CHAPTER VI

SUMMARY OF FINDINGS AND SUGGESTIONS
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This chapter provides a summary of the findings pertaining to the application of sample entropy in the study of stock price manipulation and the application of transfer entropy in the studies of price discovery in securities market and interactions between stock and other markets. Then some suggestions have been given based on such findings. Also, the scope for further research as a continuation of this study, is outlined.

SUMMARY

Since entropy quantifies the irregularity or complexity of a random variable and it is feasible to compute entropy for short and noisy time series like the price data of a scrip during a trading day, it is opined that entropy theory may be useful in the study of manipulation in stock prices. Sample entropy (SampEn), which considers both linear and non-linear structure in a time series, has been computed for the time series of trade price data related to the scrips of Lupin Laboratories Ltd., Morepen Hotels Ltd. and Surya Rooshni Ltd. on various days during the periods October 1999 – January 2000, September 2000 – March 2001 and April 2000 - October 2000 respectively, during which the scrips have been reported to be subject to price manipulation. It is observed that SampEn values are very low on 16 days in respect of Lupin Laboratories Ltd., on 39 days in respect of Morepen Hotels Ltd. and on 25 days in respect of Surya Rooshni Ltd., implying that these are days of potential manipulation in the price of the respective scrips.
scrips. Further, it appears that price manipulation has been rampant in the scrip of Morepen Hotels Ltd during the months of February and March 2001 and in the scrip of Surya Rooshni Ltd during the months of June and October 2000, since sample entropy has remained at very low level continually for many days during these months. Thus, among the various versions of entropy, sample entropy is found to be suited to study price manipulation in the stock market.

Another entropic measure called transfer entropy quantifies the exchange of information between two non-linear dynamical systems and hence it is proposed that entropy theory may be applied in the study of price discovery in the securities market. Transfer entropy between the Nifty index (representative of the equities segment of the Indian securities market) and the near month Nifty futures contract (in the derivatives segment of the Indian securities market) for the period October 2005 – September 2006 has been computed and is found to be in consonance with the results of previous studies using other methods, however it may be noted that transfer entropy quantifies information transmission, including non-linear dynamic relationship also. Further, the computed transfer entropy values are interpreted using the notions of net information flow, normalised directionality index and relative explanation added. Specifically, in the Indian stock market, apart from information flow from derivatives segment to equities segment, information dissemination in the reverse direction also is observed during the period considered, however the flow from derivatives segment to equities segment is generally more pronounced. Thus transfer entropy proves to be a promising measure to identify causal relationship.
In a similar manner, the application of entropy theory in the study of interactions between the stock market and the foreign exchange market of India is illustrated by computing transfer entropy values between the Nifty (stock) index and the RBI reference (forex) rate for the period November 1995 – March 2007. Considering the important developments in the two markets, the period under study is divided into 3 sub-periods and transfer entropy is computed for each sub-period separately, to study the interactions between the two markets in view of the developments. Further, net information flow, normalised directionality index and relative explanation added which are computed from the transfer entropy values throw more light on the nature of relationship between the two markets. The results obtained for the different sub-periods are more or less consistent with those obtained for the entire period and reiterate that

- there exist only low level interactions between the stock and the forex markets of India at a time scale of a day or less, although theory suggests interactive relationship between the two markets
- the flow from the stock market to the forex market is more pronounced than the flow in the reverse direction
- the entropy rates of both the markets become zero on considering 8 or more past values realised in the respective markets, implying that the information generation in the markets tend to zero if 8 or more past values are considered.

Thus transfer entropy is found to be a useful measure to identify directional information.

Further, the application of entropy theory in the study of interactions between the stock market and the commodities market of India is illustrated by computing transfer entropy
values among the Nifty index of stock market, Nifty futures contract of stock derivatives market, NCDEXAGRI index of commodities spot market and FUTEXAGRI index of commodities derivatives market of India for the period from June 2005 to September 2007 and the results obtained across the markets are found to be more or less consistent and reiterate that

- there exist interactions between any two markets, with upto 6 days old price information and the feedback between any two markets is almost at the same level in both the directions
- information generation in the markets tend to zero if 7 or more past values are considered.

SUGGESTIONS

Based on the analysis and the findings, the following suggestions are made.

(a) Stock exchanges may use the non-linear invariant of sample entropy (SampEn) to filter potential manipulation cases instead of using linear measures of variation. SampEn of the time series of order prices of each security may be computed on a day-to-day basis and the daily SampEn value of a security may be compared with the previous values over a period. Repeated drops in the value, if found, suggest that the security may have been subject to price manipulation on the days corresponding to low values of SampEn. Such scrips may be filtered out for detailed investigation in order to ascertain the facts behind the trading pattern of the participants.
(b) In the Indian stock market, apart from information flow from index futures to Nifty index, information dissemination in the reverse direction also is observed during the period October 2005 – September 2006. However, both the relative explanation added (REA) by the derivatives segment to the equities segment and that by the equities segment to the derivatives segment are found to be low. This suggests that hedging an exposure in a segment with a counter-exposure in the other segment may not be highly effective. Further, margins prescribed by market regulators or stock / derivatives exchange authorities, on positions taken by participants in the two segments may be levied separately without netting their positions across the markets i.e. application of cross-margining in the equities and the derivatives segments of the Indian capital market may not be advisable at this juncture.

(c) Interactions between the stock and the forex markets in India have been observed to exist at low level only, even by using the non-linear measure of transfer entropy to quantify the information transmission between the two markets. Hence any policy intervention in a market is not expected to have significant impact on the other. Specifically, any intervention to support exchange rate levels or allowing a full float exchange rate is not likely to affect foreign portfolio investment. Further, global investors may reduce risk exposure by diversifying their portfolios across the two markets.

Interactions among the stock market, the stock derivatives market, the commodities spot market and the commodities derivatives market of India have been observed to
be significant between any two markets in both the directions. Hence, depending on
information from one market, policy makers may take pro-active steps for the other
markets since policy intervention would be effective in the desired direction.

SCOPE FOR FURTHER RESEARCH

Entropy theory is a novel area in the Indian stock market and there is a lot of scope for
the application of entropy theory in the Indian financial market. In the absence of
conspicuous research efforts to apply entropy theory in the Indian financial market,
sample entropy may be used to study trading patterns in the derivatives and the
commodities futures markets of India, with a view to identify potential price
manipulation cases.

In the study of price discovery in the Indian securities market, data pertaining to one year
period viz. October 2005 – September 2006 have been considered. Derivatives trading
started in India from June 2000 and by July 2001, both futures and options contracts on
stock price indices and individual stock prices were made available, in stages, for trading.
Hence the study may be made for a longer period, perhaps starting from July 2001.
However, it may be noted that in the current study, minute-wise trade data over the one
year period have been considered. Such high frequency data over a longer period may be
unwieldy on account of the enormous number of data points. Hence daily data or high
frequency data, depending on the availability of computing resources, for longer period
may be used to study price discovery in the Indian securities market.
LIST OF RESEARCH ARTICLES PUBLISHED


6. Y.V.Reddy and A.Sebastin "Interaction Between Forex and Stock Markets in India: An Entropy Approach" Vikalpa, IIM Ahmedabad (Accepted for publication)

7. Y.V.Reddy and A.Sebastin “Are commodity and stock markets independent of each other? A case of India” Journal of Alternative Investments, Institutional Investor, USA (Accepted for publication)