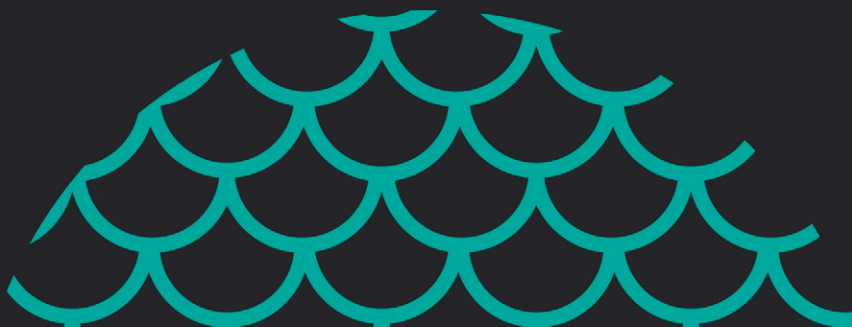
EMERALD POINTS

DEVELOPING AN EFFECTIVE MODEL FOR DETECTING TRADE-BASED MARKET MANIPULATION

DR. JOSE JOY THOPPAN
DR. M. PUNNIYAMOORTHY
DR. K. GANESH
DR. SANJAY MOHAPATRA



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JOSE JOY THOPPAN
Saintgits Institute of Management, India
M. PUNNIYAMOORTHY
National Institute of Technology, India
K. GANESH
McKinsey & Company, India

And

SANJAY MOHAPATRA
Xavier Institute of Management, India

United Kingdom – North America – Japan – India
Malaysia – China

Emerald Publishing Limited
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ABSTRACT

'Every day criminals may be stealing up to $400 million – 1 quarter of a percent of total trades – by manipulating the stock market', says Alex Frino of the Sydney based Capital Markets Co-operative Research Centre. Most manipulation is detrimental to the trading venue and its participants. Market manipulation impairs price discovery and misrepresent the fair value of a security. The distorted prices force investors to migrate to more efficient markets for deploying their capital. This reduces order flow and increases the cost of trading at a particular trading venue. It further motivates companies coming up with new issue to list their securities at other markets where there are better regulations and more efficient monitoring. Hence, ways and means of understanding and eliminating manipulative practices attract great interest from researchers, regulators and exchanges.

This research seeks to determine an appropriate model to help identify stocks witnessing activities that are indicative of potential manipulation through three separate but related studies. In a market like India, where there are about 5,000 plus securities listed on its major exchanges, it becomes extremely difficult to monitor all securities for potential market abuse. In this research, classifiers based on three different techniques namely discriminant analysis, a composite classifier based on Artificial Neural Network and Genetic Algorithm and Support Vector Machines are proposed. The proposed models help investigators, with varying degree of accuracy, to arrive at a shortlist of securities which could be subject to further detailed investigation to detect the type and nature of the manipulation, if any.

Chapter 1 provides an introduction to the topic. In this chapter, the market structure and an efficient stock market are discussed. The topics covering Indian stock markets, stock price manipulation and stock market surveillance are also introduced.

Chapter 2 provides a detailed literature survey on the topics covering efficient markets, market integrity, market manipulation and market surveillance. In Chapter 3 the issues, scope and objectives of the research

are discussed. In Chapter 4, the data and the three techniques that are used in the research are discussed.

In Chapter 5 and 6, the first classifier built based on discriminant analysis, which is one of the most popular classification techniques, is developed and applied. As a first step, the most popular and widely used Linear Discriminant Function is discussed as it has been widely used by researchers. It was also observed that researchers have used this technique without validating the assumption that governs the model. It is shown that the data collected from the Indian exchanges do not comply with the assumptions that govern the use of the Linear Discriminant Function. Based on literature review, it is shown that the Quadratic Discriminant Function (QDF) is the appropriate discriminant analysis based classification technique for instances where the data does not meet the stated assumptions of the Linear Discriminant Function, to categorize stocks as manipulated and non-manipulated. This classification is archived based on certain key market data variables that capture the characteristics of the stock.

In Chapter 7, a hybrid model using advanced data mining techniques like Artificial Neural Network and Genetic Algorithm is developed. An empirical analysis of this model is carried out to evaluate its ability to predict stock price manipulation for the same data that was used earlier. Further, the performance of this hybrid model is compared with a conventional standalone model based on Quadratic Discriminant Function (QDF). Based on the results obtained, it is concluded that the hybrid model offers better prediction accuracy than the conventional model.

In Chapter 8, the essentials of a Support Vector Machines (SVM) based model, first proposed by Vapnik, is presented in a simplified but detailed elucidation. Subsequently, a detailed description for applying SVMs to identify stocks that are witnessing activities indicative of potential manipulation is provided. Finally, the superiority of the model for the data has been established by comparing with the results obtained from the QDF and the ANN-GA composite classifier.

Keywords: *Artificial neural network, genetic algorithm, market manipulation, quadratic discriminant function, radial basis function, support vector function, surveillance*

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LIST OF ABBREVIATIONS

ADS	Advanced Detection System
ANN	Artificial Neural Network
ARIMA	Autoregressive Integrated Moving Average
ASBA	Application Supported by Blocked Accounts
BBC	British Broadcasting Corporation
BSE	Bombay Stock Exchange
CDSL	Central Depository Services (India) Limited
CMCRC	Capital Markets Co-operative Research Centre
DCA	Department of Company Affairs
DEA	Department of Economic Affairs
DMA	Direct Market Access
DSE	Dakha Stock Exchange
EMH	Efficient Market Hypothesis
EPS	Earnings Per Share
ETF	Exchange Traded Funds
FIX	Financial Information eXchange
GA	Genetic Algorithm
IMSS	Integrated Market Surveillance System
IOSCO	International Organization of Securities Commissions
IPO	Initial Public Offering
KKT	Karush Kuhn Tucker
LDF	Linear Discriminant Function
MCX	Multi Commodities Exchange
MDA	Multiple Discriminant Analysis
NASD	National Association of Securities Dealers
NSDL	National Securities Depository Limited
NSE	National Stock Exchange
OTC	Over the Counter
P/E	Price to Equity
QDF	Quadratic Discriminant Function

RBF	Radial Basis Function
RBI	Reserve Bank of India
SEBI	Securities Exchange Board of India
SEC	Securities Exchange Commission
SONAR	Securities Observation, News Analysis and Regulation
SOR	Smart Order Routing
SRO	Self-Regulating Organisation
SVM	Support Vector Machines
TSE	Tunisian Stock Exchange

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INTRODUCTION

This thesis attempts to develop efficient and effective models to detect the manipulation of securities in the Indian Stock Exchanges.

The history of manipulation in stock market dates back to the most ancient time. One of the earliest accounts of manipulations in markets dates back to about 300 years ago when Joseph De La Vega described the Amsterdam stock markets where manipulation was a common occurrence. He was quoted by Fridson (1996) as below:

> *The greatest comedy is played at the Exchange. There,… the speculators excel in tricks, they do business and find excuses wherein hiding places, concealment of facts, quarrels, provocations, mockery, idle talk, violent desires, collusion, artful deceptions, betrayals, cheatings, and even tragic end are to be found.*

De La Vega details the various manipulative techniques adopted by unscrupulous traders to trick unsuspecting investors. The improvements in technology and regulatory systems have not been able to eradicate manipulation in stock markets. The manipulators have always managed to be one step ahead and have managed to carry out more and more sophisticated market manipulation. This has forced the regulators to continuously evaluate the system and evolve better models to track manipulation.

Manipulation of stock prices can have an extremely disruptive impact on the core functions of the equity market. It can adversely impact the pricing efficiency of the market and the ability of the market to act as an intermediary between the various sources of finance like households and entities that require finance. The chances of artificially influencing the price of a stock is thus an issue of paramount importance to all those involved in the business ranging from exchanges, investors, intermediaries, regulators, etc.

1.1 MARKET STRUCTURE

The key elements of market structure as espoused by Capital Markets Cooperative Research Centre (CMCRC) are the various participants in the market, the instruments or securities traded in these markets, the role of the regulator and the regulations that govern these markets, the technology comprising the hardware and software powering the markets, and the market data dissemination infrastructure.

1.1.1 The Market Participants and Intermediaries

The Market Participants are the various entities that participate in the market. The definition has expanded in scope from the conventional categories of investor/speculator, retail/institutional to include the research analysts, brokerage houses, smart order routing systems and automated trading platforms.

1.1.2 The Instruments

The instruments include any contracts that are traded on an organized trading platform. This can range from bonds, equities, equity derivatives, interest rate derivatives, currency derivatives, electricity contracts and going to the exotic contracts like weather, carbon etc. In our research, we limit ourselves to the listed equity securities on the Indian exchanges.

1.1.3 The Regulator and Regulations

Regulations are the laws and rules formulated by various national and international watchdogs supervising the markets or by the trading platforms on their own accord, to govern the trading in markets/platforms under their control. This is a very dynamic arena of the market structure and change frequently.

1.1.4 The Technology

Technology refers to the combination of the hardware and software that supports the trading platforms in the various exchanges and alternative trading venues and at the intermediaries that connect these trading venues with the end investor.

1.1.5 Market Data Dissemination

A critical element in enforcing integrity in any market is by the eradication of information asymmetry. This can be achieved by ensuring that all sorts of material information that helps a trader to make an informed decision are readily available at his disposal. This can be in many from covering company announcements and voluntary disclosure filings and market data. These can be sourced from the trading venues directly or through information vendors like Reuters and Bloomberg etc.

1.2 AN EFFICIENT STOCK MARKET

The price of a stock at any moment can be directly attributed to the number of buyers and sellers who want to acquire or part with the stock and the consideration that they are willing to pay. This can simply be equated to the demand and supply of the stock at any one moment. The consideration or the price of the stock adjusts itself to try to attain equilibrium and sustain it till there is a change in the number of buyers or sellers. The rate at which the prices move in either direction favouring the buyer or the seller indicates its volatility. The Efficient-Market Hypothesis (EMH) states that markets are inherently efficient with respect to its ability to disseminate information. It considers that no investor can achieve returns that are higher than the average market returns on a sustained basis, given the information available at the time of investing.

The volatility witnessed in recent years however is contrary to the postulates of the EMH and we have enough instances to show that markets are not perfectly efficient, especially in emerging markets where there are few well-informed professional investors. A second theory based on Behavioural Finance states that humans are more often than not irrational in making decisions on buying and selling of securities. The theory attributes this behaviour to fears and misperceptions on the end result that often cause security prices to fluctuate from their rational, fundamental price. However, not all fluctuations resulting in high volatility in stock prices can be attributed to irrational decision-making by investors.

1.3 THE INDIAN STOCK MARKET

The history of the capital market in India dates back to the eighteenth century when East India company securities were traded in the country. It has been a

long journey for the Indian capital market. Today, the capital market is organized, fairly integrated, mature, more global and modernized. The Indian equity market is one of the best in the world in terms of technology as well as value-cum-volume of business.

The two major exchanges in the Indian Stock Market are the National Stock Exchange and the Bombay Stock Exchange.

1.3.1 The Bombay Stock Exchange

BSE Limited is the oldest stock exchange in Asia. It has its origins in 'The Native Share & Stock Brokers' Association' which was established in the year 1875. Over the past 137 years, BSE has helped corporate India raise capital through its trade floor and later the electronic trading platform. BSE is the world's largest exchange in terms of the number of listed companies. It has over 4,900 securities listed on its various segments. It is one of the largest exchanges in terms of number of transactions handled through its electronic trading system and also by market capitalization of its listed companies. The BSE Index, SENSEX, is India's first and most popular Stock Market benchmark index.

1.3.2 The National Stock Exchange

NSE was promoted by leading Financial Institutions at the behest of the Government of India and was incorporated in November 1992 as a demutualized entity. The National Stock Exchange (NSE) operates a nation-wide, electronic market, offering trading in Capital Market, Derivatives Market and Currency Derivatives segments including equities, equities based derivatives, Currency futures and options, equity based ETFs, Gold ETF and Retail Government Securities. The NSE's communication network stretches to more than 1,500 locations and supports more than 2,30,000 terminals. The NSE supports more than 10 asset classes and supports several new products like Mini Nifty, Long Dated Options and Mutual Fund Service System.

1.3.3 Key Developments in the Indian Stock Market

Some of the key developments in the Indian Capital Market are as mentioned below. The Retail equity investor limit is increased to Rs. 2 lakhs from 1 lakh,

reduction in issue-listing period to 12 days, opening of pre-market auction sessions, increase of stock exchanges trading duration, improvement in price-discovery mechanism, introduction of ASBA in IPOs, trading and allowing of Anchor-investors in IPOs etc., Moreover, the fundamental infrastructure for regulation, disclosure, surveillance and trading are all in place. Responding to market needs, the Indian exchanges have introduced services like Smart Order Routing (SOR), Direct Market Access (DMA), FIX capabilities, co-location facility and mobile trading to cater to the evolving need of the market and various categories of market participants.

The Indian Stock Market is regulated by various agencies, such as the Department of Economics Affairs (DEA), the Department of Company Affairs (DCA), the Reserve Bank of India (RBI) and the Securities Exchange Board of India (SEBI). The Activities of these agencies are coordinated by a high level committee on capital and financial markets.

1.4 STOCK PRICE MANIPULATION

Market manipulation can be recognized as a conscious attempt to obstruct the free and fair functioning of stock markets and create artificial, false or misleading situations relating to the price of, or market for a stock. Recent fluctuations in the stock prices have raised serious concerns about the determination of stock prices, speculative tendencies and most of all illegal market manipulation. A manipulator having significant money power can choose a company, most often illiquid, and engage in sustained heavy buying on the market thus driving up the prices. He might also plant some fraudulent stories in the business press to further his agenda. Once the prices have significantly ramped up, he hopes to sell out at the high price and walk away with a windfall. This is one of the most common types of market manipulation existing in the financial markets, typically the emerging markets.

Most manipulation is detrimental to the trading venue and its participants. Market Manipulation impairs price discovery and misrepresent the fair value of a security. The distorted prices force the migration of investors to more efficient markets for deploying their capital, thus reducing order flow and increasing the cost of trading at a particular trading venue. This further motivates companies coming up with new issue to list their securities at other markets where there are better regulations and more efficient monitoring. Hence, ways and means of understanding and eliminating manipulative practices attract great interest from researchers, regulators and exchanges.

Some of the most widely reported incidents on market manipulation include the 'The Guinness Four Business Scandal' (BBC, 2001) and the 'The Livedoor Scandal' (Time, 2006).The well-known scams in the Indian market (Basu & Dalal, 2009) are the twin scams of 1992 and 2001 involving Harshad Mehta and Ketan Parekh. In 1992, it was Harshad Mehta who in collusion with Indian banks, businessmen, brokers, foreign banks and mutual funds orchestrated a false bull market that ended in a meltdown. In an incredible recurrence of history, a different set of banks, brokers, foreign investors and companies connived with Ketan Parekh produced a sequel which was equal if not greater in magnitude to the earlier scam causing a systemic collapse of the Indian Capital Market.

The National Stock Exchange (NSE), India's largest Stock Exchange and a frontline regulator (Self-Regulatory Organization), has reported that in the cash equity segment, the top 10 participants accounted for about 24% of the turnover while the total client level delivery percentage was about 36% during the period April to June 2010. In the Derivatives Market, the top 10 participants accounted for about 38% of the turnover and the daily intra-day square off turnover accounted for about 67% of the total turnover during the same period. Based on this information we could come up with a crucial inference that unlike what was portrayed in the popular media, which gives a perception of a vibrant and broad based stock market in India, the market remains narrow, shallow and illiquid with the pricing power concentrated in the hands of a few individuals located in a few centres. This is not to cast aspersions at the integrity of the market but to show that it is easy for a rogue trader who could be among the leading volume contributors to adversely impact the market efficiency. This also goes on to highlight the need for effective and continuous monitoring of the market activity to identify manipulative and illegal trade practices.

This is not a phenomenon restricted to India alone. Ravi Narain, Managing Director of NSE, in a letter addressed to key government officials including the Reserve Bank of India (RBI) Governor and the Chairman of capital market regulator Securities and Exchange Board of India (SEBI) pointed out that, major global exchanges had such skewed figures. He cited the examples of the New York Stock Exchange having 38% of trades contributed by the top 10 brokerages and Bursa Malaysia and Johannesburg where the figures are much higher at 66%. This shows that, worldwide, the larger participants have the ability to move the markets to suit their need. This again is not to be construed as an aspersion on the integrity of the Global Capital Markets but as a pointer

to the possibility of some rouge elements having the potential to destabilize the fair pricing mechanism of the market.[1]

In light of the above manipulative incidents and situations where the environment is conducive for a manipulator to be active, there is a perceived need for a competent Market Surveillance System. The surveillance systems help these agencies pursue appropriate preventive/corrective actions to prevent abusive, manipulative, or illegal trading practices that could be detrimental to the market. Effective monitoring of markets is achieved by scrutinizing the trading activity based on certain mathematical models which analyse data on identified market parameters.

Aggarwal and Wu (2006) provide evidence based on SEC actions that potentially informed participants including corporate insiders, brokers, underwriters, large shareholders and market makers are likely to be the manipulators especially in illiquid securities.

1.4.1 Issues in Identifying Manipulation

The purpose of market regulation is to keep a market fair and orderly, by effective surveillance and identifying potentially illegal trading. Surveillance is difficult: the number of transactions that must be examined is enormous, and even if the necessary databases exist, analysts cannot examine every transaction. Potential illegal trading is likely to consist of associations of traders and possessors of information: analysts must be able to detect unusual patterns of trading activity, as well as links between patterns of names.

From time to time the regulator has noticed that the prices of certain stocks have witnessed dramatic upsurges on the day of listing, or soon thereafter. An analysis of the trading pattern in shares on the day of listing showed that certain clients had placed abnormally large orders of shares at prices much below prevailing market prices leading to doubts on the intentions of the entities placing such orders. A common excuse provided by the suspected manipulator is that they are intraday trader and the orders were placed at the price calculated on the basis of fundamental and technical analysis of the company. They place these orders as fully disclosed orders claiming to gain preference in execution because of the quantity. They try to hide behind the legitimacy of intraday trading and that the same should not be deemed to be a fraudulent

1 This is an extract from an article titled 'NSE "refutes" its own data which indicates that Indian markets have a long way to go', written by Sucheta Dalal, Moneylife, 27 August 2010. This article is available at http://www.moneylife.in/article/72/8633.html

and unfair trade practice. They state that their activities were never intended to only inflate, depress or cause fluctuation in the price of the scrip's for any wrongful gain or avoidance of loss. They also claim that the orders were placed within the permissible price range of the stock exchange and the size of the said orders was also with their financial capabilities and hence cannot be categorized as manipulation.

Day trading, as an observed market practice, entails 'buy' and 'sell' of a scrip at the prevailing market price sans the element of delivery. The investigator can verify if the orders placed at off-spec price fructify into trades. If found true then this will indicate that the components of day trading are totally absent as there were no intention to complete a trade and hence can be marked abnormal.

In India, on the first day of listing, the stock exchanges do not apply circuit filters in order to facilitate price discovery through its order matching mechanism. Therefore, it is expected that on the first day of listing the price of the scrip is discovered through the interplay of demand and supply. This situation is taken to the advantage of the manipulator and they place large orders much below the prevailing market price and subsequently the entire quantity of the said order are either completely deleted or downsized to nugatory proportions with the objective to distort market.

As the price quoted by the manipulator will generally be much below the prevailing market prices, it is naive on their part to suggest that since the system permits the disclosure of the entire quantity and they have done so to get the order preference. It is obvious that the orders placed would not get executed as the price quoted by them may be much below the prevailing market price, thereby precluding the possibility of the order entering the 'best five orders' displayed on the market picture window. Therefore, the only reason for placing such buy orders (disclosing the entire quantity) is prima facie to create an artificial demand in the respective scrip's. This is just one of the scenarios.

The other commonly observed scenario is the manipulation in illiquid penny stocks. In India, stocks with a face value of Rs.10 or less and market capitalization of less than or equal to Rs. 20 million, generally quoting at less than the face value, are referred to as 'penny stocks' or 'small cap stocks'. In these companies wherever the manipulator was active, a common modus operandi was noticed. A flurry of seemingly price sensitive announcements detailing proposed corporate developments, status of business, projects and status thereof, corporate actions such as dividend, bonus, stock split etc., were made. It is then observed that the promoter shareholding decreased substantially. This indicates that promoters took advantage of the price rise and benefited from it. This is another scenario that is prevalent in the market.