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Behaviors in Markets Conditions Before Stock Market Crash

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Liiketalous ja matkailu

ABSTRACT

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Title	Behaviors in Markets Conditions Before Stock Market Crash
Year	2011
Language	English
Pages	36
Name of Supervisor	Mikko Ranta

This thesis studied stock market crashes and possible similarities between crashes. Stock market crashes and generally stock exchange are more and more important in today´s society. People invest in stocks, bonds, derivatives and other valuable papers even more, which makes them more interesting. It is only a few years when the last big stock market crash started, which is why this subject is very relevant. The goal of this research was to compare markets condition before the crash to time period after the crash and to periods that are opposite of the time periods like crashes are. This thesis tries to find similarities in markets conditions between different crashes and to find out if it is possible to predict future crises based on this research.

The methods that were used in this thesis were descriptive statistics and wavelet variance. In descriptive statistics average, standard deviation and variation are calculated. In wavelet variance analysis time periods are separated up to diverse periods, when differences can be seen between different time sections. The research contains three sections, where all the stock market crashes are processed separately.

From the results it can be seen that variance and standard deviation grow remarkably before a stock market crash happens. Also, differences in variance are remarkable, especially on long time scales. It could be possible to foresee when the next stock market crash is about to start.

Wavelet, variance, stock market crash

VAASAN AMMATTIKORKEAKOULU

Liiketalouden koulutusohjelma

TIIVISTELMÄ

Tutkimus tutkii pörssiromahduksia sekä niiden mahdollisia yhtäläisyyksiä. Pörssiromahdukset sekä yleisesti sijoittaminen ovat jatkuvasti enemmän otsikoissa ja ihmiset investoivat entistä enemmän sijoitusinstrumentteihin, mikä lisää niiden kiinnostusta. Viimeisen pörssiromahduksen alkamisesta on vain muutama vuosi, joten aihe on hyvin ajankohtainen. Tutkimuksen tavoitteena on verrata markkinoiden tilaa ennen romahdusta, romahduksen jälkeiseen sekä ajanjaksoa joka on päin vastainen kuin romahdus. Tutkimuksen tehtävä on pyrkiä löytämään mahdollisia yhtäläisyyksiä markkinoiden tilassa eri romahdusten välillä sekä pyrkiä selvittämään, onko tulevia romahduksia mahdollista ennustaa näiden tulosten pohjalta.

Tutkimus tehtiin laskemalla aluksi perinteisiä tilastomatematiikan tunnuslukuja, jonka jälkeen tehtiin tarkempia tutkimuksia wavelet-varianssin avulla. Tilastomatematiikassa laskettiin keskiarvo, keskihajonta sekä variaatio. Wavelet - varianssi analyysillä jaettiin aikasarjat eri pituisiin ajanjaksoihin, jolloin nähtiin eroja eri ajanjaksojen välillä.Tutkimus käsittää kolme osaa, jossa jokainen pörssiromahdus käsitellään erikseen.

Tutkimustuloksista huomattiin variaation sekä keskihajonnan nousevan huomattavasti ennen romahdusta. Myös varianssi kohoaa huomattavasti ennen romahdusta etenkin pidemmillä aikaskaaloilla. Tuloksista voisi mahdollisesti ennakoida seuraavan romahduksen alkamista.

Wavelet, varianssi, pörssiromahdus

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INTRODUCTION PART

This section includes introduction to the subject. It consists of the reasons why this matter was researched and what were the most important questions in this thesis. Introduction section also includes description of the data that is used and also what methods are used in researching this matter.

1. INTRODUCTION

1.1 Topic of the study

The latest big stock market crash happened only two years ago, and it still influences people's lives. Consequences were enormous and stock markets all over the world haven't risen to the same level they were on before the crash. That is why this subject is relevant and hopefully also useful to financial institutions.

There have always been speculations about why stock market crashes happen and why no one knows when crashes happen. This research concentrates on finding out if there are similar behaviors in market conditions before a stock market crash. This thesis is about to research market conditions and the possibility to predict when a crash is about to happen. Specific date when a crash happens is impossible to know, but something can be presumed from the results.

Nowadays more people than before are investing in stocks and other valuable papers. Therefore people track values and more people know how stock markets work. People are more interested in stocks and in investing generally. It is more economical to invest money in stocks and bonds than keep money in a bank account, which is possibly the main reason why people want to find out even more about the stock market.

Education level has increased enormously in the past centuries all over the world. Developing countries in Africa, India and China have raised their education level. Development increases investing in valuable papers. Increased development and education raises salaries and therefore people have more money to invest. People know that by investing the extra money you can have more income. Also, increased education level has made people to want more information.

1.2 Aims and research questions

This research focuses on two indexes, Dow Jones Industrial Average (DJIA) and Financial Times Stock Exchange (FTSE). FTSE is the main index in Great Britain. The purpose of this thesis is to find out if there are similar actions before every crash and weather it is possible to predict crashes based on the results. After finding some results, the empirical study is concentrated on finding out differences between normal time periods and times before the stock market crash. The research aims to answer to the question; is it possible to predict larger draw downs in index prices based on this research?

1.3 Data and researching methods

This research is accomplished by using stock market data. The data is the closing values of Dow Jones Industrial Average and FTSE indexes. The material in this thesis is only stock market data. This thesis requires lots of closing values so that the results are reliable. By looking at the matter from that point of view, this data is adequate.

In the research wavelet estimators are used based on maximal overlap discrete wavelet transform. Wavelet analysis can find components from data that traditional methods cannot find. Also descriptive statistics are used in this thesis. Those give basic statistics from the data that is used.

1.4 Previous research

Predicting stock market crashes is not that common a subject to research. Therefore not that many studies can be found. Especially wavelet variance analyzes have never been used in this kind of subject.

There are other studies on this matter, but wavelet correlation analysis has been used in those studies. Researching wavelet correlations is more common, but it gives other results from a given data. (e.g. Mikko Ranta, 2010 ; Mikko Ranta, 2007)

1.5 Matlab

Matlab program that is used in this thesis is a new way of researching data, also for the author. Matlab is a program that is used to analyze the information from the data. This thesis only includes wavelet variance analysis, which gives enough information of markets conditions and –changes to this thesis.

1.6 Structure of the study

This thesis starts with an introduction. It gives the reader required information on the thesis so that the reader knows what this thesis consist of. Theoretical study includes basic information on stock markets, the two indexes that are researched in this thesis and the largest stock market crashes that have happened before. Formulas to counting the descriptive statistics and wavelet variance were also included in the theoretical study.

The empirical study included researches of descriptive statistics and wavelet variance. Descriptive statistics are counted individually from all stock market crashes and also from both indexes separately. The same is done with wavelet variance.

THEORETICAL STUDY

Most important theories that are needed in this research are explained in the theoretical part of the study. Theoretical study starts with an explanation on what stock markets are, the history of stock market and a study of the biggest stock market crashes that have happen. Theoretical study also includes an explanation of the formulas that are used in this content.

2. STOCK MARKETS

A basic definition of stock market is that, stock market is where shares of stocks are bought and sold. A share is defined as a portion of the total ownership in public companies. (Jack Guinan, 2009)

The history of stock market reaches to 17th century when in the Netherlands and Great Britain stock exchange became possible to investors to buy and sell shares. First public securities were banks, insurance companies and manufacturers. The first and largest was London Stock Exchange until World War 1 began. In 1792, twenty four New York business men signed the Buttonwood Agreement, and finally founded New York Stock Exchange (NYSE) in 1817. NYSE is located on Wall Street in New York, which is probably the best known stock exchange institution in the whole world. (London Stock Exchange 2009 , Michael James , Michael Wilkins 2010)

The most important task of stock market is to raise money to companies; stock markets allow companies to go public and raise capital by selling shares. (Michael James)

2.1 Dow Jones Industrial Average

Dow Jones Industrial Average (DJIA) is the main index in the United States. It was founded by Charles Dow, Edward Jones and Charles Bergstresser in 1882. Charles Dow started the index with 11 stocks in 1884. At the beginning, the average did not include any industrial stocks, only transportation companies. It was first called Transportation Average but on May 26th, 1896, Dow created two indexes, thus creating the Dow Jones Industrial Average. *(Tom Streissguth)*

In spring 1896 the index increased to 12 stocks. Already in the autumn Charles Dow changed the index again, now it became railroad index of 20 - stocks. The final

change in the number of stocks became relevant in 1928 when the number of stocks was raised again to its final amount, 30 stocks. *(Tom Streissguth)*

Calculation

The first step to calculate the price of Dow Jones Industrial Average is to calculate all stock prices together. After that, the sum is divided by a divisor which chances. By calculating those, the result is the price of Dow Jones Industrial Average. As said before the divisor changes. On January 11th, 2011 it was 0.132129493. (Cam Merrith, Dow Jones, Joe investor online)

2.2 FTSE

FTSE (Financial Times Stock Exchange) all-share index was formally called the FT actuaries all-share index, when it was invented in November 26th, 1962. FTSE includes all suitable companies that are listed on the London Stock Exchange`s main market, and it is a market-capitalization weighted index. FTSE all-share index includes 630 companies with a total worth of about £1,6 trillion, in May 28th, 2010. (FTSE, 2010)

Calculation

"The FTSE Global Equity Index Series is an arithmetic weighted Series where the weights are the market capitalization of each company. The price index is the summation of the free float adjusted market values (or capitalizations) of all companies within the index and each constituent company is weighted by its market value (shares-in-issue multiplied by share price multiplied by free float factor) to which an investibility weighting may be applied. The price movement of a larger company (say, representing five per cent of the value of the index) will, therefore, have a larger effect on the index than a smaller company (say, representing one per cent of the value of the index) (Guide to Calculation Methods for the FTSE Global Equity Index Series, November 2010) "

2.3 Stock market crash 1929

The first big stock market crash started on October 24, 1929, also known as The Black Thursday. At that time, banks loaned money to people to buy shares. Anyone could buy shares but only putting down 10 percent of purchase price of his own. Everywhere quick and easy wealth was talked about. But suddenly something unexpected happened. *(Harold Bierman Jr., 2008; New York Times, 1999)*

Normal stock trade in those times was around 4 million stocks, but on that day trading volume was a phenomenal 12,9 million. Price tracking systems could cope with 4 million stock exchange, but when the trading amount raised so rapidly, price trading machines were not capable of following and price data came 90 minutes late. That also raised stock holders' panic and everybody tried to get rid of stocks. Banks tried to contact people, to hand out more money to shares but the problem was that no one could afford to do so. Banks had to make a quick decision to sell stock and minimize losses. That was one of the reasons why trading level raised to that level. At the end of the day markets had fallen 9 percent. Friday and Saturday were silent before the big crash happened. At that time stock markets were open also on Saturday. (*Money-Zine, 2004 – 2007; Harold Bierman Jr., 2008)*

Against all hopes for quick and easy wealth, became Monday. People hoped that markets could rebound on Monday, but the result appeared upside down. Trading volumes fell a bit from Thursday, but volumes still remained over two times bigger than normal, with 9,25 millions exchange. At the end of the Black Monday, markets had fallen another 13 percent. When trading levels are in level like Thursday and Monday, thicker tapes could not hand out information in time and that increased panic. (Money-Zine, 2004 – 2007)

Tuesday was like a copy of two other crash days. Trading volume was over 16 million shares, and thicker tapes were over 3 hours late. Markets continued falling

and falling, and the bottom of the crash was reached as late as 1932 when markets had fallen 89 percent. (Money-Zine, 2004-2007)

The reasons why the crash happened were dividends and media pressure. Divided payments had been raising and it was expected to continue. In the media, it was written that stock prices were too high, which made people think that it is time for selling. (Harold Bierman Jr.,2008)

Recovery

From the first big stock market crash it took remarkable long time to recover. When the crash was over in 1932, healing started, but it took 22 years to get to the same level that in 1929. The level of trading volumes like in 1929 was reached as late as in 1969. Recovering from the crash took a long time and because of that those were hard times in every sense. After the crash peoples did not believe in stocks and very few people bought stocks, because almost everyone had lost a big part of their wealth. (Money-Zine, 2004 – 2007)

2.4 Stock market crash 1987

Over the year 1987 positive hopes increased for the future and American companies promised growing earnings to share holders. The number of foreign investors also increased at that time. Before the real crash, investors got insecure because of the weak dollar.(Jennifer Itskevich, 2002)

In between 14th and 16th October 1987 the second big crash in history had started. At the same time weak dollar and hopes for growing earnings raised volatility to a new level again. Uncertainty was in the air. In 19th October 1987 it happened again. Markets faced the second big stock market crash in history. Stock exchange was

partly routinized, and that accelerated the unavoidable. A computerized systems and portfolio insurances together made the crash possible. A new computerized system used stop loss orders, where computer sold shares if stocks value reaches certain point. On Monday when markets were nervous, the market started sinking. After it had sunk to a certain point, computers started selling shares and that accelerated the crash. At the end of the Black Monday, the market had fallen 22 percent and over 500 billion dollars were lost in one day. (Money-Zine, 2005 – 2007; Jennifer Itskevich, 2002)

The reason in this crash was imperfection of the computer system. The program was invented to handle bigger volumes at the same time, but it did not work as it was planned at this case. (Money-Zine, 2005 – 2007)

Recovery

Comparing this crash to the earlier crash in 1929, recovery was remarkably faster from this crash. At the end of 1989 Dow Jones Industrial Average set new highs again. When comparing this to the crash in 1929, the rebound was extremely fast in this stock market crash. (Money-Zine, 2005 – 2007)

2.5 Stock market crash 2008

In 2008 the next big stock market crash happened. For the most parts it is different than the 1929 and the 1987 crashes, but one thing is common to all of them. All of these three crashes started in October; is that just a coincidence or is there a reason why markets crash in October? That is an interesting question, but in this thesis it cannot be explored.

This crash of 2008 was based on sub - prime mortgages. Individuals were given a loan that they really could not afford. The reason for that was because house prices were rising all the time. If people could not afford to pay a loan back, banks could

foreclose the house. The problem started in 2007 when house prices began to fall and soon houses were not worth the loan. (Money-Zine, 2008)

Federal National Mortgage Association and Federal Home Loan Mortgage Corporation, better known as Fanny Mae and Freddie Mac, two institutions which owned or had quarantined peoples' loans for worth 6 trillion dollars. When prices started to fall, they were in serious trouble. The Federal Housing Finance Agency helped these companies to stabilize their actions. National debt had risen to 800 billion dollars. (Money-Zine, 2008)

Also many banks were in trouble. Bank of America helped some banks to avoid bankruptcy. The first big victim was Meryll Lynch on 14 September 2008, and the second- and probably most serious was American International Group (AIG). If AIG had gone bankrupt, it could have been a worldwide disaster. (Money-Zine, 2008)

The crash started on 1st October and on 6th October begun the Black Week. During the week Dow Jones Industrial Average fell 18,1 percent. (Money-Zine, 2008)

The White House tried to set a bailout plan for the market, but it failed, which accelerated the speed of the crash. (Alexandra Twin, 2008)

Recovery

Recovery from the last crash is still going on. Congress gave opportunity to give a $ 700 billion bailout plan, but White House did not accept that. Central banks, including Federal Reserve made it possible to give aid for billions to the troubled banks. Almost all banks were in a lot of trouble, including the United States' largest banks like Bank of America and Merill Lynch. (Alexandra Twin, 2008)

As it is said that recovery is still going on, and no one knows if the bail out plans are adequate or will there be more aid packages.

3. FORMULAS

3.1 Average

Average is also called as arithmetic mean.

Formula is,

$\bar{x} = \frac{\sum_{i=1}^{n} x_i}{n}$, where numerator is the sum of the researched values and denominator is the number of researched values.(Lehtonen, Niemi 1992)

3.2 Standard Deviation

Standard deviation is a value that shows the average deviation from arithmetic mean.

Formula is,

$s = \sqrt{\dfrac{\sum x_i^2 - \dfrac{(\sum x_i)^2}{n}}{n-1}}$,where the nominator's first part is that every value powered to two and then the total sum of the raised values. In the second part in the nominator all the values are added up and powered to two, and divided by the number of researched subjects. After that, everything that is calculated before is divided by the number of researched subjects minus one. Finally a square root is taken from the formula to get the right answer. (Lehtonen, Niemi 1992)

3.3 Variation

Variation indicates how much standard deviation is from the arithmetic mean.

Formula is,

$$V = \frac{s}{\bar{x}}$$,where s is standard deviation, which is divided by the arithmetic mean.

(Lehtonen, Niemi 1992)

EMPIRICAL STUDY

In the empirical study there is explained how the calculations are made and the results that appeared. This part is separated to calculations of descriptive statistics and to wavelet calculations that are made by MATLAB-program.

4. DATA AND RESEARCH METHODS

This thesis consists of three time periods per stock market crash. All the time periods that are investigated include 263 samples. A three week long time period has been left out in every crash, because of the enormous change in values. In this thesis Dow Jones Industrial Average and FTSE index are researched.

In the first stock market crash a normal time period is between 26 February1934 and 15 March 1935. The time period before the crash is from 1 October 1928 to 17 October 1929 and after the crash in 1929, the time period is between 4 November 1929 and 21 November 1930.

The stock market crash 1987 also has three time periods, but as difference to the first crash, in this one two indexes, Dow Jones industrial Average and FTSE are researched. In Dow Jones Industrial Average normal time period is between 3 January 1983 and 16 January 1984. The time period before the crash is between 1 October 1986 and 14 October 1987 and the time period after the crash is from 2 November 1987 to 14 November 1988.

FTSE has a little different time period, because stock market crashes do not start at the same time all over the world. In 1987 stock market crash, the normal time period that was used in the thesis is between 7 January 1985 and 8 January 1986. The time period before the crash is between 10 October 1986 and 13 October 1987 and after the crash from 9 November 1987 to 9 November 1988.

The final stock market crash was researched in 2008 and also in this crash was researched by both indexes. The normal time period that was researched is from 2 January 2004 to 18 January 2005. The time period before the crash is between 19 September 2007 and 26 September 2008 and after the crash from 21 October 2008 to 4 November 2009.

For FTSE the normal time period is from 29 October 2003 to 29 October 2004. The time period after the stock market crash is between 1 June 2007 and 3 June 2008 and the time period after the crash is between 26 June 2008 and 29 June 2009.

4.1 Reliability and validity in this subject

In this thesis reliability is very important and the importance of reliability grows even more when trying to predict crashes. This thesis is reliable because there are so few variables and also the results in the research are strong.

This research is valid, because it gives answers to the researched subject. Answers respond to research questions in this thesis.

4.2 Reasons why methods are used

Wavelet analysis is used in this context because it is a new way of researching and this method has not been used earlier in this kind of research. The goal in this thesis is to create new and open – minded research that gives new perspectives in the issue. This thesis can hopefully be used to further investigations. More investigations can be done based on this thesis, but it was not possible now because there was a limited time as well as resources for completing this thesis. Wavelet variance gives new components from the researched matter that basic statistics cannot implicate.

5. DESCRIPTIVE STASTISTICS

Descriptive statistics is used to calculate basic statistics from all the time periods that are taken under research. Minimum and maximum values were taken from every analyzed time period but also average, standard deviation and variation were calculated. When these values were calculated, differences can be seen and assumptions can be made of those results.

5.1 Descriptive statistics in the crash 1929

	Normal time period 26.2.1934-15.3.1935	Time period before the crash 1.10.1928-17.10.1929	Time period after the crash 4.11.1929-21.11.1930
Minimum	92,53	237,75	171,60
Maximum	141,31	381,17	294,07
Average	112,91	313,21	243,34
Standard deviation	13,31	33,87	29,75
Variation	0,12	0,11	0,12

Table 1: Descriptive statistics in Dow Jones Industrial Average, 1929 stock market crash

Calculation shows that the variance is almost the same in every investigated time period. The result is extraordinary when researching these descriptive statistics, because in other cases difference in standard deviation and variation between different time periods is remarkable, as can be seen later on. In this research, variation is smaller in time period before the crash and on the other hand variation is bigger in normal time period and also in the time period after the crash.

In this case it can be seen that standard deviation grows bigger when crash is about to happen, but also the average is bigger. More assumptions cannot be made from these statistics.

5.2 Descriptive statistics in the crash 1987

5.2.1 Dow Jones Industrial Average

	Normal time period 3.1.1983-16.1.1984	Time period before the crash 1.10.1986-14.10.1987	Time period after the crash 2.11.1987-14.11.1988
Minimum	1027,04	1774,18	1766,74
Maximum	1287,19	2722,42	2183,50
Average	1193,98	2250,72	2031,38
Standard deviation	165,33	266,68	83,62
Variation	0,055	0,118	0,041

Table 2: Descriptive statistics in Dow Jones Industrial Average, 1987 stock market crash.

In these descriptive statistics there is a totally different situation; variations are smaller in a normal time period and after the crash than in the time period before stock market crash. This means that standard deviation and variation grow when moving closer to a stock market crash and when variation grows that much bigger, it could mean that something is happening in the market conditions. This reveals that market conditions change notably before a crash happens compared to a normal time period.

5.2.2 FTSE

	Normal time period 7.1.1985-8.1.1986	Time period before the crash 10.10.1986-13.10.1987	Time period after the crash 9.11.1987-9.11.1988
Minimum	590,17	782,10	784,81
Maximum	702,06	1238,57	978,58
Average	633,69	1010,08	918,68
Standard deviation	26,67	145,33	43,06
Variation	0,042	0,144	0,047

Table 3: Descriptive statistics in FTSE, 1987 stock market crash.

When researching descriptive statistics from FTSE in 1987, the gained results were similar than before but stronger. First when investigating standard deviation and comparing the time period before the crash and a normal time period, differences are extraordinary big. In the time period before the crash, standard deviation is over five times bigger than in a normal time period. Similar results can be discovered in variations. Variation is over three times bigger before the crash than in a normal market condition. As said earlier, standard deviation and variation grows when moving closer to a crash. The results are the same as before; something happens in markets conditions before a stock market crash.

5.3 Descriptive statistics in the crash 2008

5.3.1 Dow Jones Industrial Average

	Normal time period 2.1.2004- 18.1.2005	Time period before the crash 13.9.2007- 26.9.2008	Time period after the crash 21.10.2008- 4.11.2009
Minimum	9749,99	10609,66	6547,05
Maximum	10854,54	14164,53	10092,19
Average	10327,68	12507,25	8618,30
Standard deviation	248,40	862,40	784,91
Variation	0,024	0,069	0,091

Table 4: Descriptive statistics in Dow Jones Industrial Average, 2008 stock market crash.

The results in the stock market crash of 2008 are similar to other crashes. Variation is smaller in a normal time period than in the time period before the crash. The only difference is that variations after the crash are different in every case. In some cases, variation is smaller than before the crash and in some cases bigger. In this thesis the goal is to find out whether stock market crashes can be predicted with these implemented analyses before the next one happens – not after. In that case it is not that relevant to investigate the time after the crash, but it is important to research what happens to market conditions after a stock market crash has happened.

5.3.2 FTSE

	Normal time period 29.10.2003-29.20.2004	Time period before the crash 1.6.2007-3.6.2008	Time period after the crash 26.6.2008-29.6.2009
Minimum	2114,98	2777,55	1781,64
Maximum	2334,84	3478,99	2868,69
Average	2215,07	3196,91	2274,88
Standard deviation	48,08	167,00	297,06
Variation	0,022	0,052	0,131

Table 5: Descriptive statistics in FTSE, 2008 stock market crash.

The research continues on the same track and results are similar to earlier investigations. As has been said in earlier investigations, variation is smaller in normal time period than the time period before the crash.

Almost all of these calculations of descriptive statistics have similar results. The only exception is the first stock market crash. All the other investigations gave similar results. Differences in markets conditions between a normal time period and a time period before the crash, is clearly on show. As has been said before, more important are the results between normal time periods and time periods before the crash than the times after the crash. It is important to find out whether the differences between normal time periods and the time periods before the crash are remarkable, that something can be forecasted from those results. Based on the results, something happens in market conditions before a stock market crash.

6. WAVELET VARIANCES

6.1 Wavelet variance 1929

The stock market crash in 1929 was only possible to examine with Dow Jones Industrial Average because FTSE index was founded much later. Variations at a longer time scale vary much more compared to normal times.
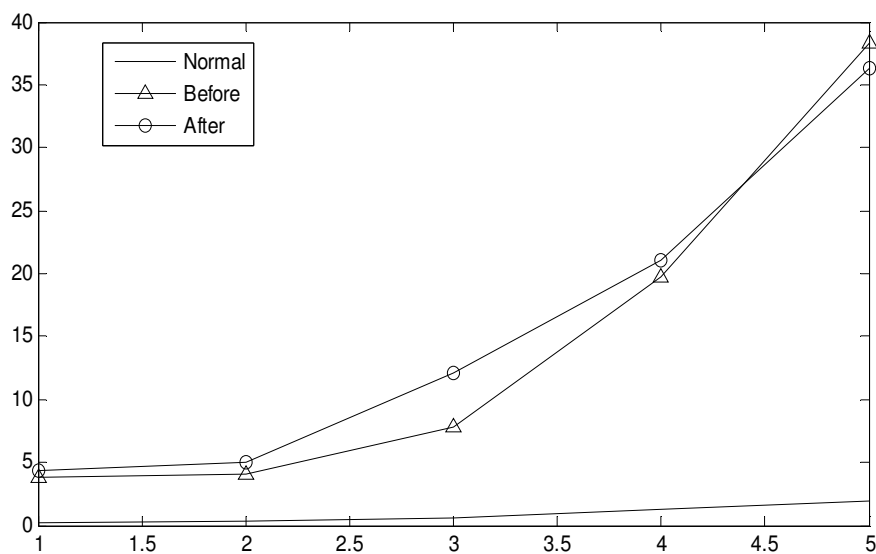

Figure 1: Wavelet variance in Dow Jones Industrial Average, 1929 stock market crash.

In figure 1, numbers in the x – axis are powers to two, so the first place is a two day long time period. And on the other hand, number five is a 32 - day long time period. And as can be seen in this picture, when moving from a two day long time period to a 32 - day long one, differences are remarkable. When looking at the first and shortest time period, the normal time period and the time period before crash, the difference is not that obvious. On the other hand when moving to a longer time section, the difference grows remarkably. The difference is significant between different time sections. Also the time period after the crash, has a significantly bigger variance in longer sections than a normal time period.

6.2 Wavelet variance 1987

6.2.1 Dow Jones Industrial Average

This analyzes gives similar results to earlier investigations. As was noticed in descriptive statistics market conditions change and variation tells also of similar results.
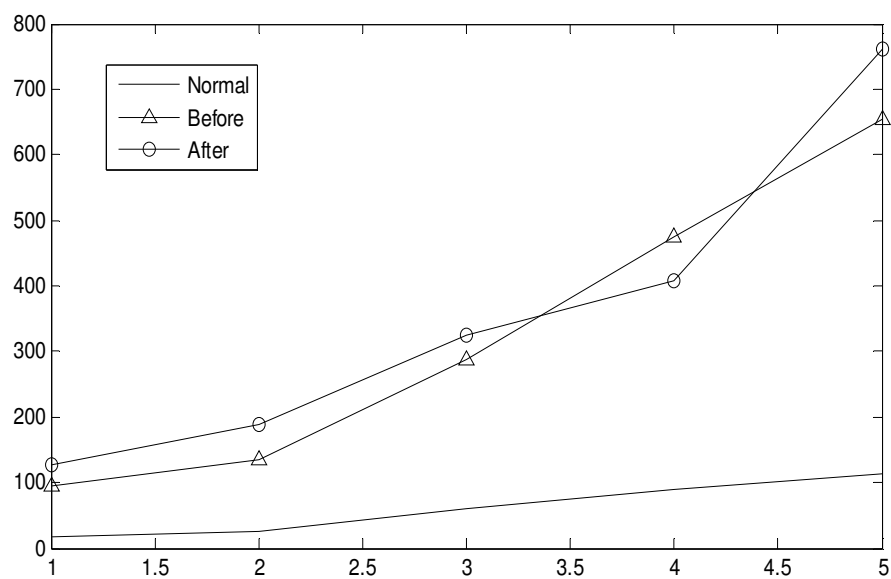

Figure 2: Wavelet variance in Dow Jones Industrial Average, 1987 stock market crash.

In figure 2 when moving from place one in the x – axis to place five, variation changes remarkably. In place one, where there is a two days long time section the difference can be seen, but when moving to place five where the 32 - day long section is, the difference grows even more. Variance before the crash is over six times bigger than in a normal time period.
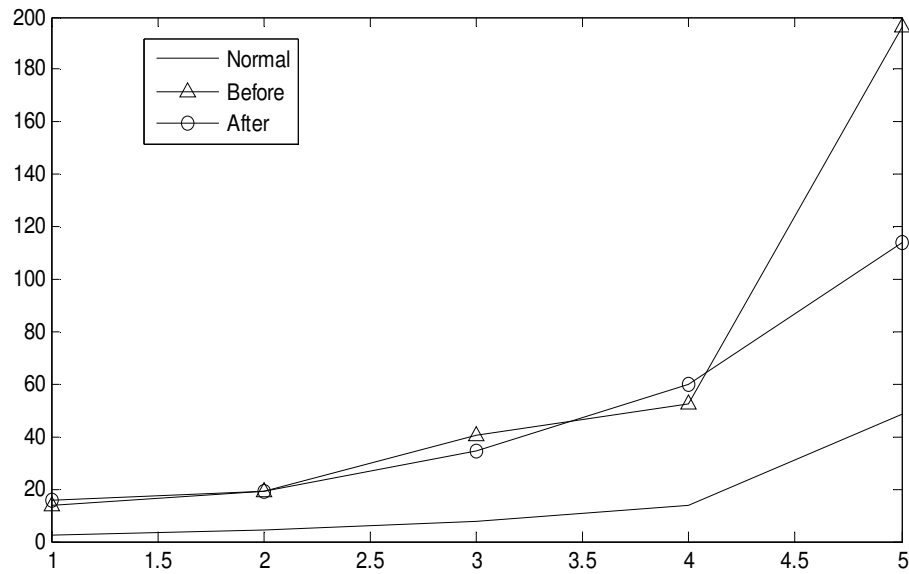
6.2.2 FTSE

Figure 3: Wavelet variance in FTSE, 1987 stock market crash.

First stock market crash that could be researched using FTSE was the 1987 crash. In this case there is a slight difference to other cases, but the formula is similar to other. The difference in variation stays in the same level, until it starts growing monumentally between places four and five in the x - axis. That tells that variation grows more in long time sections than in shorter sections. In place four there is a 16 day long time periods. Also, variation in the time period after the crash has almost the same kind of line but it does not grow that much in between 16 and 32 - day long time sections.

6.3 Wavelet variance 2008
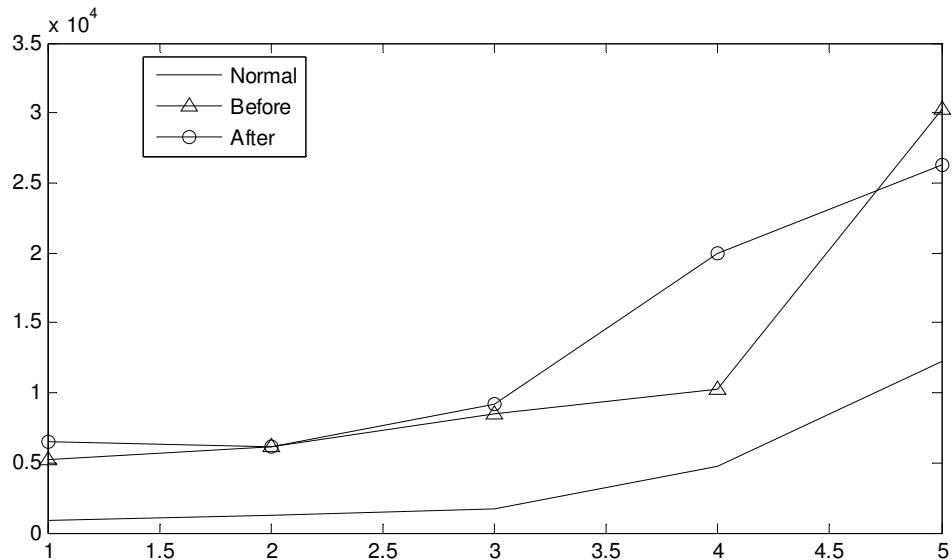
6.3.1 Dow Jones Industrial Average

Figure 4: Wavelet variance in Dow Jones Industrial Average, 2008 stock market crash.

This analysis has almost the same kind of results than earlier FTSE analysis from the 1987 crash. The difference between a normal time period and the time period before the crash is like a copy of the earlier research. This analysis also indicates similar results as earlier investigations, in between 16 and 32 - day long time periods, variance grows enormously as shown on Figure 4. Also in this case, results that appeared are significantly strong.

The only difference to that earlier FTSE analyze is that variation after the crash is slightly different. But also in this case it is not that relevant on focus to things that happen after the crash.
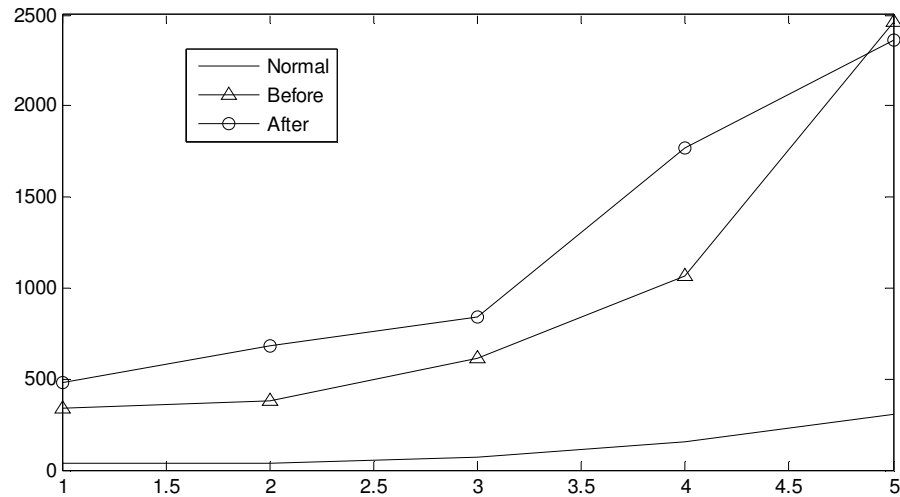
6.3.2 FTSE

Figure 5: Wavelet variance in FTSE, 2008 stock market crash.

This case is more or less similar to the others. As can be seen in the figure 5, variance is once again remarkably bigger in the time period before the crash than in a normal time period. Also in this case, in 32 - day long time period, the difference between a normal time period and the time period before the crash is notable, variance being about seven times bigger. What comes to differences in variance, the results in this case are remarkably strong. In every case that has been researched, the results have been strong and therefore something might be presumed from the results.

The results in every researched case are similar, that means that something must be happening to the market conditions before the crash. The results can be found, when looking for differences in long time sections. Variations vary much more before the crash   than   in   normal   times.

7. RESULTS

The results from standard deviations can be read very clearly. In the first crash, the results were extraordinary, but that is only one part of the research. Crash variations were almost the same in all researched periods, but a difference can be seen in the wavelet variance. The difference is big, in a normal time period variance in a 32 - day long time section it is between 2 and 3, and variance before the crash in the same time section is almost 40. Everybody can see the difference is in this case.

When investigating the second case, the stock market crash in 1987, the investigation includes two indexes, Dow Jones Industrial Average and FTSE. First, when investigating descriptive statistics from Dow Jones Industrial Average, it can be seen that variation is smaller in a normal time period and also after the crash. Before the crash, variation is once again remarkably bigger than in other investigated time periods.

Other index in case two was FTSE, and the results are similar to Dow Jones Industrial Average. Variation is over one third smaller in a normal time period than in the time period before the crash. Similar behaviors can be seen on both indexes in the 1987 stock market crash.

This research also includes wavelet variance analysis from both indexes. Also in this research, variance grows remarkably bigger when moving from shorter time sections to longer time sections. Variance is about six times bigger in a normal time period than before the crash. These results are in longer time sections that this investigation includes.

Another index that was investigated in the year 1987 stock market crash was FTSE. The result in this index is similar to others. Wavelet variance grows four times bigger in the time period before the crash than it is in a normal time period. Variance grows about four times bigger in this case when moving from short time sections to long.

The last stock market crash started in 2008 and it is still influencing peoples' lives. Also in this descriptive statistics were firs researched and the results were similar. In Dow Jones Industrial Average differences in standard deviation and variation are similar than in 1987 crash. Variation is notably smaller in a normal time period than before the crash. So as a conclusion, variation rises again when moving closer to the stock market crash. Variance after the crash is bigger than in the two time periods that was researched before.

Another index that was researched is FTSE. Descriptive statistics are similar to Dow Jones Industrial Average. Once again variance is smaller in a normal time period than in the time period before the crash. Similar conclusions can also be made of this data.

Next research was the wavelet variance from the stock market crash of 2008. Variance grows in Dow Jones Industrial Average, remarkably bigger in 32 - day long time sections, when comparing to a normal time period and the time period before the crash.

Wavelet variance was also investigated from FTSE index. As has been seen before, variance is also in this case bigger before the crash than in a normal time period. In this FTSE for the crash of 2008, the results are remarkably strong.

7.1 Conclusions

Based on descriptive statistics investigation, it can be seen that standard deviation is bigger in almost every crash that is investigated in this thesis. Comparing standard deviation before the crash happens and a normal time period, it can be seen that there are big differences. Variation also starts growing when moving closer to a crash. This is one part of how crashes might be predictable.

The second part in this thesis is an analysis with Matlab. As can be seen in all of these wavelet variance analysis, when investigating the time period before the crash, variance is in every case tremendously bigger than in normal years, when moving

from two day long time periods to 32 days long. Variance grows remarkably in every case, which gives possibility to predict crashes based on these researches.

The results are so strong in variation and variances that future crisis might be predictable based on the results.

7.2 Further investigations

Further investigations could be made by researching more falling economic trends. It could implicate are there similar actions in market conditions in smaller crashes. Also more investigations could be made by researching issue with wavelet correlation. That implicates do different indexes or different time periods act the same way before a stock market crash happens. Those could give more valuable information to this researched matter.

8. SUMMARY

As a summary, when researching standard deviation, variation and wavelet variances, all at the same time, it could be possible to predict when a stock market crash happens. However, the number of investigated crashes is quite minimal so that the study does not give reliable results based on that. But on the other hand, results in these analyses are so strong, that predicting future crisis may be possible. More investigation needs to be done to be more certain.

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