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An Empirical Study of Volatility and Market Quality

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Declaration of Authorship

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Abstract

Macquarie Graduate School of Management

Masters of Research

An Empirical Study of Volatility and Market Quality

by Chen Yu YAN

The aim of this study is to develop a simplified tool to measure pricing efficiency using volatility from price. Volatility is a major aspect of today's markets and is considered a quintessential aspect that is rooted within practical applications of trading, investing, compliance, and risk management. Current developments and research concerning asset pricing incorporates the factors of market quality and liquidity, which can be reflected through volatility. What can be determined is whether public information derived from end of day pricing can be used to infer the market quality within a short time-frame. This study investigates over 2,000 active trading accounts from a leading broker, and concludes that information derived from volatility can act as a short term predictor of market risk. Within this framework, volatility is seen to be highly correlated with the number of margin calls and liquidations. This can serve as an objective indicator of market quality in general when used by risk management and traders alike during decision making processes…

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Chapter 1

Introduction

This study intends to create a simple method for managers to quantify market risk based on recent volatility. During periods of volatility, margin calls increase on average approximately 150%. During these volatile periods, the market's ability to price assets becomes ineffective. This is similar to what occurs when there is a decrease in market quality as measured by market efficiency, proxied by transaction costs (through effective spreads and/or price discovery). I find that high volatility creates situations where traders are unable to maintain positions either due to a strict strategy or the inability to maintain margined positions, face losses as they are required to close out and sell at inopportune moments. Such losses feed into the market as 'noise' due to the on-market liquidations with the effect of pushing prices further from equilibrium, resulting in further market quality deterioration. I conjecture that a deterioration in market quality caused by unseen stimuli should be anticipated when measuring the market volatility as any trades must leave an impression on liquidity and price. This affects how the market prices assets. Modern applications of asset pricing models are often based upon the works of Fama and French's Efficient Market Hypothesis (EMH). On one hand, EMH creates an ideal environment from which more complex studies can be investigated due to the simple nature and assumptions involved. On the other hand, the markets have shown to display a poor level of quality in efficiency during the more volatile periods. This is not to claim that the market is inefficient. Rather, the proposal is that we can gather information from the market that can potentially alert us to when market quality decreases. When the market is functioning well and assets are priced accurately, price movements are expected to contain all public information (including information that is in the period of transforming from new to stale) which will in turn allow an analyst to infer information based on the available data. As the purpose of this study is to measure and quantify risk, it focuses on more volatile periods.

Price is arguably the most important aspect of an asset. Portfolios have their values determined by the price of the assets; traders stare intensely every day at a screen full of prices; senior managers overlook the stock price of their companies. Stock price movements are observed in two components in this study. These are the informed movement, and the excess volatility. From a price discovery perspective, one may expect to see stock price move from A to B in an orderly and timely fashion. However, as soon as one observes the market, it is clear that the movements do not reflect those elements. Fama's application of the Random Walk Hypothesis (1965) is often used to explain the short-term price movements of stock prices. However, what we observe is anything but random. If a stock released unfavourable news, the price may fall continuously over several weeks. Bernard & Thomas (1989) demonstrated what they referred to as post earnings announcement price drift and showed robust evidence that these kinds of reactions are common in the market. However, these types of movements are not considered dangerous for those who manage market risk as the reactions are somewhat predictable. Further, many of the current asset pricing models also fail to incorporate microstructure information. Changes to market conditions, execution speed, and regulations all affect asset prices in different ways. The recent rise of electronic trading, along with complex algorithms dominating the market, has evolved the market into a faster paced environment compared to 30 years ago. Such changes need to be well understood. Otherwise there stands to be major risk factors as many asset pricing models do not account for the effects of these changes.

This study proposes a ratio specifically designed to isolate the excess volatility from the market volatility based upon the open, high, low, and closing prices daily. Acting as a numerical interpretation of the candlestick (see Appendix Figure A.1) or OHLC charts that traders use, the volatility ratio quantifies the graphics into a figure that can be easily grasped by managers and traders while maintaining a level of subjectivity that is axiomatic with well-defined formulae. Extensive research has been conducted in equity markets in relation to volatility and equity risk. However, they mainly deal with returns and conditional volatility. French (1987), and Campbell and Hentschel (1992) find the relation between volatility and expected return to be positive; while other such as Nelson (1991) and Glosten et al (1993) finds evidence suggesting otherwise. Bekaert and Wu (2000) expanded upon the priori and considered the asymmetric volatility phenomenon at both market and firm level, but their research is not aimed at risk management and hence fails to explore further insights which this study will attempt to provide. The ratio in this study will become a proxy that captures the excess volatility factor among other causes of market inefficiency and will act as a gauge on the overall market quality from an efficiency perspective. It should be noted that the absolute range is not used as it will remove information, most importantly whether the market is in a bear or bull market. Green et al (2010) has shown that during periods of low liquidity, prices for over-the-counter (OTC) financial products rise faster than they fall. I concede that this is not exact. However, similar to the value at risk models that many banks use, it was never intended to be an exact figure. It is used as an additional layer of security for managers and traders, designed to act as a guideline into market quality, and to improve prudence in the process of due diligence. The intended contribution of this study is to extend the literature in that it provides a new framework and measure for margined equity and risk that arise from inter-day volatility. Further, the methodology increases our understanding of volatility in a number of ways. First, it measures volatility against different forms of market efficiency. The selected forms of market quality proxies are chosen due to the low pair-wise correlation among the data set, and also clears the data set of selection bias. This uses a market based approach to understand how market quality affects volatility. Based on the stock specific intraday volatility and effective spread data, these are measured against the proxy generated from the volatility to determine whether or not market quality is a factor that affects volatility. Namely, it is important to determine how volatility relates to different market quality indicators and any significance that may arise from their relationship. The use of effective spread and intraday volatility would also allow this measure to include price discovery as these measures are closely related (Blume and Goldstein, 1997). The purpose of the ratio is to serve as an indicator to determine how much market microstructure affects volatility. This in turn will allow the volatility ratio to become a measure of market quality itself in the future. Secondly, the daily volatility of the ASX 200 is measured against the margin call and liquidation data from over 2,000 unique active trading accounts from FP Markets over the same time period as is used from the initial section of this research. FP Markets provide both traditional equity trading services, as well as a margin trading service. The group of traders selected range from active to inactive with trading frequency from multiple times every day to once in several years. It also covers a range of traders using different strategies. The most prominent would be those who trade by margin, and hence the importance to this research. As margins are available for as low as 1% on futures products, this research aims to deduce whether or not the volatility ratio can be used as a proxy to anticipate a rising number of margin calls in futures markets. The study is focused on the Australian equity market as it represents the vast majority of the clients' position. Finally, this study examines the implications that the proposed proxy offers. It seeks evidence to argue that the findings extend the knowledge and presents a useful model for financial compliance and regulation practitioners in understanding. The new methodology could become useful in generating a simple to understand measure that overcomes the difficulties of smaller firms to gather all the necessary data to generate the different proxies that measures the efficiency of the market. These difficulties are further emphasised when these measures are all subjective to the people who are using it. Hence it is important to create a 'market based' approach to objectively define the level of market quality. The rest of the dissertation is organised as follows. Section 2 examines the relationship between market information, market quality, margin requirements, and price volatility. Section 3 presents the empirical data used in this study. Section 4 expands into the methodology where I create a proxy for volatility that allows an objective approach towards quantifying and measuring market quality. Section 5 discusses the results of both the ratio against market quality as well as the ratio against margin calls and liquidations. Section 6 presents some applications of this study, followed by the conclusion.

Chapter 2

Factors of Volatility and Market Efficiency

2.1 A new look at Volatility

The objective of this study is to create a ratio to determine the market quality based on historical volatility. Assuming an efficient market, different information is incorporated into every asset price. These asset prices then develop in the market based on the market quality and condition, regulatory environment, and underlying performance over time. When all information is distributed symmetrically and incorporated into the asset prices, it is improbable to make abnormal returns using past prices as indication. However, when the information within the market is asymmetric, it is reasonable to assume that the market is composed of participants who have different levels of information. News grows from new to stale, during which the market itself undergoes a transformation that can affect the pricing depending on the nature of the information (O'Hara, 2003). The flow of information in the markets creates noise in these price movements. Hence when news is processed over time in the market, it is possible to detect the flow of information as noise or abnormal movements. This can derive information from any excess price movements to give a simple overview of the current market efficiency. This information is useful on a firm specific level as brokers may provide margin trading to their clients. It is important to adjust the margin requirement such that it allows the clients to maximise any short term returns they aim for while also ensuring that short term volatility does not place them constantly under margin call. Long exposure to margin calls causes liquidations which add to unwanted volatility. An example of this could be a client holding a long position in a particular equity. The price of the equity drops below the required margin level, causing a liquidation to occur which applies further downward pressure on the stock price. This downward pressure is not caused by any new information. Rather, it is due to bad margin maintenance and can be avoided, hence increasing the overall efficiency and quality of the market.

2.2 Asset Pricing and Price Discovery

O'Hara (2003) uses liquidity and price discovery to determine the flow of information in the market. As new information becomes stale, the process in which the market undertakes to price securities also changes. Such change is reflected in the pricing vis-a-vis transaction costs of liquidity and risks. Price is also shown to partially contribute towards the explanation of the equity premium puzzle. O'Hara shows that pricing will be influenced by the level of information that traders possess. She further postulates that such information risk could affect the overall level of price. Uninformed traders will demand a higher premium for the risk they must take compared to informed traders. Hence they will hold more bonds over equity, and in turn affect the overall price in the market. This also contributes to the explanation of other issues such as home bias. The implications of such analysis can be applied to modern asset pricing models that are used in the industry. Most asset pricing models today fail to incorporate market microstructure techniques. With the implementation, it is probable to see more multifaceted pricing models that consider more than the original approach when it comes to asset pricing. The recognition of information risk associated with asymmetric information would improve an analyst's understanding of the market. It would also allow risk management to improve upon the current models by incorporating this variable that is shown to have tangible effects in the market. When information in the market is asymmetric, uninformed investors demand compensation for undiversifiable portfolio induced risk. Of course this requires the assumption that the market is efficient. However, there are no contradictions between an asymmetric market and an efficient one. It merely addresses how the efficiency comes about. Hence such effects can be detected within the pricing of assets. She notes that researchers have long focused on the informational efficiency of asset prices and her innovation is the argument that "when information is asymmetric, uninformed investors demand compensation for portfolio-induced risks which they cannot diversify." The undiversifiable risk can be said to be the risk of traders using obsolete information. Even though market prices can be martingale against information, when traders have diverse information, then the expectations are not necessarily the same. Hence the process in which the price adjusts to full information value will differ across markets due to different levels of efficiency. By the same argument, the prices will adjust within the same market at different rates under different market conditions.

2.3 Market microstructure and price discovery

The term 'market quality' is used as a generalising term for measurement proxies for fairness and efficiency. Hence it is important that these proxies are accurately termed. Market quality is split into market efficiency and market integrity (fair market). I use Aitken & Harris' (2011) definition of an efficient market as markets that minimise transaction costs while maximising price discovery; and a fair market are defined as markets that minimise the extent to which market participants engage in prohibited trading behaviour. Market fairness deals with concerns of illicit transactions. While this has overlapping implications with market efficiency, it is generally separated for clarity. Market efficiency is measured by transaction costs and price discovery. These directly influence the flow of trades in the market and do not contain an element where the transactions are traded under illegal premises. By using only market efficiency as a measure, I can maintain a simple model, while eliminating possibilities of arbitrage within the market, and hence contradicting the EMH.

Riordan and Storkenmaier (2011) also discussed similar issues and approached it as an event study. They studied the upgrade to the Deutsche Boerse's trading system with the 8.0 release of Xetra and noted how the reduction in latency led to a reduction in both quoted and effective spreads. They concluded that the prices became more efficient due to the upgrade. They showed that spread decomposition pointed towards a reduction in the information conveyed by trades. Using the CIRF as provided by Hasbrouck (1991), they used it to control for past returns and trades and demonstrates a relatively unbiased measure of the information content of a trade. The permanent price impact of the trade is generally interpreted as the private information content of a trade. I shall use this interpretation to assist with the measurement of the 'staleness' of the information as mentioned by O'Hara (2003). Riordan and Storkenmaier also note that efficiency begets efficiency. The results yielded from their study demonstrate that the aversion and fear of market automation are misplaced.

For investors, limit orders are favoured unless the rate of information arrival is high. This allows slower investors to take advantage of the more efficient quoted price. As markets become more efficient, participants are able to profit from smaller derivations in price which leads to further efficiency. Interestingly, the spreads widened four folds after the upgrade despite the increased efficiency. This points towards the lack of competition among liquidity suppliers. Riordan and Storkenmaier indicated that effective spread in the market tend to narrow as price discovery increases. Hence there is a strong relationship from a microstructure perspective that as the market efficiency increases, so does the transaction cost and asset pricing ability. One may consider this to be axiomatic, but it needs to be stated that this study concludes that this relationship is bi-directional. This is useful when determining whether or not volatility can be used to anticipate any changes in market quality. Subsequently it is important in determining whether or not volatility can be used in an industry environment to anticipate margin calls and adjust margin requirements on a firm specific level.

2.4 Risk Management and Volatility

Hsieh and Miller (1990) analysed government regulations with regards to margin vis-à-vis stock market volatility. Their research showed that Federal Reserve margin requirements tend to follow margin requirements rather than predict changes in market volatility. The intention for raising margin requirements were simple; if higher margins reduce speculation, and if speculation is destabilising, then higher margins would reduce volatility. However, speculation is not always destabilising and could act as a stabilising influence (Telser, 1959). A higher level of volatility may represent a faster incorporation of new information into prices, similar to price discovery under EMH. Therefore, there is a need to define the differences between the incorporation of new information and any excess volatility caused by unwanted influences before any effective actions could be taken. As volatility is highly auto-correlated and margin requirements, like all regulations, cannot be changed instantly, therefore, it is important to check which of the two is the leading factor. On a large scale, this will imply whether or not margin requirement regulations are truly predictive in nature and allow for regulators to anticipate and evade shocks to the market. On a smaller scale, it will show what individual companies can do to minimise the amount of margin calls that may occur from client positions. Using observations from the Federal Reserve daily and monthly margin requirement data since October 1934 and the daily returns on the S&P 500 index, Hsieh and Miller found no short term negative relations between a change in margin requirements and volatility. They can however detect from the monthly data that volatility leads margins. They conclude that Federal Reserve margin requirements have no data to support any effectiveness in reducing stock market volatility. Although Hsieh and Miller did not provide any applications from their results, one could be inferred from their conclusion. It is clear that increasing the margins reactively is not enough. There is a need to anticipate and prevent shocks. On a lesser level, the need to prevent shocks is unnecessary and impossible to do without a large market share. Thus, focus should be upon anticipation and prevention of margin calls which can further add to the excess and unwanted volatility due to the increase in liquidations.

Bekaert and Wu (2000) explore volatility in equity markets from both the market level and firm specific level. They analyse news (shocks) at both levels and look for leverage effects, persistence, and any volatility feedback. The extension of the traditional capital asset pricing model (CAPM) investigates both the leverage effect and the time varying risk premium explanations of the asymmetric volatility phenomenon. Applying the conditional CAPM model with a GARCH-in-mean parameterisation to a market portfolio and three constructed portfolios from the Nikkei 225, they find that any variance dynamics were driven from a firm level. The leverage effect on volatility peaks corresponding to large declines in the market. Hence, when large movements occur, all betas converge to 1 as all portfolios react similarly. This illustrates the volatility feedback mechanism generating volatility asymmetry. The asymmetry of the high and medium leverage portfolio is covariance asymmetry. The main increases in conditional covariance arise from negative shocks. Positive shocks provide mixed impacts and results.

Hardouvelis and Theodossiou (2002) studied the effects of margin requirements on volatility within the framework of equity markets in bullish and bearish markets. They showed that a change in margin requirement only affected volatility during normal and bullish periods. During bearish periods, they found no significant effects arose from a higher margin requirement. Their results showed a negative correlation between stock returns and margin requirement. The deduction is due to the reduction in systematic risk. They believe that margins and other regulatory restrictions should be lowered sharply during bearish markets to enhance liquidity. The lack of any significant impacts from a reduction in margins during bearish markets from their results indicates that this would bring about little excess volatility. They also stated that margin requirements should be raised during a bullish market to prevent a future pyramiding effect.

Basak and Shapiro (2001) suggested an alternative approach towards risk management that improves upon the standard Value at Risk (VaR) model. They show that when risk managers employ the VaR approach, stock market volatility tends to increase at times of down markets and low liquidity, and reduce volatility during times of upswing. Focusing on the effects of risk management on optimal wealth and consumption choices and on optimal portfolio policies, Basak and Shaprio first specified scenarios where risk managers must behave to maximise utility based on constraints surrounding VaR. They discovered that some effects that arise from these actions could be seen as undesirable by regulators. Losses incurred by VaR risk managers out rank those by non-risk managers in adverse states. It is easy to understand that as VaR assumes a normal state in the market, during times of distress, the model would suffer in terms of accuracy and hence relevancy. VaR estimates are used as a tool to manage and control risk and exposure limits are often set at a predetermined value.

Realising the inefficiency that arises from the lack of understanding of the economic implications in regards to the VaR risk management policies, Basak and Shaprio aimed to create a new system that limits the expected loss when losses occurs. This limited expected loss (LEL) risk management system is what they wish to replace VaR with as it overcomes several shortcomings that are unique with the VaR style of risk management. VaR deals with controlling the probability of a loss rather than the magnitude. It could turn out that the loss made is larger than what is originally anticipated than if the risk manager had not engaged with the VaR. Ideally, the risk manager would want to control both magnitude and probability. This would involve the risk manager controlling all moments of the loss distribution. Using the LEL, the expected loss, rather than the probability of loss, is limited. This ensures that risk managers do not take on additional risk based from the flaws that are inherent within the VaR system.

Chapter 3

Hypotheses

3.1 Hypothesis on Volatility and Market Quality

H1: *Excessive volatility and market quality should be negatively correlated.*

If volatility is high, the expected market quality should prove lower or show signs of deterioration. Specifically, the expected evidence includes effective spreads widening, and intraday volatility increasing when the volatility ratio approaches 0. This differs from the traditional sense of volatility in that it contains more information and can be used to determine whether the market is currently in an upswing or downswing. The traditional measure of volatility is simply:

$$Volatility_{it} = \frac{HighPrice_{it} - LowPrice_{it}}{ClosingPrice_{it}} \tag{3.1}$$

The primary role for this formula is to find the percentage move of an equity within a certain time period. It is sensitive to the absolute movement of the price and indicates the range at which the stock is likely to move. Similar to most indicators, it can be arranged into a time series in which one can interpret the results of volatility as a moving average or find confidence intervals to use in risk management. Extending the usage of this formula into this study presents two key problems:

The market moves in two directions. Taking the absolute volatility removes information that can be otherwise obtained. Any large upward or downward swing for that day is ignored in favour of taking the maximum and minimum movements. This creates a situation where unless the periodic range values are all that is required, the number holds minimal value.

The formula ignores any intraday price movement. A stock price can move up gradually over the course of the day and be shown to contain the same volatility as a stock that moved rapidly with large spikes throughout the day.

To address these problems, the opening price is included within the calculation. In relation to the first issue, by having a direct comparison between the opening and closing prices, any information generated contains another element that can show the direction of the market. If the opening price is lower than the closing price in the same session, then it can be inferred that the stock price that day has gone down. The opposite also holds true. This addition solves the first problem where directional information is removed. This in turn enables the testing of asymmetric information between bullish and bearish markets and is employed in the latter half of this section to determine the relationship between volatility and margin requirement from a prime broker perspective.

The additional information contained within the opening price would also justify the second issue. By having the opening and closing prices, it reveals the sentiments of the market at two points in time. This creates a new range which is independent to the high and low prices. This independent range is what allows the new ratio to give insight into any intraday movements. For the purpose of this study, the interest lies within the dynamic range of stock price movements throughout the day rather than the frequency at which it hits certain ranges.

3.2 Hypothesis on Predictive Nature of Volatility and Margin Requirement

To extend the inferences from above, this study looks for evidence that volatility can predict the number of unique clients in margin call. The correlation will depend upon the net position among those who are often in margin call. If there exists a clear trend of what nature the net positions held are on a daily basis, the data can determine whether the clients will be affected more in a bullish or bearish market using the historical data of positions that are in margin call. Currently, the standard VaR model is often employed by funds, banks, and brokers. Basak and Shapiro (2001) suggested an alternative approach towards risk management. They created the LEL risk management system to limit the expected loss rather than the probability of loss. The volatility ratio should allow risk managers to anticipate an increase in margin calls and liquidations and hence make adjustments to the book positions ahead of time. This can be achieved by adjusting margin requirements (and hence incentivising clients to exit positions both long and short), or adjusting positions to the net book directly via any house positions.

H2: *The lagged average volatility ratio and the amount of margin calls and liquidations should be clearly correlated.*

As mentioned above, the correlation can be both positive and negative depending on the positions held by clients in margin call. This directly affects the number of liquidations as well. The reasoning behind this would seem apparent to those familiar with trading in most markets. In a bullish market, clients in margin call are expected to hold short positions and in a bearish market, those in margin call are expected to hold long positions.

Chapter 4

Data and Methodology

4.1 Data

4.1.1 Market Data

The data for this study is publicly available from the SIRCA Australian Equities database. I aggregated the end of day data for the top 20 stocks in Australia for the period from 1 January 2012 to 31 December 2015. The most variables are the Opening, High, Low, and Closing prices. These will be used to construct the volatility ratio. There are 1,015 trading days over this period, with each stock having a different number of trading days depending on the length they have been in the top 20 and the number of trading halts due to new events. The top 20 stocks were selected based on the stability of the ASX 20 index (XTL as of 31 December 2015), the liquidity, and the market capitalisation of the equity within the index.

I applied a number of filters to clean the data. I performed this to consolidate the trading periods for each stock due to the mismatch that occurs from firm specific announcements and trading periods. In total, I have 1008 observations over this period for each stock (some are observations are null as the equity taken in the XTL is as of the 31st of December 2015).

A summary of the ASX 20 data is shown below:

TABLE 4.1: ASX 20 Summary Statistic.

	Average	Minimum	Maximum	St. Dev
Volume (millions)	5.31	0	135.13	6.84
Off-Market Volume (millions)	1.11	0	148.72	2.84
Turnover (millions)	93.66	0	920.52	76.51
Off-Market Turnover (millions)	19.95	0	166.55	45.22
Spread	0.01295	0.0001	0.1431	0.00362
Number of Trades	9,797	0	47,284	5,512
Number of Off-Market Trades	213	0	12,794	296
Price Return	-6.98799E-05	-0.09213	0.10194	0.01058
Simple Price Return	0.99999	0.91198	1.10732	0.01296
Market Capitalization ($Million)	$42,156	$13,409	$131,822	$33,624

The table shows the a summary statistic of the ASX 20 firms. These firms are selected due to their market capitalization and liquidity. The properties of their liquidity and turnover can be seen as well as the tightness of the spread. It should be noted that the "price return" summary statistic is the average of the average price return of each ASX 20 stock component.

The weighting by market capitalisation of the XTL is mainly composed of the financial sector, representing 61.3% of the total market capitalisation with the big four banks (ANZ.AX, CBA.AX, NAB.AX, and WBC.AX). Materials and Consumer Staples represent the majority of the remaining 40%. The full sector breakdown can be seen below in Graph 1 in the Appendix.

I use the XJO as the proxy to measure the market because the futures product is based upon the XJO. This is used over the XTL as it is widely accepted due to its diversified nature. However, from the holdings data from FP Markets, a majority of client holdings are in the XTL. As the XTL represents over 65% of the XJO by liquidity and market capitalisation, the correlation between the two is high. The differences are the increase in diversification and the reduced concentration in the banking and finance sectors. Noteworthy is that both XTL and XJO are taken as continuous figures and do not include dividends.

When taking into account of the differences between the XJO and XTL, one notices that the XJO has a lesser weighting on banking and mining. However, the distribution of stocks still weighs heavily in favour of the banking and mining sectors. There should be a slight difference in results when using a weighted XJO as a comparison for study over the weighted XTL. This differences should arise from the difference in the allocation of stocks and compositions. On the overhand, the differences should only be limited these factors and the overall trend and correlations should remain the same.

The second section includes all the data aggregated from the CMCRC market quality dashboard. I use the effective spread to test for market efficiency, and the intraday volatility to test for market resilience. Intraday volatility is used for market resilience as it lies closely with the theme and can be used as a reference as well as a comparison in the analysis against daily volatility. It is expressed in a percentage value and can be directly compared to the volatility ratio that works on an inter-day basis. Effective spreads are used to calculate transaction costs and are expressed in basis points. As these two are the major components for price discovery, I exclude this due to the high correlation it holds with the other two measures.

4.1.2 Client Data

I gathered data from FP Markets from 2,395 active accounts. I retrieved the margin call and liquidation data between 1 January 2012 and 31 December 2015. It should be noted that these liquidations and margin calls may include trades on the futures, foreign exchange, foreign equity, and commodity markets. However, these account for less than 5% of all margin calls. These margin call and liquidation data comprise of the date, and the number of unique clients either fully or partially liquidated that day. It is important to separate which accounts under margin call are considered for this study. The margin call data of any client under 90% required margin is included as that is the level deemed to be unacceptable to be under on an intraday level. There are 2,175 which are leveraged and also not a house account. For the purpose of this study, I will focus upon the leveraged accounts. It should be noted that the accounts are not tracked over the years and are given as a snapshot on 31 December 2015. This constraint arises from the amount of data available. The summary of clients is as below:

TABLE 4.2: FP Markets Client Holdings Summary Statistic

	GLV	Free Equity	Margin	Exposure	Total Leverage
Average	$ 11,165	$ 7,539	-$ 3,468	$ 25,878	1.1187076
Maximum	$ 972,205	$ 500,575	-$ 884,190	$ 3,481,261	66.48
Minimum	$ 0.01	-$ 14,555	N/A	N/A	0
Unique clients in Margin Call	41				
Number below 90%	13				
Total Number of Active Clients	2395				
Number of Leveraged Clients	2175				

The table shows the a summary statistic of 2395 FP Markets clients who actively trades in their account. Activity is defined by having traded or funded the account at least once during the period relevant to the study. The top 3 rows shows the summary of the clients; the next two shows the average number of unique clients on a daily basis; the final two are self evident and are simple descriptions.

As shown, the majority of accounts are not currently in margin call. From the 41 currently observed to be in margin call, 28 are cases where the current gross liquidation value (GLV) is above 90% of the required margin. From a practical perspective, these are not considered to be at a value that is critical to managing the risk. This is due to how a margined position can swing in and out of margin call if the client decides to fully leverage. It should be noted that by observing the highest leveraged account, that this study is important to margin lenders and providers.

When observing the net client positions, the clients are net positive on a daily basis 100% of the time during the period of this study. It should be noted that since inception, client position has always had a long bias and there has never been a day where clients are net short. However, this is contrasted by those who are in margin call or who are liquidated. These clients are more likely to be holding a short position. There are a total of 82,191 margin call positions for clients who fell below the 90% required margin threshold during the period of this study. Out of the 82,191 margin call positions, 67,252 positions, or 81.8% of them are short positions. The average marked to market exposure of all positions shows -$11,660.05. From the 786 days that margins calls occurred, only 17 days had a net position which had a marked to market value of greater than 0 (See Graph 3 in the Appendix). This is important as volatility on bullish and bearish days must then be categorised and included. Hence the ratio cannot be taken as an absolute value and must rather be taken in its raw form.

4.2 Methodology

4.2.1 Volatility and Market Quality

The data is organised into three sections. In the first, there is the daily data of the ASX 20 stocks. This includes the open, high, low, and closing (OHLC) price. I intend to use this to isolate the excess noise that the market creates due to mis-information or asymmetric information that causes inefficiencies. Inspired by Bekaert and Wu's (2000) exploration of asymmetric volatility and risk, the data will be analysed both from a firm specific level, as well at the market level. The OHLC representation is similar to the mathematical representation of a candlestick or OHLC chart that traders use today (see Figure 1 in the Appendix). This is used to create the volatility ratio using the formula:

$$VR_{it} = \frac{O_{it} - C_{it} + 0.0005}{H_{it} - L_{it} + 0.0005} \tag{4.1}$$

The ratio for stock i at time t is given by measuring the absolute difference between the open and close prices against the intraday price range. Both the numerator and denominator include an additional 0.0005, which denotes a half of a 0.1 cent tick, which is the lowest possible on the ASX. The function of this value serves two folds. Firstly, it eliminates the occasional error when applied on smaller, less liquid stocks, when all the trades are over one price, creating a denominator of 0. Secondly, it allows the function to have a range between -1 and 1. The original design was to create the ratio with an absolute value of the open and close and hence giving the absolute range. That creates the issue where it overlooks how the market is reacting and whether it is rallying or falling. Hence the true range will offer a more accurate image of the market relative to the absolute range. The ratio is lagged by taking the average of the previous 3 days and the average ratio is given by:

$$AVR_{i,t+4} = \sum_{\tau=1}^{3} \frac{O_{i,t+\tau} - C_{i,t+\tau} + 0.0005}{H_{i,t+\tau} - C_{i,t+\tau} + 0.0005} \tag{4.2}$$

The 3 day moving average is chosen based on the results of Chen (1999) who expanded the results of Smirlock and Yawitz (1985) and showed that equity prices adjust to announcements (in this case, new information) in approximately 2 days. Hence, 3 days would provide sufficient time for information to be processed such that the market can price the announcement. Furthermore, for short selling, Reed (2007), and Diether, Lee, and Werner (2007) estimates that it takes an average of 3 to 5 days to cover positions during periods. As short selling is an important aspect of information efficiency and price discovery, the short term aspect of this can be extended to estimate the amount of risk clients will potentially risk over the coming days. In theory, if a price action is quickly reversed, then there would be no persistent change in the quoted spreads and hence there would no no large changes in the effective spread. Hence any false information captured by the market would represent too much noise. These noise, however, becomes irrelevant on an intraday time frame. If a shorter time frame is chosen for the lagged average, then it would increase the number of observational errors that arise from these noise. In comparison, any real information in the market would affect the effective spread and create a scenario where a change in market quality can be determined. This arises from two reasons. Firstly, market makerts tend to go flat reducing the pen trading positions and secondly liquidity providers reduce on market positions as a protection against more informed traders. Hence any intraday movements that matters for this study can be observed on a daily level. This also benefits the study as it eliminates the need to determine real information from the noise on an intraday level.The same ratio is recreated for the ASX S&P 200 (XJO). I aggregate and stratify the effective spread and intraday volatility data by creating a weighted mean from the average daily turnover. I run a linear regression in the following form:

$$AVR_{i,t} = \alpha_t + \beta_t ES_{i,t} + \gamma_t IV_{i,t} + \epsilon_{i,t} \tag{4.3}$$

As the ratio is designed to show periods of both bullish and bearish markets, it is important to measure what happens when the figure approaches 0. To do this, I split the data into deciles based on the original ratio.

4.2.2 Volatility and Margin Requirement

The concept of using volatility to demonstrate controls of margin requirement is an extension of Basak and Shaprio (2001). Their work demonstrated that controlling the expected loss is equally as important as controlling the probability of a loss. The following is to demonstrate that it is possible to also anticipate any possible losses due to the nature of margined equity. The method itself is simple. The margin call and liquidation data is stratified by unique clients daily. The margin calls were only considered if they had a GLV to margin ratio of less than 90%. I extend the works of Hsieh and Miller (1990) and use different variables to derive to determine the relationships between volatility, margin calls, and liquidations. Similar to how Hardouvelis and Theodossiou (2002) deduced the relationship between margin requirement and volatility, a different proxy is applied to test for market volatility and uses margin call and liquidation data directly from FP Markets. I run a linear regression in the following form:

$$AVR'_{i,t} = \alpha'_t + \beta'_t ES_{i,t} + \gamma'_t IV_{i,t} + \epsilon'_{i,t} \tag{4.4}$$

Chapter 5

Results

5.1 Volatility and Market Quality

The results from the weighted average ratio obtained from the XTL are presented in the table below:

TABLE 5.1: Estimation results: Weighted ASX 20 ratio against weighted Effective Spread and Intraday Volatility

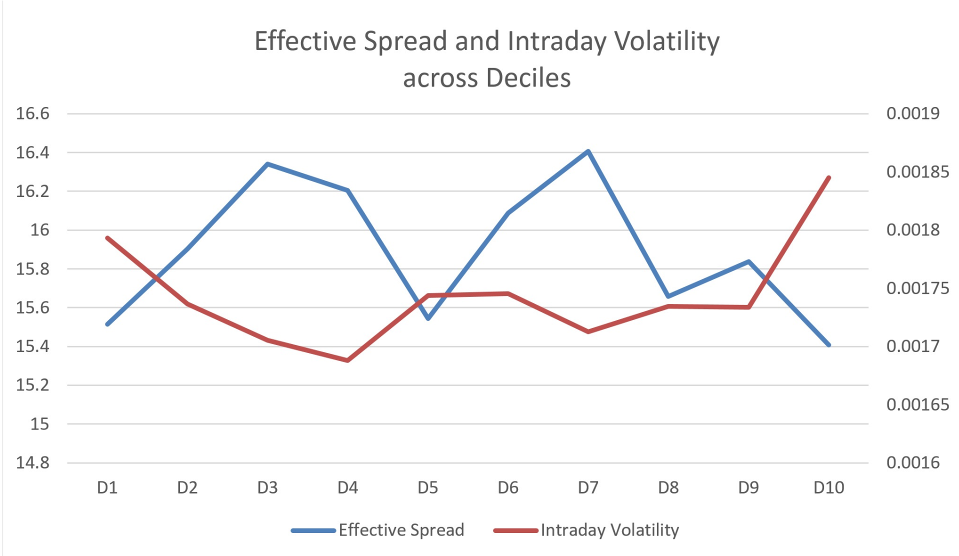
Variable	Coefficient	(Std. Err.)	t-value
Effective Spread	-0.005	(0.003)	-1.5
Intraday Volatility	29.718	(15.010)	1.98
Intercept	0.025	(0.057)	0.41

The results are from the OLS estimation of the 3-day average volatility ratio against the effective spread and intraday volatility of each of the ASX 20 component stocks (weighted for each stock based on market capitalization from the marked to market end of day price).

The results are congruent with many of the individual stock specific results (see appendix). There is little evidence to support a short-term predictive nature for market quality using volatility. However, intraday volatility is significantly correlated with the average weighted ratio. This is in line with the results from individual stocks.

Due to the nature of the ratio, it is more important to determine what happens around 0 and at the extreme ends (values approaching -1 and 1). To clarify the trend, the data is split into deciles based on the original volatility ratio. From Figure 5.1 (shown below), it can be observed that the effective spreads are lower on both ends and is higher in the middle. There is a sharp drop in the 5th decile which cannot currently be accounted. However, there are several possible explanations that will be explored further later on. When observing the deciles of intraday volatility, both ends and the middle show higher volatility relative to the 2nd to 4th and 7th to 9th deciles.

FIGURE 5.1: Effective Spread and Intraday Volatility of the Weighted ASX 20 component stocks by Deciles



The graph shows the weighted effective spread (right hand side) and the weighted intraday volatility (left hand side) split by deciles. The deciles arise from the 3-day weighted average ratio of the ASX 20 component stocks (weighted for each stock based on market capitalization from the marked to market end of day price).

5.2 Volatility, Margin Requirement and Risk Management

Next I provide evidence regarding how volatility affects margin requirements. The observations made for the lagged average 3-day ratio versus the number of unique daily margin calls (that are below 90% required margin to GLV ratio) and number of unique daily liquidations. To my knowledge, this is the first study of client data from a broker perspective in regards to volatility and margin requirement. Prior investigations deal with a macro perspective and discuss the nature of margin requirements and volatility via the Federal Reserve policies (Hsieh and Miller, 1990). I display the general regression results below:

TABLE 5.2: Estimation results : 3-day average ratio against margin calls and liquidations

Variable	Coefficient	(Std. Err.)	t-value
Unique Margin Calls	0.005	(0.001)	6.1
Unique Liquidations	0.025	(0.009)	2.75
Intercept	-0.226	(0.028)	-8.21

The results are from the OLS estimation of the 3-day average volatility ratio against the number of unique FP Markets clients in margin call (below a margin ratio of 90%) and those who have been liquidated.

From the observations made about net client holdings, the results provide evidence that the ratio can be used to anticipate days of high numbers of margin calls. As clients who are in margin calls are more likely to be holding short positions, when the market is rallying their required margin is more likely to drop below 90% when a large swing occurs. This also extends the work of Hsieh and Miller (1990) and Hardouvelis and Theodossiou (2002) to a micro scale. It shows that a change in market conditions precedes an increase in margin calls. Their conclusion that Federal Reserve margin requirements have no data to support any effectiveness in reducing stock market volatility would be reversed in this case, as a smaller firm has more autonomy than the Federal Reserve. This means that firms are able to take more flexibility in clients' margin requirement. Hsieh and Miller (1990) only discussed how margin requirements affect the market volatility, but failed to provide any insights into the contrary. Hence management should take notice of this change and clients' required margins should increase before market conditions deteriorate.

Hardouvelis and Theodossiou (2002) showed the effects of margin requirements on volatility in the market and gave advice on margin requirement policies. However, once again it is only applicable on a macro scale. I used the number of unique margin calls and liquidations as a proxy for margin requirements. If the number of margins calls and liquidations are high, one aspect of prevention is to adjust the margin requirements. The effects of changes in margin requirement and the volatility of the market during different periods is useful for regulatory bodies, but fails to create value for individual businesses and firms for their internal margin requirements.

Basak and Shaprio (2001) demonstrated the flaws within the VaR risk management system as being limited to measuring the probability of a loss rather than the expected value of the loss itself, which prompted the LEL risk management system. The results would suggest that both of these can be further improved by allowing risk managers to anticipate losses to a finer level where the firm's net positions can be analysed both individually and as a portfolio. As mentioned above, the flexibility to change margin requirements as a firm allows a detailed level of control where losses can be limited based on the LEL, but anticipated ahead of time using the volatility ratio.

To interpret the results, one can observe the high level of correlation between the lagged average ratio, unique number of daily margin calls (required margin below 90%), and unique number of liquidations showing that there is a predictive nature. It can also be argued that when the market has been in a poor condition consecutively for several days, the number of margin calls and liquidations will increase.

Chapter 6

Application

The study of trading and risk management is an obvious direction in which to apply this model. Studying the impacts of utilising this model over time in a real trading or market risk management scenario should yield interesting results. The current quantitative methods that are often applied do not resonate with middle and upper level of management due to the complexity of the calculation and process. A misconception would be that those in management would not understand the results. While that may be true for some, I believe that they do have the ability to interpret the results. However, given the plethora of different measurements for market efficiency, the particular combination that is selected or the weightings that are used may cause the interpretation of market conditions to be subjective. This subjectivity does not only exist between managers and managers. Opinions differ day to day and can be influenced by immediate context.

An immediate application would be for brokers dealing in CFD and margined equity lending across equities, futures and derivatives markets risk departments. This would allow them to anticipate volatile market conditions, and based on the book positions (or net positions at the prime broker), allow them to anticipate margin calls and liquidations. Thus far risk procedures in such brokerages can be described as consisting of anticipating potential stock movements based upon movements in commodities, dual listed shares, and currency movements. However, there is no way to detect a worsening market quality which can cause widening spreads, and an increase in unwanted volatility. The influences of using the proxy to anticipate risk works two-fold. Firstly, it can be used to anticipate any possible excess movements from the client perspective where actively managing margins on individual stocks will reduce market risk for clients over the long run. This will be reflected in the number of margin calls and liquidations during volatile periods. Secondly, this can be used to maintain margins at the prime broker level. This will allow for any excess cash to be reinvested in relatively high yielding securities while maintaining a healthy amount of margin to cover for the net positions.

A less obvious application to this model would be in compliance and market regulation. It is possible to measure stocks listed in multiple exchanges and determine optimal regulations to reduce noise (unnecessary price fluctuations) in the market based on the combination of regulations used. This means that the volatility ratio can be used as a standard to measure excessive noise in the markets. There are multiple factors that would need to be included to implement the model in this scenario. These factors, including ease of access to the exchange, geopolitical context, strength and fluctuation of relative currency movements, can be restrictive in the research as the key concept behind this model is its simplicity. Aitken and Harris (2011) defined markets that have higher efficiency and fairness as those with higher quality market design. Using this as a theoretical foundation, it is possible to aid the policymaking process.

Chapter 7

Conclusion

Understanding how to identify excess volatility is critical in maintaining market quality and managing market risk. As volatility ratios increase, the amount of margin calls and liquidations also increased. This can be seen from a microstructure perspective as a sign of the deterioration of market quality. It can also be seen from an industry perspective of poor margin management. The key finding is how the volatility ratio proves to be useful in anticipating margin calls and liquidations. This is true in both bullish and bearish markets, and the ratio successfully identified excess volatility. The lagged moving average works well in determining high risk periods and can be easily applied.

There are several aspects that should be considered for improvement in future studies. Firstly, individual stocks are affected by idiosyncratic risk. They have industry specific and firm specific risk that the market would in general diversify away. Secondly, the period of the study could be lengthened to include more data. The data that is used is affected by the storage capacity of the broker for margin calls and liquidations. A more aggregated set of data should improve upon the current results. Any large systematic shocks and news events could be used as well. A longer period over multiple markets will also allow the analysis to cover periods of large bullish and bearish market conditions. Authorisation events could also be included to emphasise the impact of volatility upon the industry in terms of execution speed. This would also be affected by factors such as spread and price discovery. It would further validate the usage of a formula derived from volatility to be applied to the industry for managing market risk related projects.

As anticipated from a-priori reasoning, the theoretical aspect of the connection between the volatility ratio and market quality yielded mixed results. The market (ASX 20 and ASX 200) has proven to be significant with volatility. However, on a stock specific level, there are some which showed insignificant results. This is due to factors that affect the data set on a firm specific level. These idiosyncratic movements are diversified on a market level, but cannot be overlooked on a firm level. Hence the ratio should not be applied to specific firms, but to the market as a whole. Further studies can also be put forward in regards to using the stocks comprising the top 200 over the top 20. Theoretically, it should lead to similar results but some difficulties over the unstable nature of the top 200 should be accounted for. Otherwise there would be sufficient data for a limited study only.

The main contribution of this study would be the predictive nature of the volatility ratio. Using the asymmetric flow of information within the market, O'Hara (2003) showed the effects on liquidity and transaction cost from a trader's perspective. Further, it can be deduced that there is a reflection in the pricing movements caused by uninformed traders that push prices away from, or delay prices going towards full efficiency levels, that can be detected using volatility. This in turn creates the ratio that anticipates the change in market environment and allows appropriate margining to take place at least 1-day prior using a 3-day moving average of the volatility ratio. Also, through the extension of the research of Hsieh and Miller (1990) and Hardouvelis and Theodossiou (2002), the volatility ratio can be applied in an industry environment with a diverse pool of clients and trading styles. In this study, the application of volatility data towards margin requirement maintenance and identifying excess volatility ahead proves successful.

Chapter 8

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Appendix A

Appendix

A.1 Figure A.1

This is known as a standard candle stick. The "shadow" or the "wick" that can be seen on the top and bottom represents the price range covered during a particular time period. The solid "candle" represents the price action difference between the opening and closing price. Often, a candle stick chart would have two different colours. One represents when the opening price is below the closing price and hence an upward movement. The other colour represents otherwise.

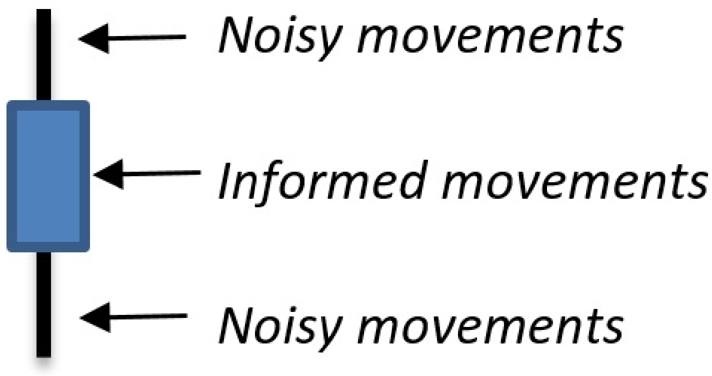

FIGURE A.1: Implications of OHLC as displayed by a Candle Stick Chart

A.2 Figure A.2

A sector breakdown of the ASX 20 component stocks. The main contribution towards the ASX 20, which represents over 61% of the market value is in the Financial Sector. However, these only represents 5 stocks (ANZ.AX, CBA.AX, MQG.AX, NAB.AX, WPC.AX)

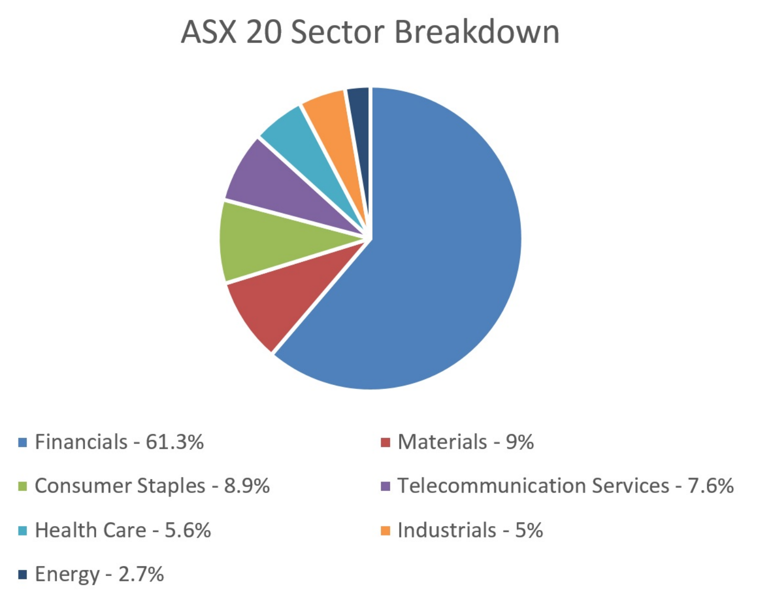

FIGURE A.2: ASX 20 breakdown by sectors

A.3 Figure A.3

A sector breakdown of the ASX 200 component stocks. The main contribution towards the ASX 200 is also the Financial sector. However, it is clear that it is more balanced than the ASX 20 components. Materials also increased in weighting demonstrating the two main drivers of the Australian economy as deduced from the ASX. There are also more sectors included within the ASX 200 (10 compared to 7 in the ASX 20).

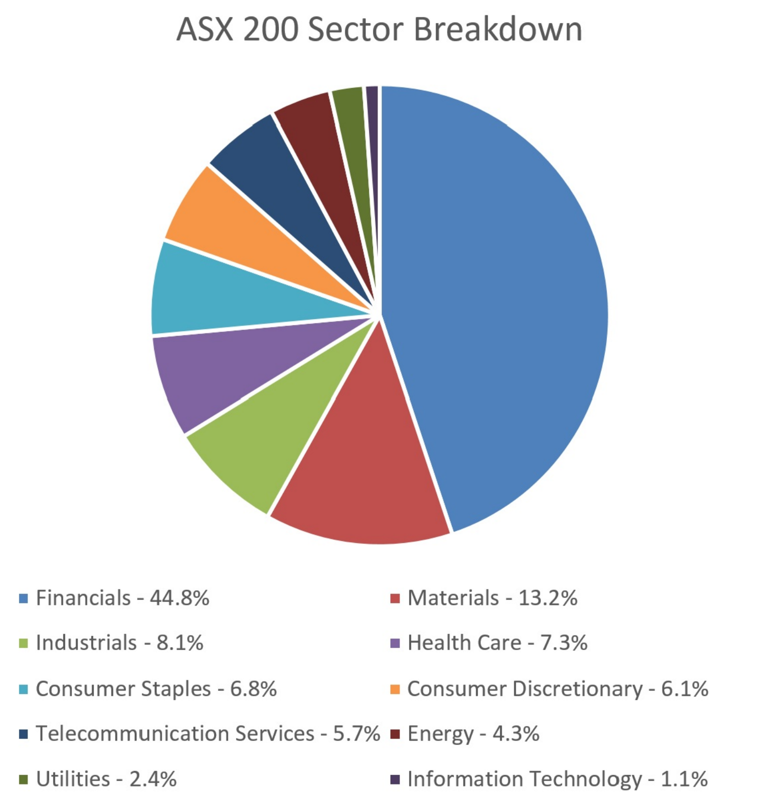

FIGURE A.3: ASX 200 breakdown by sectors

A.4 Figure A.4

All positions are obtained from the FPM SQL database. All positions are marked to market for the end of day closing price. All equity end of day timing is taken as the end of the stock trading session for that particular exchange. This is similar for any futures products. For any foreign exchange products, end of day is taken as the end of the US stock session (5pm New York time).

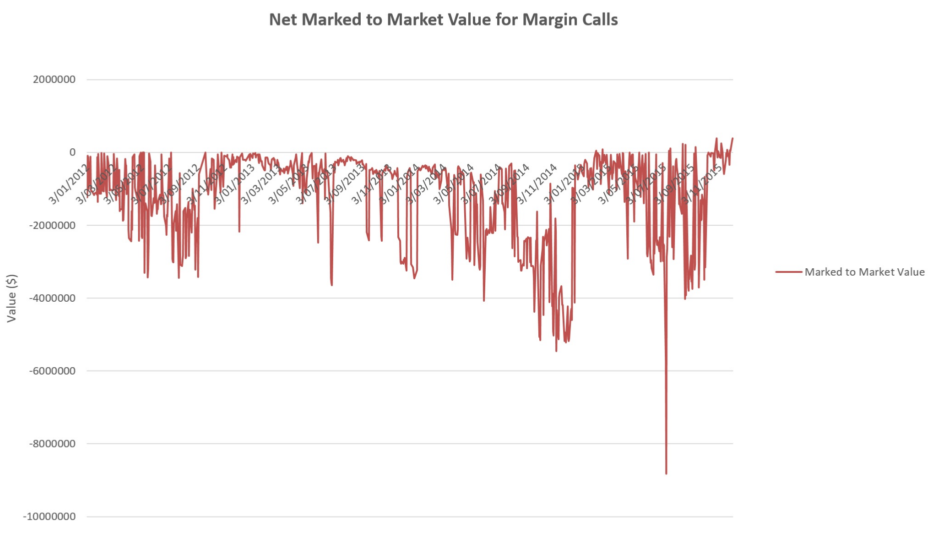

FIGURE A.4: Effective Spread and Intraday Volatility by Deciles

A.5 Table A.1

The table below presents the OLS estimates and robust standard error tests for the 3-day volatility ratio against the various stocks of the ASX 20 (as of 31/12/2015). Observations are all completed individually due to correlations between the ASX and Chi-X movements in the markets. All t-values are presented in brackets below the coefficients.

Stock	ASX effective Spread	ASX intraday volatility	Chi-X effective spread	Chi-X intraday volatility
AMP	0.0081656***	3.024114	0.0068099***	120.6852***
	(2.94)	(0.71)	(3.15)	(4.89)
ANZ	0.015522	22.61453*	0.0121814**	3.93703
	(1.32)	(1.81)	(2.16)	(1.43)
BHP	0.000745	20.0694*	0.0046677	-7.8
	(0.21)	(1.67)	(0.67)	(-1.3)
BXB	0.0006792	-18.10909	0.0001643	-3.97
	(0.16)	(-1.09)	(0.07)	(-0.16)
CBA	0.371208	13.80305	0.0090246**	42.70692**
	(1.51)	(0.73)	(2.1)	(2.15)
CSL	-0.0051282	-29.83074	-0.0008715	-11.10909
	(-0.34)	(-1.47)	(-0.25)	(-0.68)
IAG	0.0006314	-20.8831	-0.0013282	-11.34337
	(0.29)	(-1.23)	(-0.87)	(-0.51)
MQG	-0.0142881	65.60272***	0.00036	2.386036
	(-1.18)	(3.41)	(0.2)	(0.54)
NAB	-0.003773	6.921529	0.0104776	18.39189
	(-0.37)	(0.71)	(1.52)	(1.39)
ORG	0.0080444***	14.53367	0.016579***	10.78656
	(2.58)	(1.6)	(4.36)	(0.66)
QBE	0.0155859**	4.799013	0.00031778	-7.117224
	(2.43)	(1.6)	(0.11)	(-0.4)
RIO	-0.005371	31.79759**	0.0041699*	-3.994509
	(-0.35)	(2.01)	(1.76)	(-0.6)
SCG	0.0006668	6.9571315	0.007321*	18.07717
	(0.13)	(0.95)	(1.65)	(0.52)
SUN	-0.0029526	37.6832***	-0.002366	105.9726***
	(-0.76)	(2.71)	(-0.94)	(4.13)
TLS	-0.004056	3.2848	-0.0023108	40.96696
	(-1.56)	(1.06)	(-1..32)	(1.3)
WBC	-0.0006475	24.56186*	0.0010647	11.15142*
	(-0.06)	(1.83)	(0.19)	(1.76)
WES	0.007483**	8.93671*	0.004792*	25.6893
	(2.12)	(1.75)	(1.9)	(1.34)
WFD	-0.106501	24.11813	0.0008862	-24.35171
	(-1.42)	(1.09)	(0.25)	(-0.79)
WOW	0.008318	-36.52035*	-0.0205293*	20.93122
	(0.62)	(-1.75)	(-1.82)	(1.53)
WPL	0.0097348	-48.0669**	-0.0004215	-2.826569
	(0.57)	(-2.13)	(-0.43)	(-1.51)
		* $P < 0.1$	** $P < 0.05$	*** $P < 0.01$

TABLE A.1: Estimation Results: Linear regression of the 3-day average volatility ratio against market quality indicators of the ASX 20