rate of return.
Shaded bar - development measured in per capita income.

Figure 5.2 - Efficiency vs. Credit Rating



Unshaded bar - serial correlation / rate of return.
Shaded bar - credit rating.

Figure 5.3 - Efficiency vs. Market Capitalization

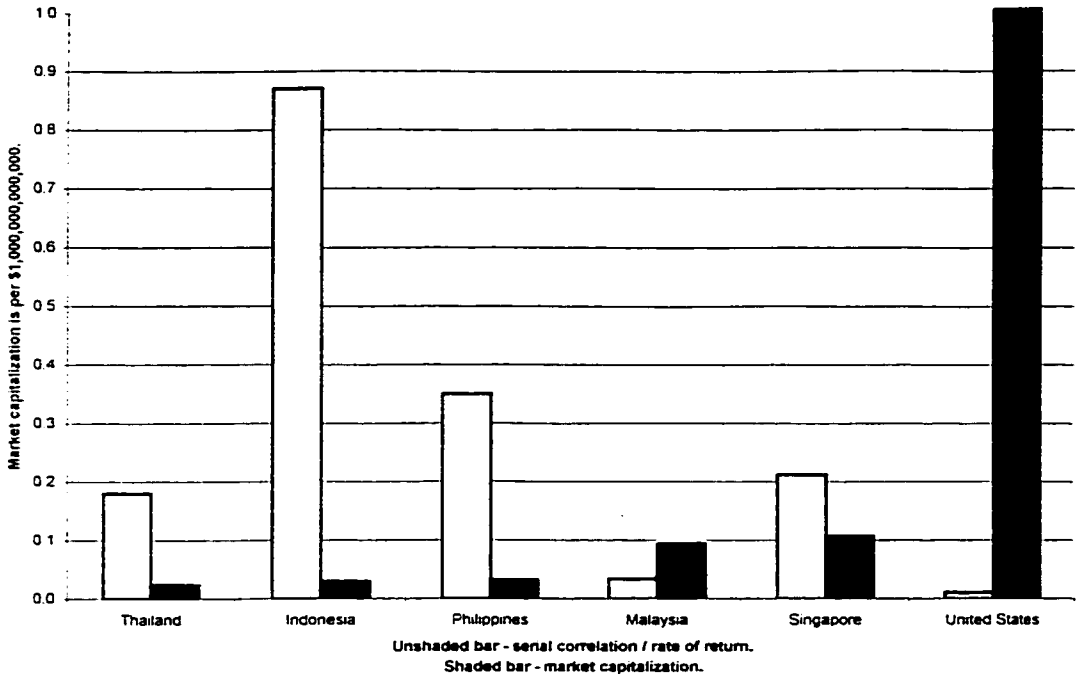


Figure 5.4 - Efficiency vs. Openness

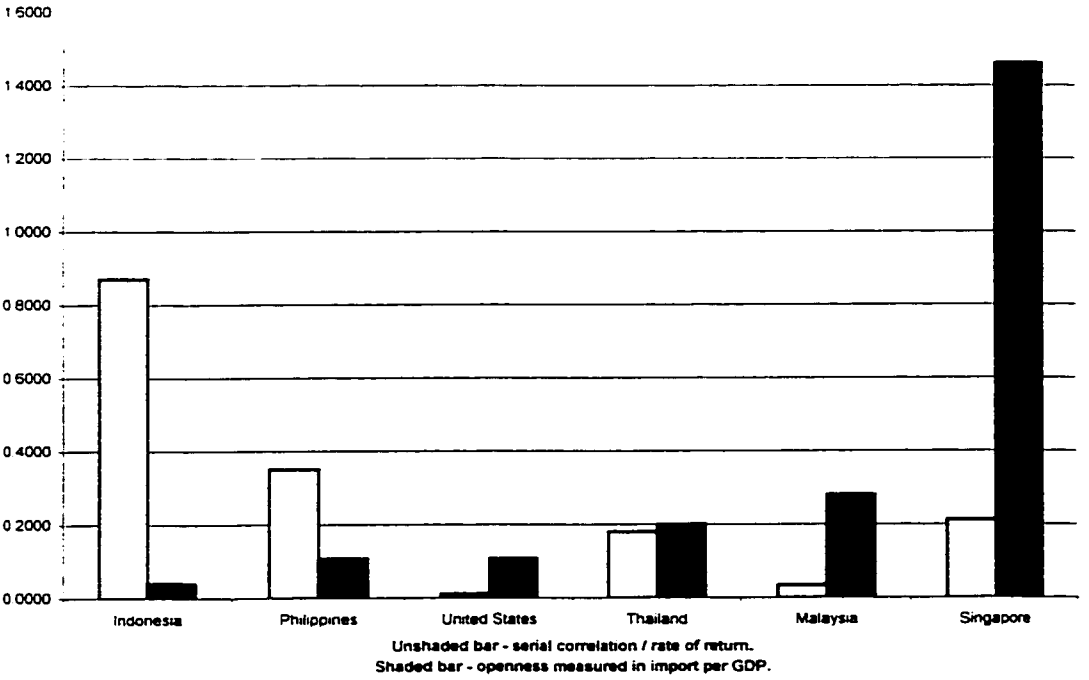


Figure 5.5 - Average VR vs. Development

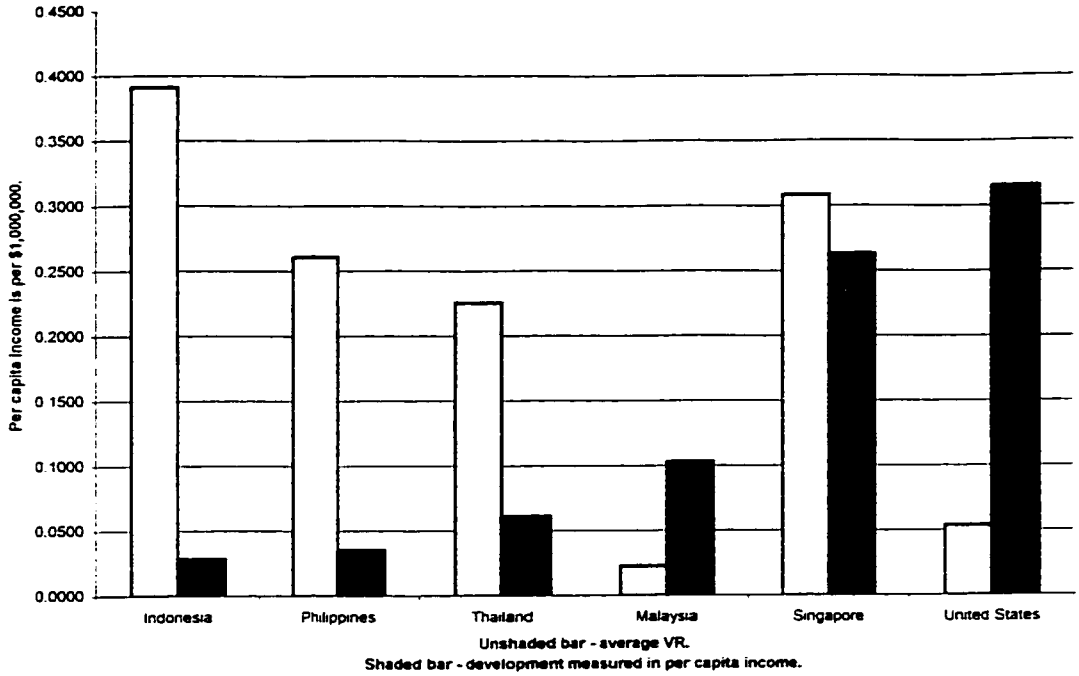


Figure 5.6 - Average VR vs. Credit Rating

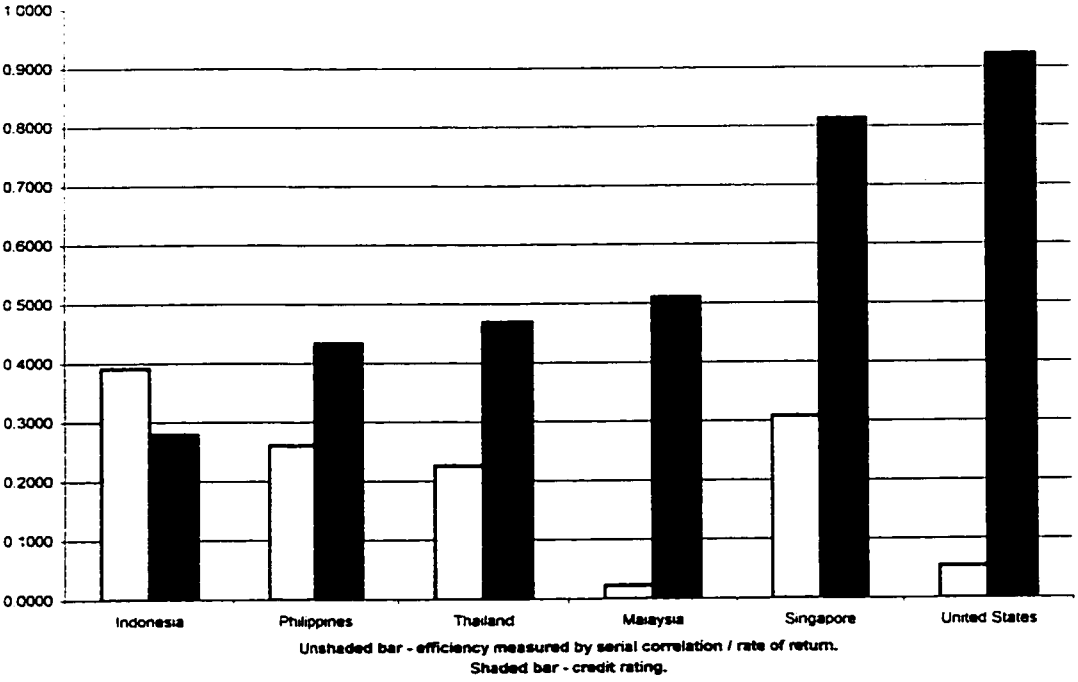


Figure 5.7 - Average VR vs. Market Capitalization

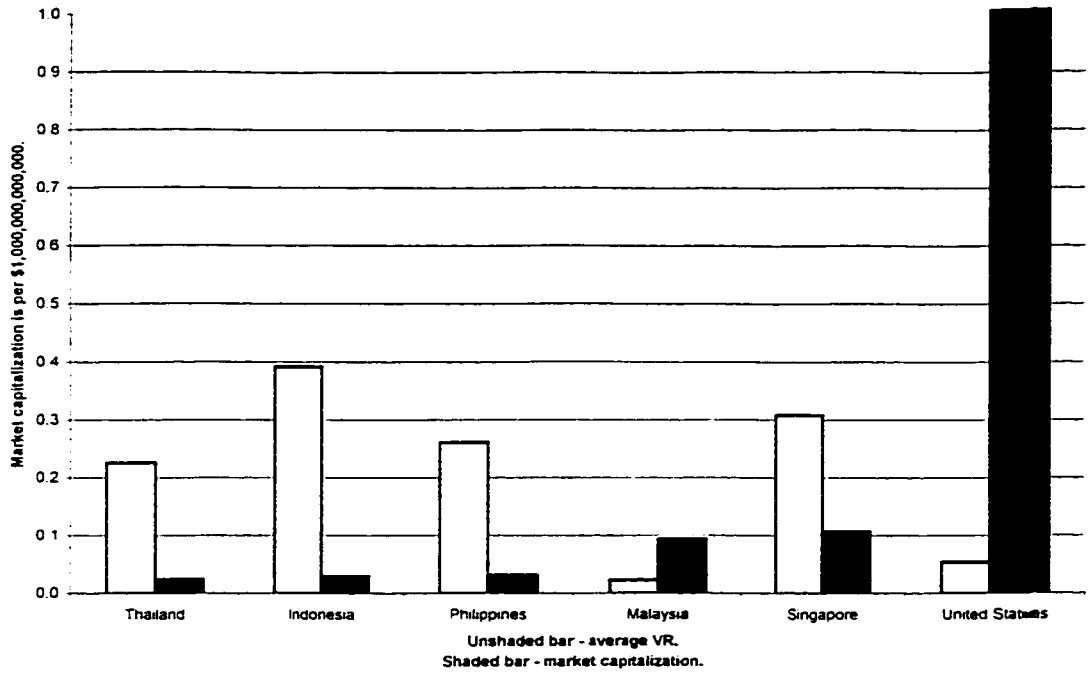
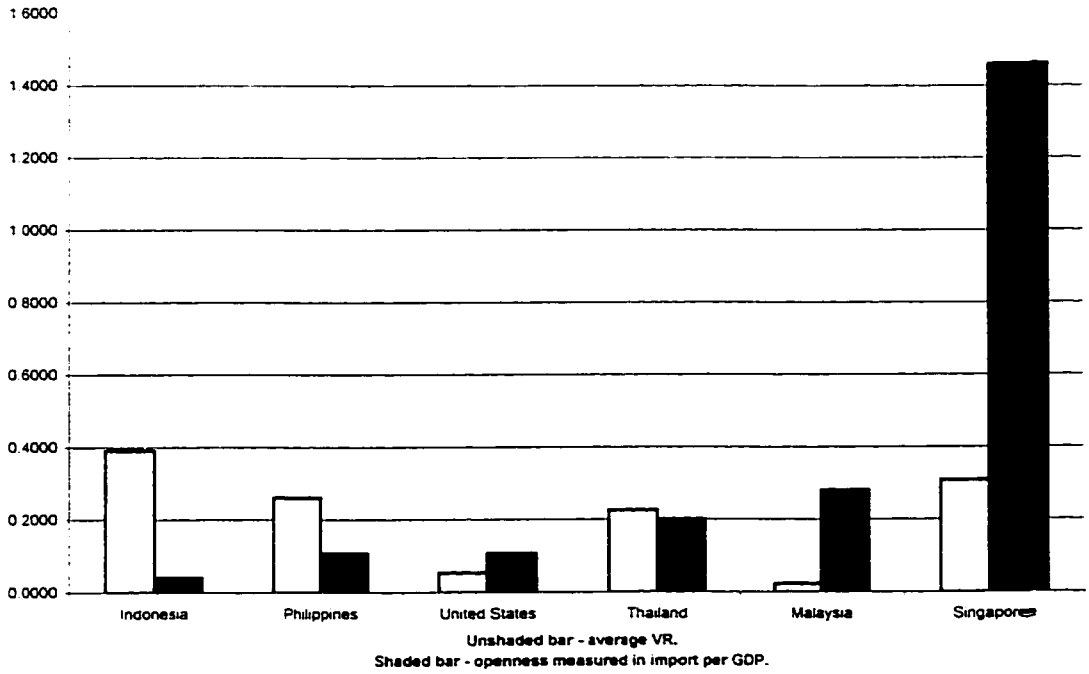


Figure 5.8 - Average VR vs. Openness



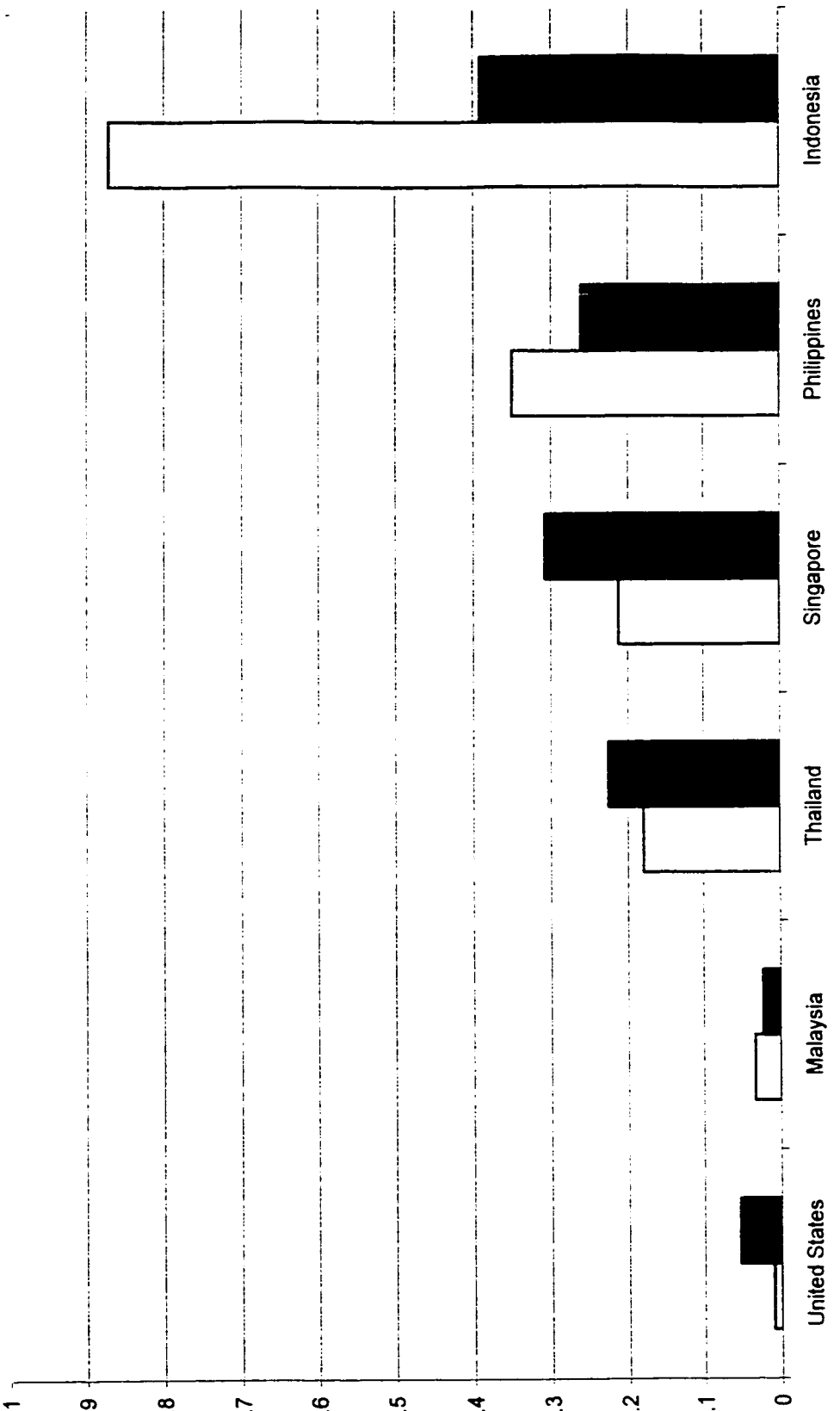


Figure 5.9 - Efficiency vs. Average VR

5.4.2 Comparing the results within the PSE

The results regressing the serial correlation's absolute value with value of stocks traded and market capitalization follow.

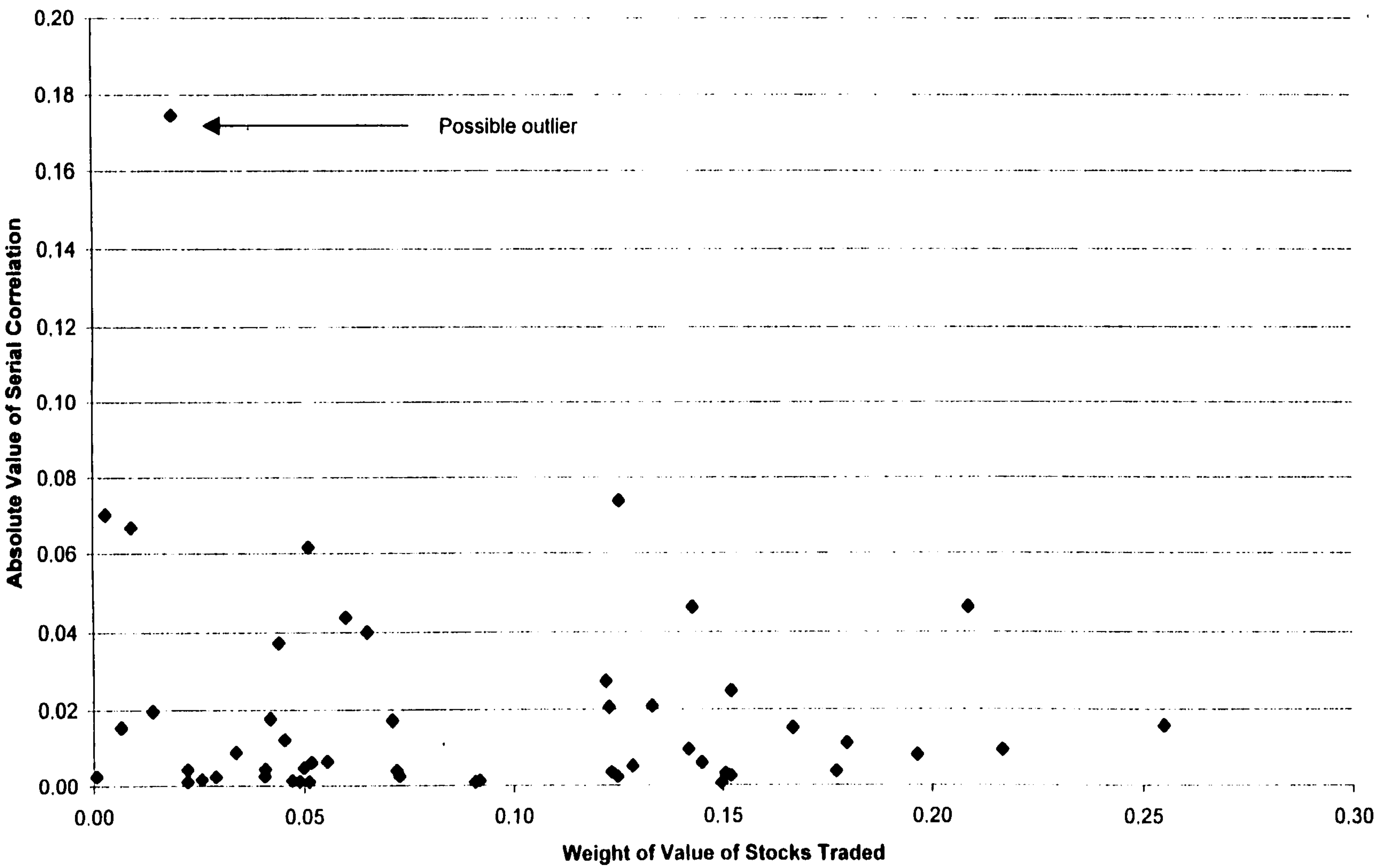
Relating the serial correlation's absolute value with value of stocks traded and market capitalization.				
Explanatory variable	N	Intercept	Slope	Goldfeld-Quandt Statistic, d=11.
Weight of value of stocks traded	51	0.0963 (0.0108)	-0.3221 (0.3072)	1.2178
Weight of market capitalization	51	0.0979 (0.0113)	-0.3636 (0.4037)	1.0276
Respective standard errors are in parenthesis. For the F-distribution, at the 95th percentile value, and with 18 degrees of freedom for the numerator and the denominator: heteroscedasticity is present if the Goldfeld-Quandt statistic is greater than approximately 2.19. The value 2.19 is the critical value for 20 degrees of freedom for the numerator and 18 degrees of freedom for the denominator.				

Note that the numbers in parenthesis represent the standard error. For example, the standard error for 0.0963 is 0.0108. Also, note that the y-intercepts are consistently significant at 5% level. They are all positive.

Regarding the slope, the parameters obtained have negative values. However, they are both insignificant. By digging further, one might suspect for the presence of heteroscedasticity as the reason for insignificance. This does not seem so as the Goldfeld-Quandt statistics are not big enough to conclude for its presence.[3]

[3] For those less involved in econometrics, Pindyck and Rubinfeld (1997) provides easy explanation and review on the usage of the Henderson-Quandt test for heteroscedasticity.

Figure 5.10


Possible outlier
Absolute Value of Serial Correlation
Weight of Value of Stocks Traded
0.00
0.02
0.04
0.06
0.08
0.10
0.12
0.14
0.16
0.18
0.20
0.00
0.05
0.10
0.15
0.20
0.25
0.30

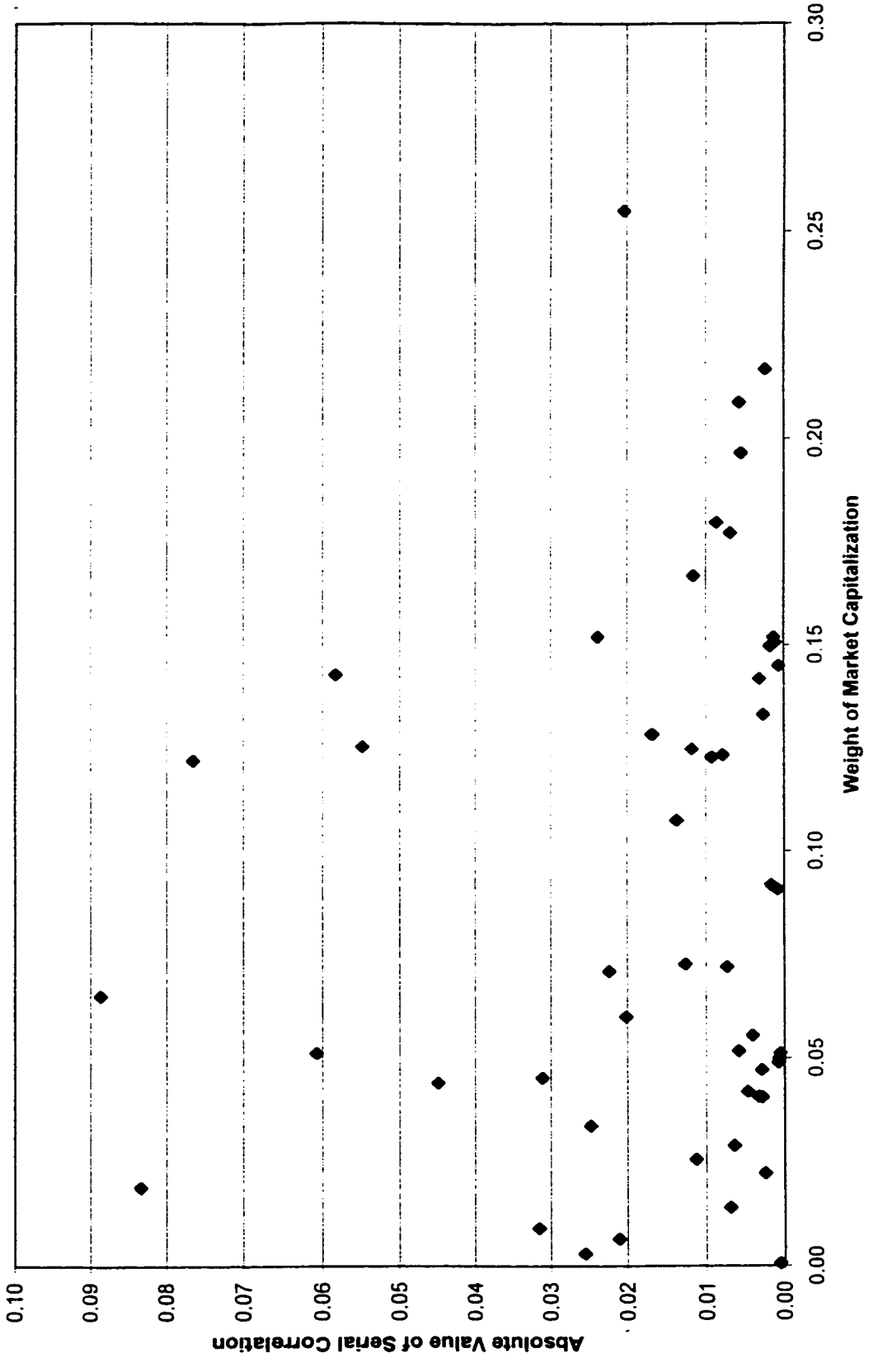

Absolute Value of Serial Correlation
0.10
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
0.01
0.00
0.00
0.05
0.10
0.15
0.20
0.25
0.30
Weight of Market Capitalization

Figure 5.11

One might also suspect for the presence of outliers. Figure 5.10 shows a scatter plot relating the serial correlation's absolute value with the weight of the value of stocks traded. The figure shows one possible outlier. This happens to be the Philippine Long Distance Telephone Co. By regressing without this particular company, the intercept becomes 0.0939 with a standard error of 0.0119 and the slope becomes –0.1502 with a standard error of 0.4664. Still, the slope is negative but insignificant. Figure 5.11 shows a scatter plot relating the serial correlation's absolute value with the weight of market capitalization. The figure does not show any obvious outlier.

A stricter criteria for efficiency is the use of variance ratio instead of serial correlation. The regression test relating the variance ratios' absolute difference from one and the weights of value of stocks traded and market capitalization follow.

Again, the results show negative but insignificant slopes. This goes to say that if there is actual relationship between efficiency measured by the serial correlation and the independent variables, it should be negative. For value of stocks traded, greater trading activity reduces the serial correlation's absolute value. Thus, the stock becomes more efficient. For market capitalization, greater market value reduces the serial correlation's absolute value. Both agree with intuition.

Relating the variance ratio's absolute difference from one with value of stocks traded and market capitalization.				
VR(q)	Explanatory variable	N	Intercept	Slope
2	Weight of value of stocks traded	51	0.1225 (0.0150)	-0.4708 (0.4245)
2	Weight of market capitalization	51	0.1304 (0.0154)	-0.8825 (0.5489)
4	Weight of value of stocks traded	51	0.2375 (0.0343)	-0.1352 (0.9692)
4	Weight of market capitalization	51	0.2787 (0.0348)	-2.2681 (1.2426)
8	Weight of value of stocks traded	51	0.5141 (0.0812)	-0.7097 (2.2964)
8	Weight of market capitalization	51	0.6056 (0.0819)	-5.5382 (2.9225)
Respective standard errors are in parenthesis.				

As to the economic reason for the linear relations' consistent insignificance, besides the independent variables given, many other factors may affect a stock's efficiency. Since these factors are not included in the OLS, the model may not be as perfect as it should. This may result to insignificant results.

Such factors include concentration of ownership in particular stocks. Intuitively, greater concentration of ownership of stocks to a few rich families tend to make the market less efficient. It also includes a firm's exposure to insider trading. As indicated, many board members, who naturally have advanced information, own or are connected with stockbrokerages (Dumlao-Arceo, 1999).

For instance, suppose that an individual owns 60% of the company's entire stocks. This entitles the person to have majority votes in electing the companies' board members, stronger control in appointing the company's executives, virtually run the company as he or she wishes, and therefore have advance information regarding the companies direction. As far as advance information is concerned, the same goes with board members who are connected or own stock brokerages. As soon as those with advance information sees decreasing value of the firm, the privileged sells and causes the stock's price to decrease. As soon as those without advanced information finds out about this, they also sell causing the stock's price to decrease further. Such sequence of consecutive decreases (or increases) result to higher serial correlation or greater inefficiency.

5.4.3 Comparing the serial correlation and variance ratio tests' results

Table 5.6 shows the Table 3.4 look-alike diagram, showing if the results of the tests complement or contradict each other.

Looking at the table, two of sixty stocks or about 3% have contradicting results. Specifically, ABS-CBN Broadcasting Corp. and Bank of the Philippine Islands (BPI) both result to significant serial correlation and with variance ratio of 1. The next question now becomes whether the contradictions result from the serial correlation's Type I error or the variance ratio's Type II error. On the first error, the serial correlation test rejects the null hypothesis of zero serial correlation when it should accept. On the second error, the variance ratio test accepts the null hypothesis of random walk when it should reject.

Table 5.6 – Comparison of serial correlation and variance ratio tests' results			
Serial correlation → Variance ratio ↓	No serial correlation	Low serial correlation	High serial correlation
VR = 1	30	1	1
VR ≠ 1	8	3	17
Note: Those without underline represents reinforcement of results of the two tests. Those with single underline do not reinforce and contradict. Those with double underline have contradicting results.			

ABS-CBN is one of the few four categorized with "low serial correlation." The right side of Table 5.2 shows this. Ranking all stocks with significant serial correlation, ABS-CBN has the lowest serial correlation. More importantly, ranking the same according to the ratio of serial correlation to standard error, the stock also places last. Thus, this paper conjectures a Type I serial correlation test error. As far as the variance ratio is concerned, ABS-CBN accepts the random walk for five of six test statistics using the conventional normal critical value of 1.96. A Type II variance ratio test error is not likely.

BPI is one of the eighteen categorized with "high serial correlation." This means that the serial correlation is high enough to result to a technical trading strategy beating the buy-and-hold strategy. Thus, a Type I serial correlation test error is unlikely. As far as the variance ratio is concerned, BPI rejects the random walk for three of six test statistics using the conventional normal critical value of 1.96. A Type II variance ratio test error is more likely.

Considering that the tests where taken at 5% level, about the same percentage should result to some sort of contradiction. For either test, about 3% at most have error conclusions. Thus, the tests perform better than expected.

The table also indicates that fifty-eight or about 97% of the sixty companies fall in boxes where the results do not contradict each other. Fifty or 83% of the sixty companies fall in boxes where the results reinforce each other. Specifically, thirty stocks with no serial correlation behave in random walk process. Seventeen companies with high serial correlation do not behave in random walk. Indeed, the tests generally complement each other.

Finally, note that those companies having negative serial correlation tend to have variance ratios less than one. This goes consistently with Poterba and Summers' (1988) intuition. When autocorrelations at some lags are negative, then the variance ratio will fall below one.

5.5 Summary

The serial correlation and the variance ratio tests result show strong evidence that the market does not follow the random walk process. Thus, this paper rejects the random walk process. The serial correlation test shows that 30% of the observed companies in the PSE behave inefficiently. By including transactions cost into the analysis, only 7% of the observed companies are inefficient. By barring brokers from acting as dealers, the potential improvement is from 30% inefficient to 7% inefficient.

Checking the results with theory legitimizes the tests undertaken. This holds true with comparing the Philippine's efficiency with other countries. Specifically, the ranking

of efficiency of the U.S. and selected ASEAN countries generally agree with theory. The legitimacy holds true as far as comparing specific stocks within the PSE. The sign of parameters obtained by regressing the serial correlation's absolute value and variance ratio's absolute difference from one with value of trade and market capitalization's weights also agree with intuition. Finally, the legitimacy holds true as far as comparing the results of the two tests is concerned. Specifically, individual serial correlation results generally reinforce with individual variance ratio results, and vice versa.

CHAPTER 6

CONCLUSION

Literature regarding the efficiency of the Philippine stock markets is limited because most writers take it as a fact that the market is inefficient. Chapter 2 discusses how qualitative researches and press releases imply a consensus that the Philippine stock markets are inefficient. Current events reinforce the consensus.

Chapter 3 shows the theoretical basis of checking the market's efficiency and random walk behavior via serial correlation and variance ratio tests. No serial correlation indicates that the market is efficient. The presence of serial correlation does not necessarily indicate inefficiency. More so, the serial correlation must be high enough relative to the return by adopting a buy and hold strategy to indicate inefficiency. One may confirm this when the technical strategy results to a return greater than that using the traditional buy and hold strategy. A variance ratio of one accepts the random walk hypothesis. A variance ratio not equal to one rejects the random walk hypothesis. Table 3.4 summarizes the conclusions by using the two tests.

Chapter 4 shows the methodology in implementing the test. The first major step is to determine whether serial correlation is present. When it is present, this paper uses a simplified Alexander (1961) filter rule to simulate whether the simple technical trading strategy can beat the traditional buy and hold strategy. Because the filter rule represents only one of infinite number of technical trading strategies and this paper cannot test them

all, the variance ratio test comes in as a stricter criteria whether the market is efficient or not.

Chapter 5 shows the results. The serial correlation and the variance ratio tests result have strong evidence that the market does not follow the random walk process. Thus, this paper rejects the random walk process. The serial correlation test shows that 30% of the companies observed behave inefficiently. By including transactions cost into the analysis, the figure improves to 7% inefficient.[1] This means that if all traders pay transactions cost, or if brokers are barred from acting as dealers, the market stands to potentially improve from 30% inefficient to 7% inefficient. This supports the current law to be in effect 1 January 2001.

Chapter 5 also checks whether the results agree with intuition. The results check as far as comparing the PSE with several ASEAN countries. Individual serial correlation compare well with the value of stocks traded and market capitalization. Then, the results between serial correlation and variance ratio tests generally agree. This proves the practicality of using the method employed in this paper in testing market efficiency.

As final note, to make the PSE even more efficient, this paper supports sanctions ridding off of broker's acting as directors in listed companies. This recommendation is not new as Almadro (Associated Filipino Press, 2000) and Dumlao-Arceo (1999), among others, suggest this. In this case, market players will have more symmetrical information regarding specific stocks.

For individual investors, this paper recommends that they concentrate on stocks with greater market capitalization and trading activity. Indeed, the statistical parameters

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[1] See section 5.2.2.

do not show significant relationship between efficiency, and market capitalization and trading activity. But the consistency of the parameters' negative sign show that stocks with less market capitalization and trading activity may be more vulnerable to inefficiency, and therefore speculative attacks and insider trading.[2]

[2] See section 5.4.2.

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EFFICIENCY OF THE PHILIPPINE STOCK EXCHANGE USING SERIAL CORRELATION AND VARIANCE RATIO TESTS

Dissertation directed by Parantap Basu, Ph.D.

Literature regarding the efficiency of the Philippine stock markets is limited because most writers take it as a fact that the market is inefficient. This paper quantitatively tests the degree of efficiency of the market using serial correlation and variance ratio tests. In so doing, this paper points to which firms are considered efficient and otherwise. In the serial correlation test, no serial correlation accepts the efficient market hypothesis and accepts the possibility of a random walk sequence. The presence of serial correlation does not necessarily indicate inefficiency but rejects the random walk sequence. To test whether the serial correlation warrants inefficiency, this paper uses a simplified Alexander (1961) filter rule to figure whether the technical trading rule can beat the buy and hold strategy. If technical trading rule beats the buy and hold strategy, then the stock is inefficient. Otherwise, the stock is considered efficient. Since, the simplified filter rule that will be employed represents only one of infinite number of technical trading rules possible, this necessitates for a more restrictive test for efficiency: the random walk test. Here the variance ratio test comes in. A variance ratio equal to one accepts the efficient market hypothesis and that the particular stock follows a random walk. A variance ratio not equal to one does not necessarily reject the efficient market hypothesis but rejects the random walk process.

VITA

Luis F. Dumlao, son of Conrado and Josefina Dumlao, was born on 3 November 1969, in Manila, Philippines. He graduated from Leonia High School in New Jersey in 1988 as member of the National Honor Society. He finished his Bachelor of Arts degree in Economics and International-Intercultural Studies from Fordham University at Lincoln Center in 1992; and Master of Arts in Economics from Fordham University, GSAS in 1996.

From 1993 to 1997, he worked as actuarial technician, programmer, and analyst for Insurance Services Office, Inc. – a supplier of statistical, actuarial, underwriting, and claims information in the property and casualty insurance industry. From 1998 to 1999, he went to the Philippines to study the efficiency of the country's equities market. He eventually wrote his dissertation on the "Efficiency of the Philippine Stock Exchange Using Serial Correlation and Variance Ratio Tests." During the same period, Luis taught as special lecturer for Lyceum of the Philippines' Claro Recto School of Advanced Studies and the College of Foreign Service; as professor for the Philippine Women's University's graduate school, and as faculty member of De La Salle University, Philippines.

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