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The capital asset pricing model and arbitrage pricing theory on the Johannesburg Stock Exchange

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Chapter Two: The Efficient Market Hypothesis.

The CAPM and APT rely on the efficient market hypothesis being true. If information does not drive markets then those theories that rely on rational behaviour cannot explain the return generating process. In this chapter no new empirical evidence is presented. The chapter provides a theoretical discussion of the theory and largely is a literature review. The chapter does contain an original theoretical explanation of the accounting anomaly that has provided evidence against the JSE being efficient.

Chapter Three: CAPM: Theories and Evidence.

This chapter follows on from Markowitz's (1952) insight into the nature of risk and return to derive the CAPM, to show its uses and to review the evidence in favour of the theory. This chapter contains three innovations. Firstly it examines the probability distributions of share returns on the JSE - whether they are stable Paretian or normal. Secondly, it contains a discussion of diversification on the JSE and introduces the idea of second order risk. Finally, the classic methodologies described in the chapter are applied to JSE data for the period 1981-1990. The evidence largely rejects the CAPM as being a descriptor of the return generating process.

Chapter Four: CAPM: Fact or Fiction?

The arguments against the CAPM are numerous. There are many anomalies (eg. the small firm effect and the Monday effect) that the CAPM is unable to explain. More seriously it is contended that the CAPM is untestable. Recently it has been argued that the CAPM cannot even explain the cross section of returns. In this chapter, these arguments are examined to determine whether the CAPM is flawed to the extent argued. There are two innovations in this chapter. Firstly, the All Share Index is examined to determine whether it is *ex ante* efficient, which it is. It is then used to test the CAPM. Again the test

rejects the hypothesis that the CAPM is a valid theory. The second innovation involves testing for the Monday effect on the JSE. That anomaly is shown to be absent from the JSE.

Chapter Five: APT: A New Approach.

Given the general dissatisfaction with the CAPM a new model has been developed that its proponents hope will replace CAPM. The APT was first developed as the assumptions of the CAPM were too restrictive. This chapter will review the theory of the APT, discuss the alleged advantages of the theory, (APT does not rely upon a mean-variance efficient market portfolio and allows for more than one risk factor to explain the comovement in security returns. Moreover these APT risk factors are fundamental macro-economic variables as opposed to the "market" variable of the CAPM) and will contain the results of previous empirical work. As little has been done in this area in South Africa (which is flawed at that), most of the chapter will rely on the American experience.

Chapter Six: APT: Empirical Evidence.

This chapter attempts to identify, firstly, the number of factors that comprise the APT on the JSE and, secondly, evaluates whether the New York Stock Exchange (NYSE) factors are priced on the JSE.factors. These include: default risk, term structure of interest rates, inflation, short term interest rates, and production or sales (a factor is always an unexpected change in the particular variable). The evidence is disappointing. It is possible to show that there should be more than one factor, but not how many there should be. In addition none of the NYSE factors are priced on the JSE.

1.2 METHODOLOGY

Share price data for the ten year period 1981 to 1990 was used for the

empirical research. Share price data and dividend data drawn from the I-NET system was used to form total returns files (log relatives). Economic data was taken from the Standard Bank ECOCATS system.

The investigation into share return distributions (section 3.1.1.2.1) involved use of the Johannesburg Stock Exchange All Share Index (ALSI) for the period 1963-1991. The reason for the extended period is that large quantities of data are required for the tests. In addition dividends were not considered in this section. To the extent that this introduces biases, the conclusions of that section are open to debate.

The discussion and tests of diversification on the JSE encompasses the period 1987-1992. This period was chosen as it offered the period where the maximum number of return files could be formed. In addition it represented a five year period, excluding the run up to and the event of the 1987 crash.

The investigation into the Monday effect covered of the period 1986-1990. This period was considered as it proved difficult to acquire daily share price data before that period.

All other tests occurred in the period 1981-1990. This period in turn was subdivided into two five year periods: 1981-1985 and 1986-1990.

1.3 CONCLUSION

The paper attempts to follow both a historical and logical approach to the development of the theories. In the final analysis, it seems that a lot of research needs to be conducted on the JSE in order to determine the nature of the process of price discovery. This research will have to expand on many fronts, it will need to consist of both theoretical and empirical/statistical work.

CHAPTER TWO

THE EFFICIENT MARKET HYPOTHESIS[1]

"...I really wish Bob [Shiller] were right about markets being inefficient. Because if they were, ... we could sure do a heck of a lot better for our clients in the money management business than we've been doing." Richard Roll (1992:29-30).

The study of any stock exchange needs to begin with the question: "Is this market efficient or not?" In this chapter, the question of market efficiency will be considered from both the theoretical perspective and by means of a review of the empirical evidence. This question and the evidence for and against market efficiency have been formalised in the efficient market hypothesis (EMH).

The structure of the chapter is as follows: a definition of the market is followed by a formal definition of the EMH. The next section distinguishes a perfect market from the EMH. Tests of the EMH are then discussed.

2.1 DEFINING THE MARKET

An early definition of the market was put forward by Anacharsis of Scythia (c. 600 BC): "The market is a place set apart where men may deceive one another" (quoted in Hodgeson 1988:172). This is a particularly useless definition of the market as it tells us nothing of what happens in a market. The veracity of the statement, given modern theories of the market, may also be called into doubt.

Modern economic theory relies on markets; given this, one expects to find

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[1] This chapter has formed the basis for a conference paper: "Some suggestions on teaching the Efficient Markets Hypothesis" delivered to the First Annual Conference of Southern African Finance Academics.

satisfactory definitions of markets with comparative ease. This, however, is not the case. Cournot (1897, quoted in Hodgeson 1988:173) defines a market in the following terms:

> "[A] region in which buyers and sellers are in such frequent intercourse with each other that the prices of the same goods tend to equality easily and quickly."

The problem with this definition is that the term "frequent intercourse" is not defined. A further problem with this definition is that given modern technology a market need not be confined to a region or geographic area.

Here the definition of Mises (1949:258) is more helpful:

> "The market is not a place, a thing or a collective entity. The market is a process, actuated by the interplay of the actions of the various individuals cooperating under the division of labour."

On first glance it would appear that Mises neglects the most important aspect of a market; however, the reference to the "division of labour" can be said to refer to exchange.

Hodgeson (1988) submits that markets need to be defined with respect to institutional relationships within the economy. These institutional relationships include "the customary, legal, political and other social arrangements which are central to all market systems" (Hodgeson 1988:174). He defines the market as such:

> "[A] set of social institutions in which a large number of commodity exchanges of a specific type regularly take place, and to some extent are facilitated and structured by those institutions. Exchange ... involves contractual agreement and the exchange of property rights, and the market consists in part of mechanisms to structure, organise, and legitimise these activities. Markets, in short, are organised and institutionalized exchange."

Stock exchanges can be defined as such a market; they certainly meet all the

requirements of the above definition. This may be seen in one of the basic purposes of the JSE:

> "to offer an orderly market where [investors] can exchange shares for cash and vice versa on the basis of adequate information" (Ryan 1989:32).

At this point we see an addition to the question of what constitutes a market: the question of information.

2.2 A FORMAL DEFINITION[2]

Fama (1970:183) describes the ideal stock market as one "in which prices provide adequate signals for resource allocation ... investors can choose among the securities that represent ownership of firm's activities under the assumption that security prices at any time 'fully reflect' all available information. A market in which prices always 'fully reflect' available information is called efficient". This relationship between price and information is known as the efficient market hypothesis.

LeRoy (1989:1583) has argued that at a general level the EMH is the Ricardian theory of competitive advantage. Instead of having an advantage in the production of cloth and wine, economic actors have informational advantages. If information is not fully reflected in price then the actor who knows that information has an advantage over other actors. The essence of the EMH (according to this approach) is that in an efficient market individuals do not have any comparative advantages in the acquisition of information. LeRoy (1989:1584) adds that, "to the extent that markets are informationally efficient, acquisition of information is a waste of time". This of course is the paradox of

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[2] Brealey and Myers (1991: 297) state that defining the EMH is much like defining a duck, "[e]veryone thinks they know a duck when they see one, but it is hard to come up with a satisfactory definition. It is rather like that with efficient markets."

the EMH[3]: searching for information is largely a "waste of time"; however, it is this very search that is the cause of market efficiency.

In order to derive any benefit from the EMH, we need to understand what is meant by the term "fully reflect".

Given the assumption that market equilibrium can be stated in terms of expected returns or a fair game model, *and* the following condition holds, the market is said reflect all relevant information.

$$E(p_{j,t+1} | \Phi_t) = [1 + E(r_{j,t+1} | \Phi_t)]p_{j,t} \quad (2.1)$$

The expected price of share j at time t+1 given the information set Φ at time t, should be equal to the price of share j at time t, plus the expected return of share j. If the information set, Φ, were to change between time t, and time t+1, then we would expect a change in share price greater than the expected rate of return on share j. If, however, the information set Φ were to remain unchanged between time t, and t+1, then given the EMH we would expect the following condition to hold.

$$\text{If: } X_{j,t+1} = p_{j,t+1} - E(p_{j,t+1} | \Phi_t) \quad (2.2)$$

$$\text{then: } E(X_{j,t+1} | \Phi_t) = 0 \quad (2.3)$$

The EMH states that (2.3) will hold as long as no new information becomes available to the market.

This briefly explains the concept, "fully reflect". The next problem arises from the phrase, "relevant information". The EMH is usually divided into three forms[4]:

- the weak form: here relevant information comprises all past price information;

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[3] It has been said that, "the only reason that markets are efficient is that nobody believes that they are totally efficient" (McConnel 1984: 66).

[4] Jensen (1969:190) attributes this distinction to Harry Roberts who used it is a speech entitled, "Clinical vs. Statistical Forecasts of Security Prices".

- the semi-strong form: here relevant information is the weak form plus all publicly available information; and,
- the strong form: here relevant information is the semi-strong form plus all information ie. non-public information.

LeRoy (1989:1584) argues that investors "have no choice but to base their investment decisions on information". King (1966:143) identifies three types of information that affect share prices:

- economy related information;
- industry related information; and,
- company related information.

The APT attempts to isolate the effect of economy related information on share prices.

2.3 EFFICIENT AND PERFECT MARKETS

It is important to differentiate an "efficient market" from a "perfect market". A perfect market is one characterised by:

- perfect information;
- price taking, (ie. an infinite number of economic actors);
- rational behaviour;
- zero transaction costs; and,
- uniform expectations.

These conditions are sufficient, but not necessary for a market to be efficient. Fama (1970:189) deems that differentiating between perfect and efficient markets is important enough to include a section on this topic in his paper. He lists the conditions required for a perfect market (similar to that above) and then argues that the conditions for an efficient market are far less stringent. We see however, in Miller (1987:4) the following: "[i]nstead of analysing actual security markets, the efficient market literature assumes perfect markets". To a large extent this is true, this confusion between perfect and efficient markets probably does more to discredit the theory than anything else.

The confusion between efficient and perfect markets arises for various reasons. The major reason being that in many instances the stock market resembles a perfect market in that there is price taking and rational behaviour. Similarly, within the CAPM, we make the assumptions of zero transaction costs and perfect information.

Many of the assumptions of perfect markets are benign. However, a major problem arises in the concept of perfect information. Perfect information implies an absolute lack of ignorance. It is submitted that this happy state is either unattainable or economically non-viable. Stigler (1961:60) has stated that, "[i]gnorance is like subzero weather: by a sufficient expenditure its effects upon people can be kept within tolerable or even comfortable bounds, but it would be wholly uneconomic entirely to eliminate all its effects." Perfect information would allow for share prices to instantly reflect all information. This, however, is not what the EMH implies.

2.4 IMPLICATIONS OF THE EMH

An efficient market will have the following characteristics:
- prices will respond quickly and accurately to new information;
- price changes between time periods will be random; and,
- there is no difference in the average investment performance of knowledgeable and unknowledgeable investors (Haugen 1990:608-609).

Hagin (1979:37) writes that in order to outperform the market, an investor must know that certain kinds of information will, with known probability, influence certain investment instruments in particular markets, in known directions, with known magnitude and must act on that information, before anyone else does. If the investor does not have this information it will be extremely difficult to outperform the market.

The question arises: "Why is it important to know whether the market is

efficient or not?" The answer lies in the implications of an efficient market. Brealey and Myers (1991:300-309) state that there are six lessons of market efficiency, viz.

- markets have no memory;
- trust market prices;
- there are no financial illusions;
- the do-it-yourself alternative;
- seen one stock, seen then all; and,
- reading the entrails.

These six lessons each have far reaching consequences for investors and in this section each implication will be discussed. We shall see that not all of the implications are necessarily valid.

2.4.1 MARKETS HAVE NO MEMORY

The weak form of the EMH states that past prices contain no information as to future prices. This translates into the dicta that technical analysis is useless. The rationale for this is the fact that tests of trading rules have proved that no technician can consistently outperform the market.

Joy and Jones (1986:51) deny that the EMH invalidates technical analysis. They submit that technical analysis has not been thoroughly tested. Specifically, they make two claims:

- there is not a one to one mapping between weak form analysis and technical analysis; and,
- many weak form tests are not direct tests of specific forms of technical analysis.

The first claim is based on the fact that technical analysis is more complex than that posited by academic analyses. *Technicians usually analyze both price and volume data. Academic studies have concentrated on price data only.* Joy and Jones (1986:51) attribute this to the fact that volume data is costly to

acquire and incorporate into tests of the EMH. They are, however, unwilling to state that tests of the weak form are unimportant: many forms of technical analysis have no predictive power. Many other forms of technical analysis, however remain untested. Joy and Jones (1986:52) submit that the validity of concluding that technical analysis is useless is questionable and limited to those techniques that have been studied.

The second claim is related to the nature of tests that have been conducted. Many of the tests of the weak form consist of correlation studies. Joy and Jones (1986:51) argue that low positive correlation between successive price changes does not necessarily imply that a no trading rule based on that correlation cannot be devised.

Notwithstanding these criticisms Joy and Jones (1986:52) are not advocating technical analysis. They admit that the evidence against technical analysis is formidable. They simply wish to warn against premature conclusions given the fact that the evidence against technical analysis is incomplete.

What is of greater interest in this case is the following: "If technical analysis is useless, why has it survived?". This is a question that Jensen (1979) considered. He concluded (Jensen 1979:52) that technical analysis survives because there is a demand for it (by both analysts and investors). There are two potential reasons for this:

- marketing reasons (demand by analysts); and,
- "religious" reasons (demand by investors).

Marketing reasons arise because of fixed brokerage fees. This precludes price competition between stock brokers. In order to compete (ie. differentiate themselves from the competition) brokers provide "free" research to their clients. The religious argument explains that portion of technical analysis that is not covered by marketing reasons. People have a fear of the unknown. By definition, the future is largely unknown. Thus, a market for research is established. The actors in this market would include: horoscope writers, gurus,

religious personnel and the like. Jensen (1979:52) argues that analysts should be added to this list. He further adds that, "[w]hen [investors] find that the "answers" provided by one source seems to fail systematically they simply change sources of information".

Thus, while it is debatable whether technical analysis is useless or not, it is certainly not irrelevant.

2.4.2 TRUST MARKET PRICES

Brealey and Myers (1991:300) argue that in an efficient market prices will contain *all available information* about the value of a particular share. All information will be contained in the price and thus shares will be fairly priced.

The dynamic of this approach is as follows: Information enters into the market. Information that is relevant to the exchange is analyzed and is incorporated into prices. In an efficient market this information is incorporated fairly quickly and accurately. The reason for this is that the first analyst to correctly analyze the information will earn an economic profit. Hayek (1978:188) views competition thus: "in highly developed economic systems competition is important as a process of exploration in which prospectors search for unused opportunities...". We should see competition among analysts to speedily and correctly analyze new information. It is this competition that ensures the efficiency of the market and leads to the fact that we can trust market prices. If shares are not correctly priced, opportunities to earn abnormal profits will exist and speculators will enter the market and arbitrage those profits away, thus driving the share price to its "true" level. Summers (1986:598) points out that this later argument fails to specify how these speculators will identify those mis-priced shares.

Haugen (1990:609) submits that the reaction of the market should be unbiased, and that the initial reaction "should accurately reflect the true

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