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The value effect of the nuclear and missile threats from the Kim Jong-Un regime on the East Asian Stock Market and Nikkei-225/Kospi-200 companies

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Abstract

For the East Asian economy, this research tried to further explore the value effect on the stock returns and stock markets resulting from the nuclear and missile threat events from the Kim Jong-Un regime. Under his command, over 100 tests have been carried out, differing from nuclear to small-range missile tests. It is tested how the main indices of Japan and South Korea react to these threats, and, by ways of an event study approach, how Kospi-200 and Nikkei-225 companies react to this. Concluding, nuclear threats have negative value effects on both stock markets. However, the missile threats from the Kim Jong-Un regime have no significant negative effect on the East Asian stock markets, which could be a sign that investors would have learned the "false-alarm effects" of North Korean risks. Additionally, there are significant negative cumulated abnormal returns for the Nikkei-225 and Kospi-200 companies in the event window of a North Korean nuclear test. This can be seen as a market overreaction to bad news about North Korea, as the nuclear test does not have the potential to result in a permanent negative effect. The cumulated abnormal returns of the Korean companies are more negative than that of the Japanese companies because the Japanese stock market is more resilient and liquid than the South Korean stock market. Despite the fact that there are significant (negative) cumulated abnormal returns for the Kospi-200 companies in the event window of a North Korean category 1 missile test, no significant conclusions can be made about the negative effect of the missile threats on the Japanese and South Korean companies.

Keywords: Kim Jong-Un regime, North Korean threats, Event Study, Abnormal Return, Nikkei-225 index, Kospi-200 index

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1. Introduction

On April the 27th of 2017, two Korean leaders – Kim Jong-un and Moon Jae-in – met face-to-face in the South for the first time in 65 years. The meeting marks the first time one of the ruling Kim leaders has crossed over to the southern side of the Korean Demilitarized Zone (DMZ) since fighting in the Korean War stopped in 1953 (News, 2017). Hailing a "new era of peace", the North and South Korean leaders sealed their talks with a joint declaration, reaffirming their commitment to Korean 'peace regime' to end the nuclear conflict. The historic summit also agreed to push for three or four-way talks involving the US and China to replace the Korean armistice with a peace treaty (Telegraph, 2017).

Recently, Donald Trump's long-awaited meeting with Kim Jong-Un took place in Singapore on June the 12th, where they signed what the US president said was a "very important" and "pretty comprehensive" joint statement. Kim declared that the "world will see a major change" and that he and Mr. Trump had "decided to leave the past behind" as they signed the document (Telegraph, 2018).

This is a remarkable turnaround in the pair's relationship from the start of the year. The same goes for the two Korean leaders meeting face-to-face for the first time. A moment that seemed impossible just months ago. Because just months ago, the two leaders were trading threats and insults as North Korea's advances in pursuit of nuclear-armed missiles capable of hitting the US sparked fears of conflict breaking out on the Korean peninsula (News, 2017). This is shown by recent big events such as the Pyongyang nuclear missile test (September 2017), the war of words between the US and North Korean leaders (September 19, 2017) and the first North Korean Hwasong missile launch (November 29, 2017).

I myself lived in South-Korea, Seoul from August 2017 to February 2018. A period when tensions on the peninsula were quite high. At the end of 2017, 54 percent of the Americans thought North Korea is the greatest immediate to their country according to an NBC News poll (NBC News, 2017). If something happened concerning North Korea, it would be all over the American and European news. Was there a good reason for this, or was it just exaggerated by the popular media?

In Seoul, there are over 3,000 bomb shelters and gas masks in every metro station. The Joint Security Area (JSA), the heavily fortified border of the Korean Demilitarized Zone, is only 50 kilometers away from the capital of South Korea. Seoul's 25.6 million residents are in the direct firing range of thousands of pieces of North Korean artillery already lined up along the border (Vox, 2017). You would assume that all the citizens of Korea are afraid of war with North Korea, but during my time in Seoul, I have experienced that this is not always the case. I have seen people making fun of the North Korean leader Kim Jong-Un by calling him 'little Kim' or 'rocket man'. When I would ask Korean citizens if they were afraid of war, they would say that this is the case for over 60 years now and "it is just a threat". So few in South Korea seem panicked over the possibility of an impending war with North Korea. Instead, they are unfazed (Vox, 2017).

But is it really 'just a threat'? The military at the Korean border is a real, just as the intercontinental missiles that North Korea is able to fire nowadays. The tension on the peninsula is nowadays one of the biggest issues for the world leaders from the USA and South Korea but also China, Japan, and many more countries. So the question is, how serious is this North Korean threat? And from an economic perspective, how do the stock markets react to this threat?

According to the efficient market hypothesis, stock market prices fluctuate according to fundamental market values (Fama, 1970). Sometimes, however, they also reflect external market factors instantly. External shocks such as geopolitical and international risks can often cause stock volatility. A report by S&P's Country Risk Assessment team (S&P 2012.4.19), for instance, stated that with nuclear-capable North Korea, the South Korean economy is exposed to some exacerbating security risks. Next to that Pak et al. (2015) proved that news related to North Korea have an impact on the stock volatility in the US and South Korea. To further investigate the effect on the stock returns resulting from the nuclear and missile threat events from the Kim Jong-Un regime, the East Asian market reaction is identified and the events of the threats are analyzed in regard to potential abnormal returns. This results in the following research question:

What are the (value) effects of the nuclear and missile threats from the Kim Jong-Un regime on the East Asian stock market and East Asia's biggest companies?

Since 1984, North Korea has carried out more than 150 missile and nuclear tests (see Appendix A). Over half have been since 2011 when Kim Jong-Un came to power. Under his command, 100 tests have been carried out. The nuclear and missile threats from the Kim Jong-Un regime are described as all the 100 events since 2011 when Kim Jong-Un came to power. The East Asian stock market is described by the two relatively big stock markets close to North Korea, which are respectively the stock market indices from South Korea (Kospi-200) and Japan (Nikkei-225). These indices are chosen as the Korean peninsula is a high-risk region due to the uncertainty of North-South relations (Pak et al., 2015) and a lot of North Korea missile tests fly over Japan, for example, the missile test from the 14th of September, 2017, that resulted in ballistic missile flying over the northern Japanese island of Hokkaido (CNN, 2017).
East-Asia's biggest companies are described by selected components from the two market indices. All the components were formed in different clusters using their SIC-code description. The companies from the clusters that are believed to have any reaction following the event of a North Korean missile launch were selected for this study. This selection will be described in the Data section.

For the East Asian economy, it is important to further explore the effect on the stock returns resulting from the nuclear and missile threat events from the Kim Jong-Un regime. Prices of individual Korean and Japanese stocks reflect investors' hopes and fears about the future. Aggregated, stock price movements can, therefore, generate a tidal wave of activity (Chen & Siems, 2004). Terrorist attacks, military invasions and other unforeseen disastrous occurrences like North Korean threats have a high liquidity level, which can have serious implications for East Asian stocks and bonds. When relevant information becomes available about a cataclysmic event – like a North Korean missile or nuclear test – investors often flee the market in search of safer financial instruments and panic selling arises. Does this initial panic have the potential to turn into chaos and a stock market falling for a prolonged period of time (a so-called long-term bear market), or can it be reversed if investors' hopes return (Chen & Siems, 2004)? How did the East Asian market react to North Korean events from the past and how should investors anticipate upcoming events? This paper will try to be socially relevant for the East Asian economy and investors by further identifying the effect on the East Asian stock returns and market resulting from the nuclear and missile threat events.

Next to that, this research will contribute to existing literature. A few studies from the past have questioned the very existence of the impact on the stock market caused by North Korea. They have claimed that this impact is exaggerated (Nam, 2004; Pyun & Huh 2014). Nam (2004) found that in the event window of negative North Korean news, stock indices dropped sharply, followed by a quick recovery. This result could be evidence of the so-called learning effect, where investors would have learned the "false-alarm effects" of North Korean threats and risks (Nam 2004; Pak et al., 2015). The study of Pyun & Huh (2014) suggests a learning effect as well, as the effects of North Korea risk on the Korean stock market had significantly declined from 2004 to 2012, eventually being relatively negligible. This learning effect of the investors could be in line with the unfazed behavior of the Korean Citizens, not being afraid of a Korean war (Vox, 2017). However, the studies suggesting a learning effect are all conducted before the Kim Jong-Un regime (Nam, 2004; Pyun & Huh 2014). Over half of the nuclear and missile launches have been since 2011 when he came to power, as seen in Appendix A. Is there still a learning effect during his regime, or are there possible abnormal returns in the event window of a missile launch or nuclear event? Therefore, this study will give insight into the events reaction of North Korean missile and nuclear threats during the Kim Jong-Un regime.

To give an overview of this research, relevant literature will be discussed first. Stock returns from the East Asian indices and companies will then be used to analyze the market reaction and the potential abnormal returns in the event window of a North Korean nuclear/missile test. These potential abnormal returns will be calculated with the mean adjusted return and market model (MAR/MR-model). A t-test will be used to identify if these abnormal returns are significant. If there are, explanations will be explored, before concluding what the value effects of the nuclear and missile threats from the Kim Jong-Un regime are.

2. Theoretical Review

First, relevant important concepts about stock market reactions, efficient markets, and event studies will be discussed. Second, literature investigating the effect of geopolitical risk on the stock market will be reviewed. Lastly, literature about the impact of East Asian and North Korean political events will be discussed.

2.1 The Theory of Efficient Markets

According to Fama (1970), the primary role of the capital market is the allocation of ownership of the economy's capital stock. The ideal is a capital market in which security prices provide accurate signals for resource allocation. In this case, under the assumption that in an efficient market security prices at any time "fully reflect" all available information, investors can choose among the securities that represent ownership of firms' activities and firms can make production-investment decisions. According to the Efficient Market Hypothesis (EMH), a market in which the prices of assets completely reflect all relevant available information at every moment in time is called efficient (Fama, 1970).

Roberts (1967) introduced the term Efficient Markets Hypothesis (EMH) and made the distinction between weak and strong form test, which became the classic taxonomy in Fama's research (1970) mentioned above. Fama et al. (1969), with their first ever event study and results, lend considerable support to the conclusion that the stock market is efficient. One year later, Fama (1970) proved that the EMH has three relevant information subsets, respectively the weak form test, the semi-strong form test and the strong form test.

In the weak form tests, the information subset of interest is just historical price or return sequences. However, in the semi-strong form tests, the concern is more focused on the speed of efficiently price adjustment to other obviously publicly available information. These are, for example, the announcement of stock splits, reserve splits and annual earnings, annual reports and new security issues. Semi-strong form tests are in general concerned with whether current prices fully reflect this publicly available information. These latter tests have supported the EMH: Fama et al. (1969) for example, find that the information in stock splits concerning the firm's future dividend payments – publicly available information - is on average fully reflected in the price of a split share at the time of the split. Lastly, in the strong form tests, it is stated that the market reflects all relevant information, both public and private information. In the case of strong form information subsets, monopolistic access to some specific information (by any investor or groups) about prices does not seem to be a prevalent phenomenon in the investment community, as this information is already reflected in the market (Fama, 1970). In all the three relevant information subsets, it is not possible for investors to earn abnormal returns based on historical price movements (weak), publicly available information (semi-strong), or all relevant information (strong), as all these information already has been reflected in the stock prices.

2.2 Event Studies and Semi-Strong Form EMH Tests

An event study approach using abnormal returns will be used, to examine the market effect on North Korean missile launches and nuclear tests (see section 4, methodology). This approach uses the semi-strong form efficiency. As mentioned, this form of efficiency is concerned with whether current stock/security prices fully reflect all publicly available information (Fama, 1970). The semi-strong form market efficiency suggests that publicly available information and announcement cannot be used by the typical investor to secure significantly higher than normal returns. However, exceptions to this rule exist, for example, the stock market reaction to the Challenger crash in 1986 (Maloney & Mulherin, 2003). While the crash was widely observed on national television, it took several months to figure out which of the mechanical components failed during the launch. By contrast, in the period directly following the crash, securities trading in the four main space shuttle contractors surprisingly singled out the firm Morton Thiokol that manufactured the faulty component causing the crash. Here raises the question: was it just luck that the market ruled out Morton Thiokol as the culprit or are markets really efficient (Maloney & Mulherin, 2003)?

With their research, Maloney & Mulherin (2003) have shown the complexity of price discovery in an efficient market. The Challenger crash is comparable on several points with the North Korea case. The Challenger crash was widely observed on national television, just like the North Korean missile tests. Next, to that, some of Morton Thiokol engineers were aware of the potential for failure of the O-rings in cold weather. In North Korean, looking at 'strange' radioactivity on nuclear test site/facilities in North Korea, geoscientists are sometimes capable of predicting that a nuclear test is highly assumable going to happen (BGR, 2016).

Comparing their results (Maloney & Mulherin, 2003) to the North Korea case it is important to identify how much information is released by a North Korean threat event or, more specifically, how much value is placed on the publicly available information by the East Asian market. Hence, it is important to determine whether this information is processed efficiently, that is immediately and completely, by the East Asian market (Van Der Sar, 2015).

Analyzing the return development at the time of the North Korean threat event as well as before and after the event (i.e. by doing event studies) could lead to indications regarding the importance and relevance of the information (according to the East Asian market) or the lack thereof, the speed and completeness of processing, and the degree to which the East Asian market was already aware of some of the information or, conversely, was surprised by it (Van Der Sar, 2015). Therefore, to measure the value effect of the nuclear and missile threats from the Kim Jong-Un regime, an event study approach using abnormal returns is conducted.

2.3 Political Risk and Stock Market

Referring back to the EMH it is stated that without insider information no one is able to exceed the market return. Depending on the level of market efficiency, common stock market prices fluctuate in the event of changes that affect the fundamental values of firms (Fama. 1970). This is all according to the aspects and assumptions of traditional Corporate Finance: rational behavior, CAPM, and efficient markets. However, proponents of behavioral finance disagree with these traditional components. According to behavioral economists, like Shefrin (2001), psychological forces interfere with all three components of the traditional corporate finance. Decision makers do not act in a rational manner and stock prices also move according to the changing expectations of investors, being at odds with fundamental values. Therefore, Shefrin (2001) states that prices do not meet the EMH and that they are inefficient, which can be explained by behavioral finance.

As described by Tetlock (2007), the media, for example, can affect the changing expectations of investors, influencing the stock prices. The level of pessimism produced by the media has a negative effect on the market. A high level of media pessimism can predict downward pressure on market prices and high market trading volume, resulting in the behavior of noise and liquidity traders (Tetlock, 2007). These traders make irrational investment decisions and tend to overreact to news about the market.

In this research, the external factors affecting investor expectations, and thereby influencing the stock prices, are the missile and nuclear threats of the Kim Jong-Un regime. These threats can be categorized as geopolitical risks and uncertainty. Political risks have negative effects on national economies and the stock market of that country in particular (Pak et al., 2015). This was for example found by empirical studies with a focus on the Middle East. Firstly, Zach (2003) found that the daily returns on the Israeli stock market's main index - Tel Aviv Stock Exchange (TASE) – following announcements of news related to the peace process (political events) are more extreme (volatile) than the returns on the same index in other days. Thereby proving that news concerning political events contributes to the variability of stock returns (Zach, 2003). In addition, Eldor & Melnick (2004) found that Palestinian terror and suicide attacks between 1990 and 2003 had strong negative effects on the TASE-index. In their research, they have categorized the terror attack types from the most extreme (suicide terror attacks) to the 'least' (terror attacks on transport). The most extreme terror attack types resulted in a permanent negative effect on the stock market, while other types of attack, like terror attacks on transport, do not, as they have a transitory negative effect on the stock market (Eldor & Melnick, 2004). Lastly, Arin et al. (2008) found that the effect of terrorism in six countries under examination (Indonesia, Israel, Spain, Thailand, Turkey and the UK) has a significant impact on both stock prices and stock volatility. The magnitude of these effects is exaggerated in emerging markets compared to Western European markets (Arin et al., 2008).

2.4 The impact of East Asian and North Korean political events

Despite some degree of difference, the conclusion of these findings mentioned above can be representative of the East Asian market and the North Korean situation as well. Financial stock market indices are sensitive to security problems, political risks and changes (Arin et al., 2008). One could assume that political risks, like the North Korean missile/nuclear threats, would have negative effects on national economies and the stock markets of the countries close to North Korea (Japan and South Korea) in particular (Eldor & Melnick 2004; Zach 2003). Moreover, concluding with the results of Eldor & Melnick (2004), the intensity of an event can also have an impact on the effect on the stock market. The intensity of the North Korean tests differs from nuclear tests (extreme) to short-range missile tests (least extreme). One could assume that the higher the intensity of a North Korean test, the bigger the effect on the stock market. To further justify these assumptions, more literature on North Korean and East Asian topics will be reviewed.

Fisman, Hamao & Wang (2014) have researched the impact of interstate frictions and political relations on economic exchange and the stock market. They have researched the relation between East Asian countries with a high degree of animosity, namely Singapore and Japan (Sino-Japanese relations). This is comparable with the relations, North-South and North Korea-Japan, which are researched in this paper. Increased animosity between the two nations, resulting in adverse negative shocks in Sino-Japanese relations, has a negative impact on stock returns and economic exchange (Fisman, Hamao & Wang, 2014). Besides looking at the nationwide stock market impact, the research has also analyzed the economic impact on individual firms. This firm-level focus will also be applied in this research, assuming the same assumptions as on the market level: negative relationship between political risks and effects on the stock market and positive relationship between the intensity of the North Korean test and the effect on the stock market.

The North Korean missile and nuclear threats could be a factor in the under-valuing of South Korean firms, resulting in the so-called “Korea Discount” (Pak et al., 2015). The presence of this discount depends on investors’ behavior following North Korean risk events (Hwang & Kim, 2004). In the event of positive news regarding North-South relations, for example, the first Inter-Korean summit in June 2000, between Kim Dae-Jung and Kim Jong-Il, the discount would decrease. Investors’ behavior would be optimistic, expecting a relatively lower level of North Korean risk than usual, resulting in a high buying volume of Korean stocks. However, in the event of negative news regarding North-South relations, for example, the resumption of North Korea’s missile and nuclear program in October 2006, this discount would increase. Investors’ behavior would be pessimistic, expecting a relatively higher level of North Korean risk than usual, resulting in a high selling volume of Korean stocks (Ahn et al. 2010; Hwang & Kim 2004). Finally, Ahn et al. (2010) found industry-specific impacts on Koreans firms listed on the NY Stock Exchange. The

stock prices of firms related to the arms industry or North Korea showed a positive relationship with positive news about North-South relations, which is interesting for the company selection procedure of this research.

By way of contrast, the "Korea Discount", described in the discussed paper above (Pak et al., 2015), is also questioned by some researchers, claiming that it is overstated (Nam 2004; Kim 2011; Pyun & Huh 2014). Firstly, Nam (2004) researched the relationship between Korean stock prices and news about North-South Korea relations in the period 1990-2002. In the event window of negative North Korean news, stock indices dropped sharply, followed by a quick recovery. This result could be evidence of the so-called learning effect, where investors would have learned the "false-alarm effects" of North Korean threats and risks (Nam 2004; Pak et al., 2015). Where Nam (2004) analyzed the relationship between Korean stock prices and news about North Korean political events over the time horizon of 1990-2002, two other studies focused on monthly data for the years 2002-2007 and 2004-2012 (Kim 2011; Pyun & Huh 2014). Respectively, they have found that there was no significant relationship between the Korean stock market and changes in the North-South Korea relations (Kim, 2011) and that the impact of North Korean threats and risks on the Korean economy was relatively negligible (Pyun & Huh, 2014). Next to that, North Korean threats before the mid-2000's (like the first nuclear test in 2006) had significantly more effect on the South Korean stock markets than threats after the mid-2000's. In line with the results suggesting the existence of the learning effect of North Korean threats, it was found that these threats only explained 0.2% of the Korean stock volatility (Pyun & Huh, 2014).

In conclusion, the results about the effect of the North-South Korea relations on the Korean stock market differ among studies. This can be explained by different research methods, time periods and classification rules by the researchers. Most studies acknowledge the negative effect of North Korean risks, others deny it, saying it is negligible. However, the studies suggesting this learning effect and undermining the significant effect of North Korean threats and risks on the stock market, are all conducted before the Kim Jong-Un regime (Nam, 2004; Pyun & Huh 2014). They have used time periods from 1990 to 2012, while over half of the nuclear and missile launches have been since the end of 2011 when he came to power. Under the regime of Kim Jong-Un, North Korea is putting a lot of money and time in the development of their nuclear program to build nuclear bombs and missiles capable of reaching the United States of America (Mosher, 2018). They are getting closer to their goal of becoming a nuclear power. So the question is, is the learning effect introduced by Nam (2004) still the case? One of the most recent studies, Pak et al. (2015), showed a negative effect of North Korean risks on the Korean and United States' stock markets. This research will continue on these findings, to see what the current value effects are of the nuclear and missile threats from the Kim Jong-Un regime on the East Asian stock market and East-Asia's biggest companies.

2.5 Composition of Hypotheses

Since the relevant theories and empirical findings are discussed, the research question can be further specified in several hypotheses based on the discussed earlier empirical findings. These hypotheses enable the possibility to test for the value effects of the nuclear and missile threats from the Kim Jong-Un regime. To answer the market level part of the research question, there will be tested for the presence of noticeable daily percentage changes on the Nikkei-225 and Kospi-200 indices following a North Korean nuclear or missile test. Then, to answer the company level part of the research question, there will be tested for the presence of significant abnormal returns for the selected Nikkei-225 and Kospi-200 companies in the event window of a North Korean missile or nuclear test. This all gives rise to the following hypotheses:

- **Market level hypotheses**

H_1: *There are significant effects for the stock market* in the event window of a North Korean missile/nuclear test*

* Each hypothesis has a Nikkei-225 and Kospi-200 index variant:

> **H_{1N}**: *There are significant effects for the Nikkei-225 index (Japanese stock market) in the event window of a North Korean missile/nuclear test*
>
> **H_{1K}**: *There are significant effects for the Kospi-200 index (South Korean stock market) in the event window of a North Korean missile/nuclear test*

H_2: *Higher intensity of the North Korean nuclear/missile test contributes to higher significant effects for the stock market**

- **Company level hypotheses**

H_1: *There are significant cumulated abnormal returns for the East Asian companies* in the event window of a North Korean missile/nuclear test*

> **H_{1N}**: *There are significant cumulated abnormal returns for the Nikkei-225 companies (Japan) in the event window of a North Korean missile/nuclear test*
>
> **H_{1K}**: *There are significant cumulated abnormal returns for the Kospi-200 companies (South Korea) in the event window of a North Korean missile/nuclear test*

H_2: *Higher intensity of the North Korean nuclear/missile test contributes to higher cumulated abnormal returns for the East Asian companies**

3. Data

3.1 Stock Exchanges Japan and South-Korea

Japan – Nikkei-225 NI225

The Japan Exchange Group (JPX), is a stock exchange located in Tokyo, Japan. This is the largest and therefore most important stock exchange in Asia and the third largest stock exchange in the world. In July 2012, the JPX was formed by a merger between the Tokyo Stock Exchange (TSE) and the Osaka Securities Exchange (OSE). The TSE is the fourth largest stock exchange in the world. The main index tracking the TSE and the JPX is the Nikkei 225 index. This stock market index consists of 225 Japanese companies, active in different sectors, like Manufacturing, Banking, Machinery, and Services. The Nikkei 225 index would, therefore, be a good indicator for the Japanese economy.

A lot of North Korea missile tests fly over Japan, for example, the missile test from the 14th of September, 2017, that resulted in ballistic missile flying over the northern Japanese island of Hokkaido (CNN, 2017). Therefore, in this paper, the Nikkei-index is used, to see if there are any significant reactions in the event window of a North Korean missile/nuclear test.

South Korea – Kospi-200 KS200

The Korea Exchange (KRX), is a stock exchange located in Seoul, South Korea. This is the only securities exchange operator in South Korea. The three indices tracking the KRX are the KOSPI, KOSDAQ and KRX 100, where the Korea Composite Stock Price Index (KOSPI), making up 93% of the total market value of the KSE, the most important one is. This is the index of all common stocks traded in the Korea Exchange, consisting of 200 Korean companies, active in different sectors comparable with the Nikkei 225. As the representative stock market index of South Korea, the Kospi 200 index would be a good indicator for the South Korean economy.

South Korea is the neighboring country from North Korea, with its capital Seoul 50km away from the Joint Security Area (JSA) and the Korean Demilitarized Zone (DMZ). The Korean peninsula is a high-risk region due to the uncertainty of North-South relations (Pak et al., 2015). For over 60 years North and South Korea are in ‘war’ (truce) and 91% of the South Koreans viewed North Korea’s influence negatively, making South Korea, after Japan, the country with the most negative feeling of North Korea in the world (BBC, 2014). Therefore, in this paper, the Kospi-index is used, to see if there are any significant reactions in the event window of a North Korean missile/nuclear test.

3.2 North Korean Missile Launch and Nuclear tests

Kim Jong-Un has been the leader and Supreme Commander of North Korea since 2011. For the period from December 17, 2011 (day of assumed office Kim Jong-Un) to December 31, 2017, all sorts of North Korean missile launches and nuclear tests will be investigated. This results in 100 events over a total of six years. As seen in Appendix A, there are 11 types of tests, differing from small range missile tests to intercontinental ballistic missile tests (nuclear).

3.3 Missile launch tests

The data from the missile launch events will be retrieved from the James Martin Center for Nonproliferation Studies North Korea Missile Test Database (NTI, 2018). This is the first database to record flight test of all missiles launched by North Korea capable of delivering a payload of at least 500 kilograms or a distance of at least 300 kilometers, since the first test occurred in April 1984, under Kim Jong-Un grandfather's command Kim Il-Sung. 117 missile test meet the criteria mentioned above.

First, as this research will only investigate the missile launches under the command of Kim Jong-Un, all the missile test (31) under the command of Kim Il-Sung and Kim Jong-Il (1984-2011) will be deleted from the sample. This results in a sample of 86[1] missile test under Kim Jong-Un's command.

Second, the missile test will be categorized into 4 different categories, where 1 is the most extreme and 4 the least (also see Appendix B1):

1. Category 1: ICBM and Intermediate Range Ballistic Missiles (IRBM)
    i. Missile names: Hwasong 12, 14, 15 and Musudan
2. Category 2: Medium Range Ballistic Missiles (MRBM)
    i. Missile names: Nodong, Polaris 2 and ER Scud
3. Category 3: Sub Launches Ballistic Missile (SLBM) and Space Launch vehicle (SLV)
    i. Missile names: Polaris 1 and Unha 3
4. Category 4: Short Range Ballistic Missile
    i. Scud B-C, KN02, Scud-B-C MaRV

Finally, events from the same category that happened multiple times on the same day, will be clustered as one event, resulting in a total of 53 missile test events (see Appendix B2).

[1] $86 \neq 100$ from Appendix A, as the 100 events from Appendix A are all the test events, while 86 are only the missile test events meeting the NTI criteria.

3.4 Nuclear events

Under the command of Kim Jong-Un, four nuclear tests have been carried out. Every one of them was seen as breakthroughs in North Korea's development of becoming a nuclear power. The Federal Institute for Geosciences and Natural Resources, a state-run geology research institute in Germany, is an institute who keeps a record of all North Korea's nuclear tests (BGR, 2018).

On February the 12th, 2013, North Korea conducts their third nuclear test, which was the first nuclear test carried out under Kim Jong-Un. The fourth test happened January the 6th, 2016, where North Korea claimed it was a hydrogen bomb. On the 9th of September, 2016, when the 5th nuclear test occurred, North Korea announced that this was a successful test of a warhead that could be mounted onto a rocket. Lastly, on the 3rd of September, 2017, the 6th nuclear test happened. North Korea claimed it to be a hydrogen bomb.

Table 1

Nuclear test during Kim Jong-Un's regime (BGR, 2017)

Nuclear test	*Date*	*Yield*
3	12/2/2013	6 – 16 kT
4	6/1/2016	7 – 16.5 kT
5	9/9/2016	15- 25 kT
6	3/9/2017	70 – 280 kT

As seen in Table 1, the estimated yield per nuclear test over the years has increased. Compared to the missile tests from the last paragraph, the nuclear tests have greater intensity. It is expected that they would have the highest impact on the East Asian stock market and daily returns of Korean and Japanese companies.

3.5 Missile and nuclear test under Kim Jong-Un's command

Combining the 53 missile tests and the 4 nuclear test, a total of 57 events[2] are received.

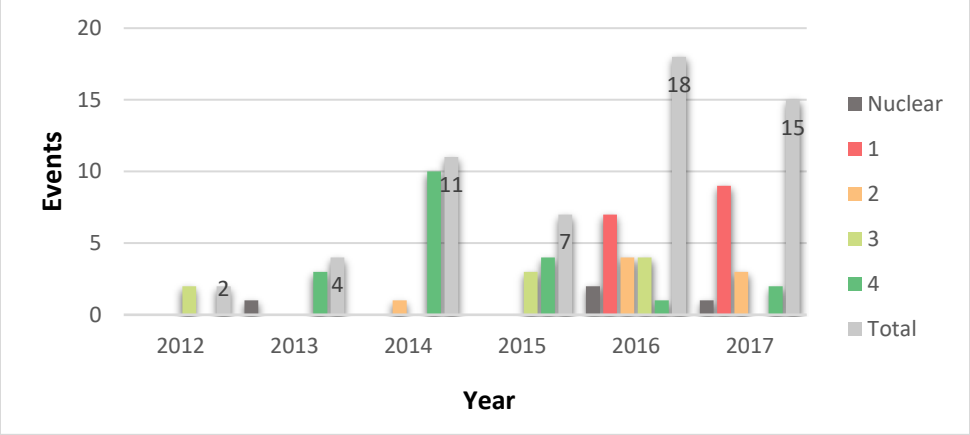

Figure 1. Nuclear and missile test Kim Jong-Un regime 2012-2017

[2] For a detailed list of all the events, see Appendix B2

As seen in Figure 1, the intensity and number of the test have risen over the years. For the years 2012-2015, the tests were mostly category 3 and 4 tests, resulting in a total of 24 events. However, for the years 2016-2017, category 1 and 2 were the main categories, resulting in a total of 33 events. Comparing the events of 2012-2015 and 2016-2017, an increase of almost 1.5x times is seen. This proves that for the past years North Korea has put more time and effort in the development of their nuclear program to build nuclear bombs and missiles capable of reaching the United States of America (Mosher, 2018).

3.6 Success and Failures

All the nuclear tests and category 4 tests have been tested successfully. However, not all category 1, 2 and 3 have. For example, the category 2 test from 18-03-2016: this missile specifically disappeared from the radar about 17 seconds into flight suggesting that it suffered a critical failure and exploded (NTI, 2017). Table 2 gives a summary of all the failed and successful events. For the year 2016, 50% of the tests were failures and 6 out of 7 category 1 test were. This number improved in 2017, where only 20% of the tests were failures and 3 out of 9 category 1 test were. This also proves that North Korea has become closer to their goal of becoming a nuclear power.

Table 2

Nuclear and missile test Kim Jong-Un regime 2012-2017 per category and success rate

Category	*2012*	*F*	*S*	*2013*	*F*	*S*	*2014*	*F*	*S*	*2015*	*F*	*S*	*2016*	*F*	*S*	*2017*	*F*	*S*	*U*
Nuclear				1		1							2		2	1		1	
1													7	6	1	9	3	5	1
2							1	1					4	2	2	3		3	
3	2	1	1							3	2	1	4	1	3				
4				3		3	10		10	4		4	1		1	2		2	
Total	**2**	1	1	**4**		4	**11**	1	10	**7**	2	5	**18**	9	9	**15**	3	11	1

All the events from table 2 will be tested to see if they have an impact on the East Asian stock market and daily returns of Korean and Japanese companies. Next to that, the Failures and Success events will be tested separately, to see if there are any significant difference in the impact of these two (see Appendix B3).

3.7 Market and company level data

The general stock exchanges, as a good indicator for the Japanese and South Korean economy that will be analyzed in this research, are the Nikkei-225 index (NI225) and the Kospi-200 index (KS200). Using the Wharton Research Data Services, all 225 Japanese and 200 South Korean companies of the used indices were found (WRDS, 2018). For this research, around 40% of the components from each index were chosen. The selection procedure of the components from the Nikkei and Kospi index were similar and will be described below.

Using Compustat, all components of the used indices were retrieved (WRDS, 2018). All companies that entered the NI-225 or KS-200 after Kim Jong-Un came into power (+/- December 2011) were removed from the sample, as well as companies that left the index during the years of his regime (December 2011 – 2017/now).

After that, the companies were formed into different clusters using their Standard Industrial Classification (SIC) codes. With this four-digit numerical codes, the firms can be identified as their primary business of establishment. As the NI-225 and KS-200 both have SIC-codes, the same identification could be used (SIC, 2018). The clusters chosen for this event study were the clusters that have something to do with war, political events and North Korea relations. This is in line with the methodology of Ahn et al. (2010), where industry-specific impacts were found on Korean firms related to the arms industry or North Korea. It is believed that the stock returns of these firms will have the highest chance to show a reaction following the event of a North Korean missile or nuclear test. The following clusters were chosen:

1. Construction
    - Heavy and Building Construction
2. Manufacturing
    - Chemicals and Allied Products, Petroleum Refining, Primary Metal Industries, Electronic, Industrial, Transportation Equipment (last specific clusters consist of mainly defense and war-related companies, e.g. Kia Motors/Doosan, advanced machinery/defense supplies)
3. Transportation & Public Utilities
    - Transportation by Air, Communication, Electric, Gas and Sanitary Services
4. Finance, Insurance
    - Depository Institutions, Insurance Carriers

The same clusters were chosen for the Nikkei and Kospi index. This resulted in a list of 78 South Korean companies and 86 Japanese companies, which can be found in Appendix C1. The proportion of the different clusters between the two indices were quite the same so that a comparison between the effect on the Japanese and South Korean economy is possible.

4. Methodology

The value effect of the nuclear and missile threats from the Kim Jong-Un regime is split up into 2 levels of effect:

1. **Market level -** the value effect on the East Asian Stock Market
    a. Japan – Nikkei-225 index
    b. South-Korea – Kospi-200 index
2. **Company level -** the value effect on the selected East Asian companies (Appendix C1)
    a. Japan – 86 selected Nikkei-225 companies
    b. South-Korea – 78 selected Kospi-200 companies

4.1 Market level – Market reaction

North Korea's sixth nuclear test on the 3rd of September, 2017, made the Kospi index fell by nearly 2% before closing down just 1.19% (Telegraph, 2017). This is an example of a value effect of a nuclear test from the Kim Jong-Un regime on the South Korean stock market. As described, the value effect of all the 5 category events (nuclear, 1, 2, 3 and 4) on the Nikkei-225 and Kospi-200 index will be analyzed.

Firstly, using the Yahoo Finance database the historical daily prices data from 2011 to 2017 of both stock markets will be retrieved (Yahoo, 2018). After that, the daily percentage changes are calculated. To examine the value effect of an event, the following days are analyzed:

- t = 0, the day of the event

As the launch time of some events was in the middle of the night, for example, the Polaris-1 missile test from July the 9th, 2016, that was launched at 2:28:00 AM, the first daily percentage change that will be analyzed is that of the day of the event: t=0.

- t = 1, the day after the event

The day after the event, t = 1, is seen as the most important day to be analyzed because it is the day after the event, where the potential value effect is best visible.

- t = 2, two days after the event

The second day after an event, t = 2, can be interesting as well to analyze. How fast did the market reflect all relevant information, was it 'just a threat' or is something worse going on? Therefore, t = 2 will also be analyzed.

- t = 1-2, day one and two after the event

Finally, the cumulative effect of the event, t = 1 and t = 2, will be analyzed. This effect will be calculated as follows: $t_{1-2} = (1 + t_1) * (1 + t_2)$.

4.2 Company level – Event study

Besides looking at the nationwide stock market impact, this research will also analyze the economic impact on individual firms, following the methodology of Fisman, Hamao & Wang (2014). To examine the market effect on North Korean missile launches and nuclear tests, an event study approach using abnormal returns will be used. As mentioned, the EMH states that the prices of assets completely reflect all relevant available information at every moment in time. Therefore, it is important to identify how much information is released by a North Korean threat event or, more specifically, how much value is placed on the publicly available information by the East Asian market. Hence, it is important to determine whether this information is processed efficiently, that is immediately and completely, by the East Asian market (Van Der Sar, 2015). An event study approach could lead to indications concerning the importance and relevance of the information (according to the East Asian market) or the lack thereof, the way it is processed efficiently, and the degree to which the East Asian market was surprised by some of the information or, conversely, was already aware of it (Van Der Sar, 2015). For this reason, to measure this value effect, an event study approach using abnormal returns is conducted. These abnormal returns will be calculated on the basis of the Market Model (MM-model) and the Mean Adjusted Return model (MAR), as recommended in MacKinlay guidelines for event studies in Economics and Finance (1997).

4.2.1 Market Model (MM-model)

Firstly, the abnormal returns, the difference between the actual return and the expected return, will be calculated based on the market model. To start, the expected return is calculated for each company based on the market model. The formula describing how the expected returns will be calculated is as follows:

(1) $E(R_{it}) = a_i + b_i \mathrm{R}_{MIt} + \varepsilon_{it}$

$E(R_{it})$ = the (expected) return for stock *i* on day *t*

R_{MIt} = the (observed) return for Datastream market index MI for period *t*

- South Korean companies – Kospi200 index (KOR200I)
- Japanese companies – Nikkei-225 index (JAPDOWA)

a_i = the idiosyncratic return on security *i*

b_i = the beta coefficient of stock *i*, a measure of the sensitivity of R_{it} on the reference market

ε_{it} = the error term (a random variable) with expectation zero and finite variance

The estimation of the parameters mentioned in equation 1 will be done by the Datastream Event Study Tool, provide by the Erasmus University (EDSC, 2018). Firstly, an appropriate market index MI should be chosen, since returns on a market portfolio are unavailable (Van Der Sar, 2015). Therefore, as mentioned,

for the South Korean market the Kospi-200 index is used (KOR200I) and for the Japanese market, the Nikkei-225 index is used (JAPDOWA). Secondly, the commonly applied estimation technique for the parameters a_i and b_i is the method of Ordinary Least Squares (Van Der Sar, 2015). This research has, as mentioned in the data section, a sample of 57 events, 78 Korean companies and 86 Japanese companies. The normal distribution can, therefore, be assumed, making the method of Ordinary Least Squares an appropriate approach for this event study (Cable & Holland, 1999). Thirdly, it is important to make some assumptions for the adequacy of this operationalization. Therefore, the assumption of stationarity, meaning zero conditional mean and independently identically distribution, is made.

(2) $E(\varepsilon_{it}) = 0 \qquad Var(\varepsilon_{it}) = \sigma^2_{\varepsilon_{it}}$

These assumptions mean that the estimations of a_i and b_i from the market model in the estimation (control) period also hold for the test (event) period of the event study. Finally, a proper estimation period has to be chosen. To analyze the market reaction to adverse shocks to Sino-Japanese relations in 2005 and 2010, Fisman, Hamao & Wang (2014) have used different estimation periods. For their Senkaku event, they used a window of 60 days, however for their textbook event they used a period of 24 days. In general, for predicting normal returns with their Fama-French three-factor model, they have used a window of [-150, -30] trading days, where 0 is the event date (Fisman, Hamao & Wang, 2014). A slightly similar estimation period was used by Cox & Peterson (1994) in their research on stock returns following large one-day declines. They have estimated mean returns and market model parameters over a 100-trading-day period [-105, -6]. Return data was required to be available over the 100-day pre-event period. Furthermore, if less than 100 days of returns were available during the post-event estimation period, parameters were estimated using however many days of returns are available, provided there were at least ten. This would then still give enough room to validly estimate the market model (Cox & Peterson, 1994).

The estimation period used in this research is a 50-day estimation period. A period slightly shorter than Fisman et al. (2014) and Cox & Peterson (1994) is chosen because of the great amount of nuclear and missile test performed by North Korea. Looking at the date section in Appendix B2, an estimation period as short as possible has to be chosen to prevent overlapping events. However, the estimation period still has to be long enough to reliably estimate the market model. Therefore, giving these facts, an estimation period of [-100, -50] is chosen.

For further justification of this 50-day estimation period, a robustness check has been carried out. As seen in Appendix D1 the Kospi-200 abnormal returns have been calculated, with the Mean Adjusted Returns model for Category Nuclear, for both estimation periods [-150;-50] and [-100;-50]. The average abnormal returns and cumulated abnormal returns of the two models are basically identical, with an absolute average difference of 0,005%. The same goes for the standard deviation, where an absolute average difference of

0.00053 is seen. All the significance levels are the same, with AR(3) as the only exception. Concluding, a different estimation period will not change the results. Therefore, as the results are basically identical with negligible differences, the robustness of this event study has been proven (Appendix D1).

Using the determined market indices, the estimated parameters from the market model and an estimation period of [-100, -50] days, the potential daily abnormal return (AR) can be calculated for each $stock_i$ during the event period. Because of 'strange' radioactivity on nuclear test site/facilities in North Korea, geoscientists are sometimes capable of predicting that a nuclear test was going to happen. This happened for example with North Korea's 5th nuclear test, when the Federal Institute for Geosciences and Natural Resources spotted nuclear activity on one of North Korea's test facilities, prior to the nuclear test (BGR, 2016). Furthermore, ING's head of Asian research Rob Carnell quoted: "like a bad horror movie, the North Korea saga intersperses moment of calm, with occasional action to jolt you out of your chair" (Telegraph, 2017). It can be concluded that a North Korean missile launch or nuclear test event can impact the returns before, on and after the event date. Therefore an event window is constructed around the test date [$-T_1$, T_2].

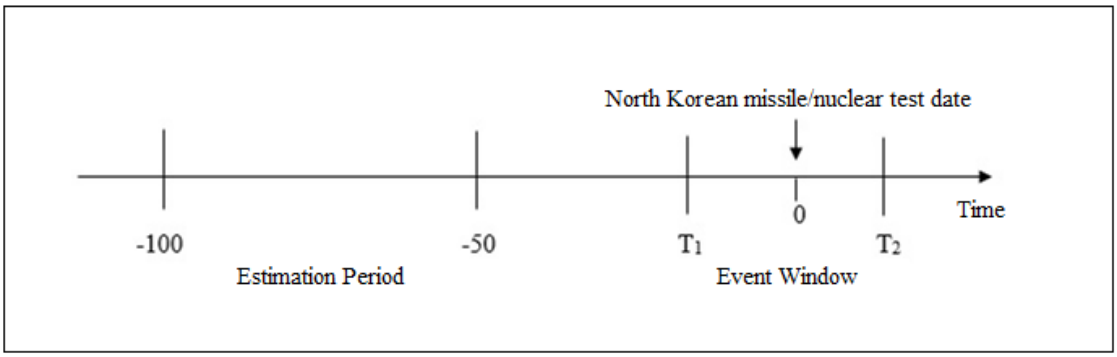

Figure 2. Event study approach - Estimation Period and Event Window

This study will analyze multiple evaluation windows of, in total 57 events through multiple different event windows [$-T_1$, T_2] → [-1, +1] till [-5, +5]. The abnormal return of $stock_i$ is the difference between the actual return and the expected return of that stock. According to the EMH, the return in the estimation period should not differ significantly from the return in the event window (see Figure 2). If this is not the case, it can be concluded that an abnormal return is present. The abnormal return of $stock_i$ in period t can be written as:

(3) $AR_{it} = R_{it} - E(\hat{\alpha}_i + \hat{b}_i R_{MIt} + \varepsilon_{it}])$

AR_{it} = the abnormal return for stock *i* on day *t*

$\hat{\alpha}_i$ = the estimated idiosyncratic return on security *i*

$\hat{b}_i$ = the estimated beta coefficient of stock *i*

4.2.2 Mean Adjusted Return (MAR-model)

Secondly, the abnormal returns will be calculated based on the mean adjusted return model (MAR-model). Although the MM-model is widely accepted as the standard model, there is also some criticism. For example the fact that the model assumes that the risk-free interest rate in the idiosyncratic return on security *i* (a_i) is constant, which conflicts with the presumption that market returns vary over time. An alternative for the MM-model is the simpler MAR-model. Among researchers and academics, there is no consensus about which method has a greater explanatory power for the daily return. Brown and Warner (1980; 1985) conclude that the latter approach is at least as powerful and often more powerful than a market adjusted approach such as the market model. The mean return model often yields results similar to those of more sophisticated models. This conclusion should be even stronger in the case of daily returns as used in this study since the significance of the market model as indicated by its R^2 is much lower for daily data than for monthly data (Masulis, 1980). Therefore, in this research, the mean adjusted return model is used as well to calculate the abnormal returns.

The same estimation period for the MM-model is chosen for the MAR-model [-100, -50]. Following the methodology of Woolridge & Chambers (1983), the average return prior to and separate from the event is taken (from 100 to 50 trading days before the event). The difference between the average return ($\widehat{\mu_{it-50}}$) in a given period and the actual return(R_{it}) makes the abnormal return (AR_{it}) based on the MAR-model.

(4) $\widehat{\mu_{it}} = \frac{1}{50}\sum_{t=0}^{-50} R_{it}$

(5) $AR_{it} = R_{it} - \widehat{\mu_{it-50}}$

$\widehat{\mu_{it}}$ = calculated average return using the daily return from the 50 previous trading days.

R_{it} = the return for stock *i* on day *t*

4.3 Cumulated Abnormal Returns (CAR)

For every day around the event [-5, +5] the average abnormal return from all the companies is calculated (AAR_{it}) for both the MAR-model as the Market model:

(6) $AAR_{it} = \frac{1}{n}\sum_{i=1}^{n} AR_{it}$

AR_{it} = the abnormal return

- calculated by the Market model (equation 3), or;
- calculated by the MAR-model (equation 5)

n = the number of companies (Appendix C1)

- 78 Korean companies, or;
- 86 Japanese companies

After calculating the average abnormal return, the cumulated abnormal return (CAR) needs to be calculated. This is because of the so-called 'event date uncertainty', as it is likely that there will be variation in the returns across the days within the event window.

Therefore, it may be useful to investigate the development of returns in relation to the event over a longer time frame. For instance, it is possible that the exact moment of an event is not available, for example when certain information comes to the market only bit by bit (Van Der Sar, 2015). This was, for example, the case with North Korea's latest nuclear test, when North Korea claimed it to be a hydrogen bomb. For a long time, there was uncertainty if this was really the case. The event period then consists of multiple days instead of just one or two. Furthermore, it is also possible that the circumstances that induced the event may already have been expressed in the returns, so before the event period (referring back to the geoscientists capable of predicting that a nuclear test was going to happen (BGR, 2016)). For this reason, the return development is analyzed on days around the event date (Van Der Sar, 2015). The cumulative abnormal return is often used for the analysis of returns over a longer time period and will consequently be calculated in this paper.

The CAR can be calculated as follows:

(7) $CAR_{ip} = \sum_{t=1}^{p} AAR_{it}$

The cumulative abnormal return (CAR_{ip}) is calculated by adding the average abnormal returns (AAR_{it}). Given the reasons mentioned in the last paragraph, this is done for the following periods:

- Before-event CAR [-5,…,-1]
- On-event CAR [0, 1]
- After-event CAR [2,…,5]
- Short total event CAR [-1, 1], Medium total event CAR [-3, 3], Total event CAR [-5, 5]

By means of a t-test, it will be checked whether there is a significant cumulated abnormal return on each individual day and period around the missile launch. This is the case when the return is significantly different from zero.

5. Results

5.1 Results market level

Table 3

Average daily %-Changes for South Korean (Kospi-200) and Japanese (Nikkei-225) stock market, per category and success rate

Average %Change (all)	4	16	8	9	20
Kospi-200 KS200	**Nuclear**	1	2	3	4
t=0	-0.89%	-0.20%	0.46%	0.37%	0.13%
t=1	**-1.15%**	**0.06%**	**0.11%**	**0.08%**	**0.05%**
t=2	0.31%	-0.03%	0.11%	0.21%	-0.03%
Cumulative t=1-2	-0.85%	0.03%	0.22%	0.29%	0.02%
Nikkei-225 NI225	**Nuclear**	1	2	3	4
t=0	-0.42%	-0.24%	-0.25%	0.25%	0.15%
t=1	**-1.29%**	**-0.30%**	**0.10%**	**0.59%**	**0.24%**
t=2	0.12%	0.13%	0.15%	-0.33%	0.50%
Cumulative t=1-2	-1.17%	-0.17%	0.26%	0.26%	0.74%
Average %Change (Success)	4	6	6	5	20
Kospi-200 KS200	**Nuclear**	1	2	3	4
t=0	-0.89%	-0.26%	0.94%	0.14%	0.13%
t=1	**-1.15%**	**0.30%**	**0.45%**	**0.33%**	**0.05%**
t=2	0.31%	0.05%	0.03%	-0.05%	-0.03%
Cumulative t=1-2	-0.85%	0.35%	0.47%	0.28%	0.02%
Nikkei-225 NI225	**Nuclear**	1	2	3	4
t=0	-0.42%	0.05%	0.49%	0.14%	0.15%
t=1	**-1.29%**	**0.09%**	**0.44%**	**0.78%**	**0.24%**
t=2	0.12%	0.40%	-0.30%	-1.23%	0.50%
Cumulative t=1-2	-1.17%	0.49%	0.13%	-0.47%	0.74%
Average %Change (Failure)	0	10	2	4	0
Kospi-200 KS200	**Nuclear**	1	2	3	4
t=0		-0.17%	-0.26%	0.71%	
t=1		**-0.08%**	**-0.72%**	**-0.17%**	
t=2		-0.09%	0.35%	0.47%	
Cumulative t=1-2		-0.17%	-0.37%	0.30%	
Nikkei-225 NI225	**Nuclear**	1	2	3	4
t=0		-0.43%	-1.36%	0.41%	
t=1		**-0.58%**	**-1.88%**	**0.35%**	
t=2		-0.15%	1.51%	0.81%	
Cumulative t=1-2		-0.72%	-0.40%	1.16%	

Note. The nuclear test is the most extreme test of the Kim Jong-Un regime. For the missile test, category 1 (Intermediate Range) is the most extreme category and category 4 (Short Range) the least. All the nuclear tests and category 4 tests have been tested successfully, explaining why there are no results for these categories in the *Failure* table.

The results of the East Asian market level effect are seen in table 3. Looking at the 'Average %Change (all)' section, there is a noticeable effect on the stock market the day after a nuclear test. The day after a nuclear test has occurred, the South Korean stock market (Kospi-index) changes on average with a -1.15% and the Japanese stock market (Nikkei-index) with a -1.29%. Next to that, the two-days-effect for these markets is also a noticeable one. Respectively, two days after a North Korean nuclear test has occurred the Kospi and Nikkei-indices have declined with 0.85% and 1.17%.

This drop is in line with the results from Eldor & Melnick (2004) and Fisman, Hamao & Wang (2014). Geopolitical risks, like North Korean nuclear threats, have negative effects on national economies and the stock markets of the countries close to North Korea. This is seen by the daily percentage drop of the Kospi-200 and Nikkei-225 indices, which are good indicators for the South Korean and Japanese economy, after a North Korean nuclear test took place (Eldor & Melnick, 2004). The nuclear tests carried out by North Korea, increase the animosity between the nations close to them and the nations around the world (the USA for example), resulting in adverse negative shocks in North-South Korea and North Korea-Japan relations. As seen in the daily percentage drop after a nuclear test has occurred, this increased animosity between the nations has a negative impact on the economic exchange of both Japan and South Korea (Fisman, Hamao & Wang, 2014).

However, this noticeable effect weakens when the test intensity falls from nuclear to category 1 missiles. The day after a category 1 missile test has occurred, the South Korean stock market (Kospi-index) changes on average with a 0.06% and the Japanese stock market (Nikkei-index) with a -0.30%. Next to that, the two-days-effect for these markets is even weaker: respectively, two days after a North Korean nuclear test has occurred the Kospi and Nikkei-indices have changed with 0.03% and -0.17%.

For the impact of a category 1 missile test, it can be concluded that there is no effect on the Korean stock market, as the results are close to 0.0%. This is in line with the results of Kim (2011), stating that there is no significant relationship between the Korean stock market and changes in the North-South Korea relations.

On the other hand, it can be concluded that the occurrence of a category 1 missile test has a negative effect on the Japanese stock market, as the market on average drops with 0.30% the day after the test. Moreover, there is an average decline of 0.17% two days after the test. It can be concluded that a North Korean category 1 missile test has a relatively small negative impact on the Japanese stock market.

Looking at the 'Average % Change (Success and Failure)' section in table 3, it can be concluded that this average decline of 0.30% is primarily caused by the failed category 1 missile tests. It is remarkable the Nikkei-225 index changes on average with a 0.09% the day after a successful category 1 missile test but drops on average with a 0.58% the day after a failed test. This is because a successful test means that North

Korea is becoming closer to their goal of becoming a nuclear power, while a failed test means that they still have a long way to go. A possible explanation for this can be found by looking more specificically at the details of category 1 missile tests (NTI, 2018). The facility location of this type of test is mostly the Wonsan Kalma International Airport in the Kangwon Province or the Sinpo Shipyard in the South Hamgyong province, both laying west of the Japanese Sea/East Sea (see Appendix E1). Therefore, the landing location of the failed missile 1 tests is mainly the Japanese Sea/East Sea, which can potentially explain the remarkable -0.58% change of the Nikkei-225 index the day after a failed missile 1 test. As a result, it can be concluded that the average 0.30% drop in the Japanese stock market is primarily caused by failed category 1 missile tests, landing in the Japanese Sea.

Lastly, looking at the average daily changes after a category 2, 3 or 4 test has occurred, it can be concluded that these tests also have almost no impact (close to 0%) on the Korean stock market. The South Korean stock market (Kospi-index) changes on average with a 0.11% (category 2), 0.08% (category 3) or 0.05% (category 4) the day after a missile test of these categories has occurred. Next to that, the noticeable drops of the Korean stock market a day after a failed category 2 or 3 missile test (0.72% and 0.17%), cannot be interpreted as the number of events (*n*) is only 2 to 4, causing volatile and biased results. As the same for the category 1 results, these results are in line with the findings of Kim (2011), stating that there is no significant relationship between the Korean stock market and changes in the North-South Korea relations. The impact of North Korean missile threats on the Korean economy is negligible (Pyun & Huh, 2014).
For the Japanese stock market, the same conclusions can be made about the category 2, 3 and 4 tests: the tests have almost no interesting impact on the Japanese market, as they are all close to zero or slightly positive. The Japanese stock market (Nikkei-index) changes on average with a 0.10% (category 2), 0.59% (category 3) or 0.24% (category 4) the day after a missile test of these categories has occurred. Similarly to the Korean results, the noticeable changes of the Japanese stock market a day after a failed or successful category 2 or 3 missile test, cannot be interpreted because the number of events (*n)* is only 2 to 6, causing volatile and biased results influenced by outliers.

In summary, there are significant effects for the Korean and Japanese stock market in the event window of a North Korean nuclear test (**H_{1K}** and **H_{1N}**). Geopolitical risks, like North Korean nuclear threats, have negative effects on national economies and the stock markets of the countries close to North Korea (Eldor & Melnick 2004; Fisman, Hamao & Wang 2014). The day after a nuclear test has occurred, the South Korean stock market (Kospi-200 index) changes on average with a -1.15% and the Japanese stock market (Nikkei-225 index) with a -1.29%. Hence, hypotheses **H_{1K}** and **H_{1N}** are not rejected for the nuclear test category.

However, hypothesis **H_{1K}** for the missile test categories 1, 2, 3 and 4 should be rejected. The South Korean stock market (Kospi-200 index) changes on average with a 0.06% (category 1), 0.11% (category 2), 0.08% (category 3) or 0.05% (category 4) the day after a missile test of these categories has occurred. It can be concluded that there are no significant effects (close to 0%) for the Korean stock market in the event window of a North Korean missile test (**H_{1K}**). This is in line with the results of Kim (2011), stating that there is almost no significant relationship between the Korean stock market and changes in the North-South Korea relations because of North Korean missile tests.

The same rejection applies to hypothesis **H_{1N}** for the missile test categories 2, 3 and 4. The Japanese stock market (Nikkei-index) changes on average with a 0.10% (category 2), 0.26% (category 3, two days-effect) or 0.24% (category 4) the day after a missile test of these categories has occurred. As these results are close to 0% it can be concluded that there are almost no significant effects for the Japanese stock market in the event window of a North Korean missile test (**H_{1N}**). **H_{1N}** cannot be rejected for category 1 missile tests, as the market drops on average with a 0.30% the day after the test. However, it must be mentioned that this drop is influenced by failed category 1 missiles landing in the Japanese Sea.

Furthermore, higher intensity of the North Korean tests contributes to higher significant effects for the Korean and Japanese stock markets (**H_{2K}** and **H_{2N}**). The average %change the day after a missile test has occurred for the Kospi-200 and Nikkei-225 indices are respectively 0.08% and 0.16%, while the average %change the day after a nuclear test has occurred is respectively -1.15% and -1.29%. In line with the results of Eldor & Melnick (2004), it can be concluded that intensity matters. The intensity change from a missile test to a nuclear test contributes to higher significant effects for the Korean and Japanese stock markets. Hence, hypotheses **H_{2K}** and **H_{2N}** are not rejected if the intensity changes from a missile to a nuclear test.

For the intensity change in missile categories, e.g. an intensity change from a category 3 to a category 2 or 1, no clear conclusions can be made for both markets as the results are all close to 0% or influenced by outliers. The value effect of the change in intensity of missile tests should be further investigated on a company level.

The small/no significant effects of missile tests on the Korean and Japanese stock market could be evidence of the so-called learning effect, where investors would have learned the "false-alarm effects" of North Korean threats and risks (Nam 2004; Pak et al., 2015). This learning effect of the investors could be in line with the unfazed behavior of the Korean Citizens, not being afraid of a Korean war and seeing the missile threats from the Kim Jong-Un regime as "just a threat" (Vox, 2017). To further investigate this threat, nuclear and missile category 1 and 2 threats will be investigated on a company level approach.

5.2 Results company level

The results of the company level approach will be mainly focused on the calculated abnormal returns by the mean adjusted return model (MAR-model). Brown and Warner (1980; 1985) have concluded that this approach is at least as powerful and often more powerful than a market adjusted approach such as the market model. This conclusion should be even stronger in the case of daily returns as used in this event study (Masulis, 1980). The results of the market model (MM-model) will be shown in the appendix.

Table 4

(Cumulated) Abnormal Returns for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Nuclear

Panel A - Abnormal Returns (Mean Adjusted Returns model) - Category Nuclear							
	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
Before-event CAR (-5,…,-1)	0.62%	0,037	(3.101)	***	-0.38%	0,041	(-1.683)	**
On-event CAR (0,1)	-1.84%	0,021	(-17.085)	***	-1.40%	0,029	(-8.516)	***
After-event CAR (2,…,+5)	-0.37%	0,027	(-2.578)	**	-0.35%	0,037	(-1.635)	**
Short total-event CAR (-1,…,+1)	-1.65%	0,027	(-11.140)	***	-1.36%	0,035	(-6.787)	***
Medium total event CAR (-3,…,+3)	-1.46%	0,049	(-5,524)	***	-2.42%	0,053	(-7.934)	***
Total-event CAR(-5,…,+5)	-1.58%	0,056	(-5.176)	***	-2.13%	0,066	(-5.677)	***

Note. CAR = cumulative abnormal return, calculated with the MAR-model for the selected companies using different event windows. St. Dev. = standard deviation, ***, ** and * indicate the significance at 1%, 5% and 10% level respectively.

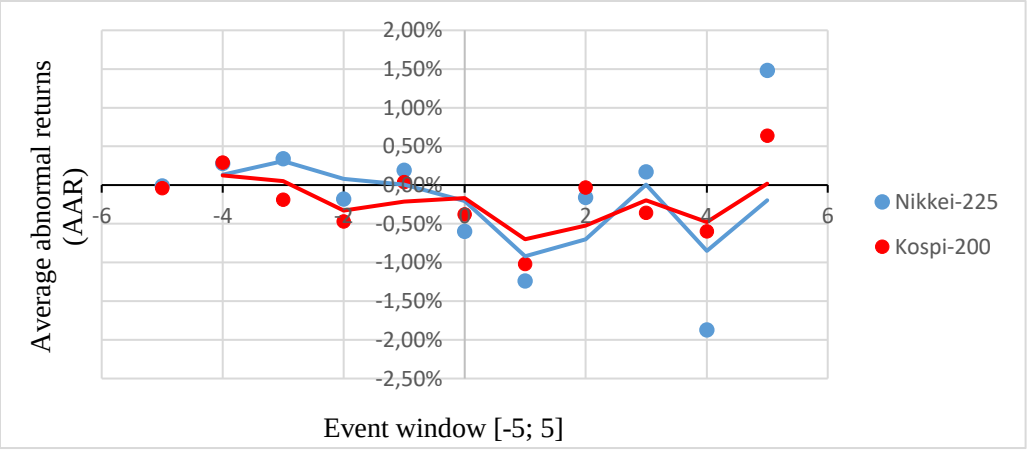

Figure 3. Average Abnormal Returns (AAR), for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Nuclear, event window [-5; 5]

The results of the potential cumulated abnormal returns calculated with the MAR-model for the East Asian (Japanese and South Korean) companies are provided in table 4 and are all significant (1 or 5%). The before-event CAR for the Nikkei-225 companies gives a positive reaction of 0.62% before the nuclear test event date. However, the before-event CAR for the Kospi-200 companies gives a negative reaction of 0.38% before the nuclear test event date. As mentioned, geoscientist are usually capable of predicting that a nuclear test is going to happen (BGR, 2016) and that this news is usually published or broadcasted by the national media. I myself experienced this in Seoul in the days before North Korea's 6th nuclear test.
Looking at figure 3, in the three days before the nuclear event, negative AARs are given, causing the before-event CAR of -0.38%. A possible explanation for this negative reaction could be that the investors' behavior was negatively influenced by the news about a potential nuclear test, which is in line with the results of Ahn et al (2010) stating that negative news regarding North-South Korea relations would increase the "Korea discount". However, this conclusion does not apply to the behavior of investors in the Japanese market, as the Nikkei-225 companies give a positive reaction of 0.62% before the nuclear test event date. Therefore, one can conclude that the negative news has no influence on the investors in the Japanese market.

Respectively, for the Nikkei-225 and Kospi-200 companies, the on event CAR shows negative returns of 1.84% and 1.40% (table 4). This is comparable with the drop of the main-indices the day after a nuclear test has occurred: Nikkei-index -1.29%, Kospi-index -1.15%. These results are in line with the results of Fisman, Hamao & Wang (2014) stating that the increased animosity between nations (North-South Korea relations and North Korea-Japan relations) has a negative impact on the economy exchanges of both nations.
The fact that the drops on company level are slightly more negative than the drops on index level can be explained by Ahn et al. (2010), showing that the stock prices of Korean firms related to the arms industry or North Korea showed an extra negative relationship with negative news about North-South relations. The companies chosen in this study followed the same clusters used by Ahn et al (2010). These were clusters that had something to do with war, political events and North Korea relations, which explains the greater negative impact as seen in the results.
Also, the after-event CAR, 2 to 5 days after a nuclear event has occurred, shows negative cumulated abnormal returns of 0.37% (Nikkei) and 0.35% (Kospi). This results in a medium total-event CAR(-3,+3) of -1.46% (Nikkei) and -2.42% (Kospi) and a total-event CAR(-5,+5) of -1.58% (Nikkei) and -2.13% (Kospi). Concluding, there are significant negative cumulated abnormal returns for the Nikkei-225 and Kospi-200 companies in the event window of a North Korean nuclear test. Hence, hypotheses $\mathbf{H_{1K}}$ and $\mathbf{H_{1N}}$ are not rejected for the nuclear test category.

The average cumulated abnormal returns ((medium) total-event CAR) of the Korean companies is more negative than that of the Japanese companies (-2.42% < -1.46% and -2.13% < -1.58%). The nuclear test of North Korea, therefore, has a greater significant negative impact on the Korean market companies than on the Japanese. This can be explained by looking at the market conditions of both East Asian markets.

As mentioned, the Nikkei-225 index, as a good indicator for the Japanese economy, is one of the largest and therefore most important stock exchange in Asia and the third/fourth largest stock exchange in the world. The value of the Nikkei-225 index is around 22.000 Japanese Yen (1000 JPY = 9.00 USD)[3] and the average market volume of the last three months is 758.347.366. The Kospi-200 index, as a good indicator of the Korean economy, is the only securities exchange operator in South Korea. The value of the Kospi-200 index is around 310 Korean Won (1000 KRW = 0.89 USD) and the average market volume of the last three months is 105.544.014. Looking at these characteristics of both stock markets, it can be concluded that the Nikkei-225 index is relatively way bigger and more liquid than the Kospi-200 index.

In their research on the effects of terrorism on global capital markets, Chen & Siems (2004) conclude that the capital markets of the United States are more resilient than in the past. Therefore, they recover sooner from terrorist attacks (like 9/11) than other global capital markets. A reason for this increased market resilience can be explained to a certain degree by a stable banking and financial sector that provides adequate liquidity to promote market stability and minimize panic (Chen & Siems, 2004). Furthermore, they found that the global stock market of South Korea needed 61 days to rebound from the September 11the terrorist attacks (09/11/2001). In contrast, to return to pre-attack level after 9/11 the Japanese (Tokyo) market index needed 14 days.

In summary, the capital market of Japan is more resilient than the one in South Korea, as they have recovered sooner from terrorist attacks like 9/11 (Chen & Siems, 2004). Looking at the current characteristics of the Nikkei-225 and the Kospi-200 indices and the findings of Chen & Siems (2004), it can be concluded that the Nikkei-225 index provides more adequate liquidity than the Kospi-200 index. Therefore, the information about a North Korean nuclear event is processed more efficiently, that is immediately and completely, by the Nikkei-225 index compared to the Kospi-200 index (Van Der Sar, 2015). This can potentially explain why the nuclear test of North Korea has a greater significant impact on the Korean market companies (-2.13%) than on the Japanese market companies (-1.58%).

Lastly, as stated by Eldor & Melnick (2004), the most extreme type of terror attacks have the potential to result in a permanent negative effect on the stock market. Other types of attacks, like terror attacks on transport, do not, as they only have a transitory negative effect on the stock market (Eldor & Melnick, 2004).

[3] Exchange rate 7/25/2018 https://www.xe.com/currencyconverter/convert/?Amount=1&From=USD&To=JPY

The North Korean threat with the highest intensity is the nuclear test. The question is, does the initial panic caused by a nuclear test have the potential to turn into chaos and a stock market failing for a prolonged period of time (a so-called long-term bear market), or can it be reversed if investors' hopes return, proving a market overreaction (Chen & Siems, 2004)?

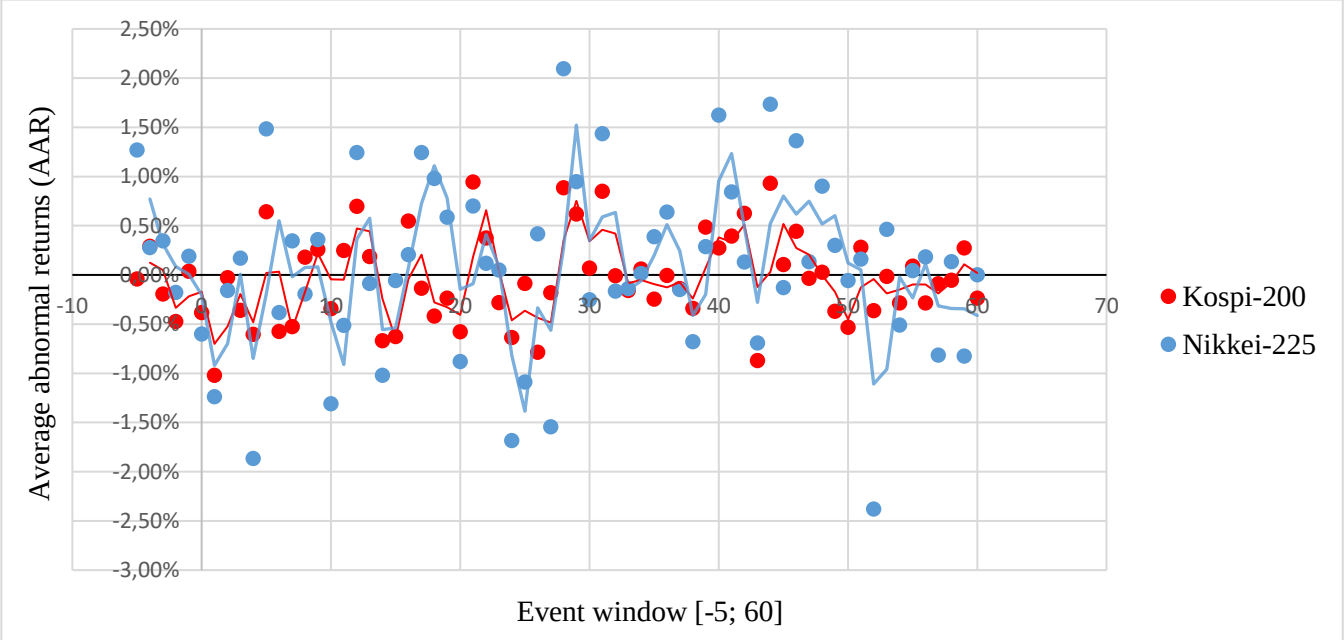

Figure 4. Average Abnormal Returns (AAR), for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Nuclear, event window [-5; 60], overreaction test

As seen in figure 4, the nuclear test of the Kim Jong-Un regime does not have the potential to result in a permanent negative effect on the companies from both the Korean and Japanese stock market indices. Looking at the moving average trendline in figure 4, it is seen that the line of both indices moves in similar directions. The first 7 days after a nuclear event, negative average abnormal returns are seen followed by a period of positive average abnormal returns. From day 15 to day 45 after the event a random walk is seen with outliers in both directions. Finally, from day 45 to 60 after the event tend to move around the x-as (meaning no average abnormal returns) with for the Nikkei-225 trendline two outliers. This means that both East Asian markets have recovered from the nuclear threats. To conclude, a market overreaction to "bad news" (occurrence of a North Korean nuclear event) with reversion by both the Kospi-200 as the Nikkei-225 companies is seen in figure 4. Both the Kospi-200 as the Nikkei-225 markets long-run reaction is consistent with market efficiency (Tetlock, 2007). The panic caused by a North Korean nuclear test does not have the potential to turn into chaos and a stock market failing for a prolonged period of time (Chen & Siems, 2004). Investors' hopes return and the nuclear threats from the Kim Jong-Un regime only have a transitory effect on the East Asian economy.

Table 5

(Cumulated) Abnormal Returns for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Category 1

Panel A - Abnormal Returns (Mean Adjusted Returns model) - Category 1

	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
Before-event CAR (-5,…,-1)	1.68%	0,049	(12.728)	***	0.40%	0,043	(3.304)	***
On-event CAR (0,1)	-0.22%	0,025	(-3.242)	***	-0.22%	0,025	(-3.186)	***
After-event CAR (+2,…,+5)	0.13%	0,041	(1.2326)		-0.80%	0,039	(-7.351)	***
Short total-event CAR (-1,…,+1)	0.17%	0,030	(2.071)	**	-0.01%	0,032	(-0.185)	
Medium total-event CAR (-3,…,+3)	0.17%	0,056	(1.140)		-0.14%	0,051	(-0.970)	
Total-event CAR(-5,…,+5)	1.56%	0,069	(8.433)	***	-0.62%	0,069	(-3.188)	***

Note. CAR = cumulative abnormal return, calculated with the MAR-model for the selected companies using different event windows. St. Dev. = standard deviation, ***, ** and * indicate the significance at 1%, 5% and 10% level respectively.

The results of the potential cumulated abnormal returns in the event window of a category 1 missile test, calculated with the MAR-model for the East Asian (Japanese and South Korean) companies, are provided in table 5. The before-event CAR for both Japanese and Korean companies gives a significant positive value of, respectively, 1.68% and 0.40%. This means that the pre-event days of a category 1 missile test do not negatively influence the returns of the Korean and Japanese companies. However, the on-event CAR shows a negative value of 0.22% for both types of companies. This means that there are small significant negative cumulated abnormal returns for both Nikkei-225 as Kospi-200 companies right after the occurrence of a category 1 missile test.

However, for the Japanese companies, the after-event and medium total-event CAR results are not significant. The total-event CAR (1.56%) is significant, however, this is influenced by the significant before-event CAR (1.68%), as there is no significant after-event CAR. So, for the category 1 missile test, despite the small on-event CAR of -0.22%, no clear conclusion can be made about (negative) effects. This is confirmed by the market-model results, seen in appendix F1 table 15. All the calculated CARs by the MM-model are insignificant, except for the before-event CAR and the medium total event CAR. However, these CARs are close to 0%, respectively 0.19% and 0.21%, confirming that no clear conclusions can be made. Hence, $\mathbf{H_{1N}}$ is rejected: there are no significant (negative) cumulated returns for the Nikkei-225 companies in the event window of a North Korean category 1 missile test.

By way of contrast, clear conclusions can be made about the Kospi-200 companies. The on-event CAR shows a negative value of 0.22% and the after-event CAR a negative value of 0.80%. The after-event CAR calculated by the MM-model is also significant and negative (-0.30%), as seen in appendix F1 table 15. Together the on-event and after-event CARs, calculated by the MAR-model), lead to a total-event CAR(-

5,+5) of -0.62%. Concluding, there are significant (negative) cumulated abnormal returns for the Kospi-200 companies in the event window of a North Korean nuclear test. Hence, hypotheses $\mathbf{H_{1K}}$ is not rejected for the category 1 missile test.

Table 6

(Cumulated) Abnormal Returns for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Category 2

Panel A - Abnormal Returns (Mean Adjusted Returns model) - Category 2

	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
Before-event CAR (-5,…,-1)	1.49%	0,058	(6.720)	***	0.82%	0,047	(4.350)	***
On-event CAR (0,1)	-0.44%	0,027	(-4.332)	***	0.45%	0,024	(4.596)	***
After-event CAR (2,…,+5)	0.52%	0,036	(3.811)	***	0.31%	0,039	(1.982)	**
Short total-event CAR (-1,…,+1)	-0.19%	0,033	(-1.496)	*	0.88%	0,031	(7.211)	***
Medium total-event CAR (-3,…,+3)	0.58%	0,051	(3.059)	***	1.44%	0,051	(7.099)	***
Total-event CAR(-5,…,+5)	1.57%	0,070	(5.870)	***	1.58%	0,067	(5.856)	***

Note. CAR = cumulative abnormal return, calculated with the MAR-model for the selected companies using different event windows. St. Dev. = standard deviation, ***, ** and * indicate the significance at 1%, 5% and 10% level respectively.

The results of the potential cumulated abnormal returns in the event window of a category 2 missile test, calculated with the MAR-model for the East Asian (Japanese and South Korean) companies are provided in table 6. The before-event CAR for both Japanese as Korean companies gives a significant positive value (respectively, 1.49% and 0.82%). This means that the days before the occurrence of a category 1 missile test do not negatively influence the returns of the Korean and Japanese companies.

When looking at the results of the Japanese companies, it is seen that the significant negative on-event CAR value (-0.44%) is followed by a significant positive after-event CAR value (0.52%). This is seen more precisely in appendix F1 table 16, looking at the AARs calculated by the MAR-model: on the day of and after the event, the AAR is -0.1% and -0.3%, while the AAR is 0.5% two days after the event. This is in line with the findings of Nam (2004), who stated that in the event window of negative North Korean news (like a missile test), the market would drop, followed by a quick recovery. The reaction of the Japanese companies in the event of a category 2 missile test could be evidence of the so-called learning effect, where investors would have learned the "false-alarm effects" of North Korean threats and risks (Nam 2004).

The total-event CAR(-5,+5) of the Japanese companies is 1.57%. To conclude, there are small negative cumulated abnormal returns for the Japanese companies in the on-event window of a category 2 missile test. However, these negative returns are immediately followed by positive cumulated abnormal returns in the after-event window. As the total-event CAR is relatively large and positive, no clear conclusions about

the negative effects can be made. This is confirmed by the market-model results, seen in appendix F1 table 16, as all the calculated CARs by the MM-model are insignificant. Hence, $\mathbf{H_{1N}}$ is rejected: there are positive significant cumulated returns for the Nikkei-225 companies in the event window of a North Korean category 2 missile test.

Looking at the results of the Korean companies, it is seen that all the calculated cumulated abnormal returns are positive and significant. The category 2 missile test of the North Korean regime doesn't negatively influence the stock prices of the Kospi-200 companies. This is in line with the main index results, as the Kospi-index changes on average with 0.22% two days after a category 2 missile test has occurred (see table 3). The occurrence of a North Korean category 2 missile test has not a negative but a positive effect on the returns of the companies. Hence, $\mathbf{H_{1K}}$ is rejected: there are positive significant cumulated returns for the Kospi-200 companies in the event window of a North Korean category 2 missile test.

In summary, for the effect of the category 1 missile tests on the Japanese companies, no clear conclusions can be made. There are no significant (negative) cumulated returns for the Nikkei-225 companies in the event window of a North Korean category 1 missile test. By way of contrast, clear conclusions can be made about the effect of category 1 missile test on the South Korean companies. There are significant (negative) cumulated abnormal returns for the Kospi-200 companies in the event window of a North Korean category 1 missile test. The total-event CAR for the Nikkei-225 companies is 1.56%, while the one for the Kospi-200 companies -0.62% is. Thus, the same conclusion of Chen & Siems (2004) about the market conditions of the Japanese and Korean stock markets can be applied to explain this difference: the capital market of Japan provides more adequate liquidity than the one of South Korea and is, therefore, more resilient. Therefore, the information about a North Korean missile category 1 test is processed more efficiently, by the Nikkei-225 index than the Kospi-200 index. In addition, Arin et al. (2008) found that the effect of terrorism has a significant impact on both stock prices and stock volatility. The magnitude of these effects is exaggerated in emerging markets compared to the Western European market (Arin et al., 2008). Because South Korea is classified as an emerging market and Japan as a developed market, the differences in effect are in line with the results of Arin et al. (2008). This suggests that financial investors in Japan are more resilient to North Korean events.

The process of efficient processing of information about a North Korean missile test, is also seen by the Nikkei-225 companies for the category 2 tests. The significant negative on-event CAR value (-0.44%) is immediately followed by a significant positive after-event CAR value (0.52%), showing that the Japanese market is resilient and processes information about a North Korean missile test efficiently, that is immediately and completely. For the remainder category 2 results (both Korean and Japanese), only significant positive cumulated abnormal returns were found in the event window of a North Korean

category 2 missile test. This means that these type of missile tests do not negatively affect the returns of the East Asian companies.

Finally, regarding the second company level hypotheses, higher intensity of the North Korean tests contributes to higher negative cumulated abnormal returns for the Korean companies. The total-event CAR(-5,+5) for the nuclear, category 1 and category 2 missile tests, are respectively -2.13%, -0.62% and 1.58%. In line with the results of Eldor & Melnick (2004), it can be concluded that intensity matters. The intensity change from a missile category 2 test to a missile category 1 test or an intensity change from a missile test to a nuclear test contribute to higher/more negative cumulated abnormal returns for the Kospi-200 companies. Hence, hypothesis $\mathbf{H_{2K}}$ is not rejected.

For the Japanese companies, the total-event CAR(-5,+5) for the nuclear, category 1 and category 2 missile tests, are respectively -1.58%, 1.56%, and 1.57%. If the intensity of a test change from a missile test to a nuclear test, the direction of the coefficient changes. This is in line with the results of Eldor & Melnick (2004), as it can be concluded that intensity matters. If the intensity changes from a missile test to a nuclear test, hypothesis $\mathbf{H_{2N}}$ is not rejected, as the positive cumulated abnormal returns of the Nikkei-225 companies in the event window of a North Korean threat become negative. Hence, hypothesis $\mathbf{H_{2N}}$ is not rejected if the intensity changes from a category 2 missile to a category 1 missile test, because there are no differences in total-event CARs(-5,+5).

6. Conclusion and Discussion

For the East Asian economy, this research tried to further explore the effect on the stock returns and stock markets resulting from the nuclear and missile threat events from the Kim Jong-Un regime. Currently, under his command, 100 tests have been carried out. Firstly, a summary of the main findings will be given. Secondly, an answer on the research question – *What are the (value) effects of the nuclear and missile threats from the Kim Jong-Un regime on the East Asian stock market and East Asia's biggest companies?* – will be given. Finally, the limitations of the research, suggestions for further research and implications for theory and practice will be mentioned.

- Market level results

There are significant negative effects for the Korean and Japanese stock market in the event window of a North Korean nuclear test. Geopolitical risks, like North Korean nuclear threats, have negative effects on national economies and the stock markets of the countries close to North Korea (Eldor & Melnick 2004; Fisman, Hamao & Wang 2014). The day after a nuclear test has occurred, the South Korean stock market (Kospi-200 index) changes on average with a -1.15% and the Japanese stock market (Nikkei-225 index) with a -1.29%.

However, these significant negative effects for the Korean and Japanese stock market are not founded in the event window of a North Korean missile test. The South Korean stock market (Kospi-200 index) changes on average with a 0.06% (category 1), 0.11% (category 2), 0.08% (category 3) or 0.05% (category 4) the day after a missile test of these categories has occurred. The Japanese stock market (Nikkei-index) changes on average with a -0.17% (category 1, two days-effect), 0.10% (category 2), 0.26% (category 3, two days-effect) or 0.24% (category 4) after a missile test of these categories has occurred.

No significant (negative) effect are in line with the results of Kim (2011) and Pyun & Huh (2014), respectively stating that that there is no significant relationship between the Korean stock market and changes in the North-South Korea relations (Kim, 2011) and that the impact of North Korean threats and risks on the Korean economy is relatively negligible (Pyun & Huh, 2014). The small/no significant effects of missile tests on the Korean and Japanese stock market could be evidence of the so-called learning effect, where investors would have learned the "false-alarm effects" of North Korean threats and risks (Nam 2004; Pak et al., 2015). This learning effect of the investors could be in line with the unfazed behavior of the Korean Citizens, not being afraid of a Korean war and seeing the missile threats from the Kim Jong-Un regime as "just a threat" (Vox, 2017)

- Company level results

Firstly, there are significant negative cumulated abnormal returns for the Nikkei-225 and Kospi-200 companies in the event window of a North Korean nuclear test. Respectively, for the Nikkei-225 and Kospi-

200 companies, the on event CAR shows negative returns of 1.84% and 1.40% (table 4), which is comparable with the drop of the main-indices the day after a nuclear test has occurred: Nikkei-index -1.29%, Kospi-index -1.15%. These results are in line with the results of Fisman, Hamao & Wang (2014) stating that the increased animosity between nations (North-South Korea relations and North Korea-Japan relations) has a negative impact on the economy exchanges of both nations.

The average cumulated abnormal returns ((medium) total-event CAR) of the Korean companies is more negative than that of the Japanese companies (-2.42% < -1.46% and -2.13% < -1.58%). The nuclear test of North Korea, therefore, has a greater significant negative impact on the Korean market companies than on the Japanese. This can be explained by looking at the market conditions of both East Asian markets. The Japanese stock market is more resilient than the one in South Korea. The Nikkei-225 index provides more adequate liquidity than the Kospi-200 index and can, therefore, process information about a North Korean nuclear event more efficiently, that is immediately and completely (Chen & Siems, 2004; Van Der Sar, 2015).

The nuclear test of the Kim Jong-Un regime does not have the potential to result in a permanent negative effect on the companies from both the Korean and Japanese stock market indices. The panic caused by a North Korean nuclear test does not have the potential to turn into chaos and a stock market failing for a prolonged period of time (Chen & Siems, 2004). A market overreaction to "bad news" (occurrence of a North Korean nuclear event) is followed with reversion by both the Kospi-200 as the Nikkei-225 companies. Investors' hopes return and the nuclear threats from the Kim Jong-Un regime only have a transitory effect on the East Asian economy. This is further explained by Fama (1970) and Shefrin (2001): long-term prices are efficient, while inefficient prices, influenced by behavioral finance, only exist in the short term. Inefficient short-term prices will disappear by adjustments of the market.

In addition, for the effect of the category 1 missile tests on the Japanese companies, no clear conclusions can be made. There are no significant (negative) cumulated returns for the Nikkei-225 companies in the event window of a North Korean category 1 missile test. By way of contrast, clear conclusions can be made about the effect of category 1 missile test on the Kospi-200 companies. There are significant (negative) cumulated abnormal returns for the Kospi-200 companies in the event window of a North Korean category 1 missile test. The total-event CAR for the Nikkei-225 companies is 1.56%, while the one for the Kospi-200 companies -0.62% is. This difference can again be explained by the differences in the market conditions of the Nikkei-225 and Kospi-200 indices, as the Japanese stock market is more resilient (Chen & Siems, 2004).

Furthermore, the process of efficient processing of information about a North Korean missile test, is also seen by the Nikkei-225 companies for the category 2 tests. The significant negative on-event CAR value (-

0.44%) is immediately followed by a significant positive after-event CAR value (0.52%), showing that the Japanese market is resilient and processes information about a North Korean missile test efficiently, that is immediately and completely. Similar findings were found by Nam (2004), who showed that in the event window of negative North Korean news, stock indices would drop sharply, followed by a quick recovery. This, and the results of the Japanese market (category 2 level) could be evidence of the so-called learning effect, meaning that investors would have learned the "false-alarm effects" of North Korean threats and risks (Nam 2004; Pak et al., 2015).

For the remainder category 2 results (both Korean and Japanese), only significant positive cumulated abnormal returns were found in the event window of a North Korean category 2 missile test. This means that these type of missile tests do not negatively affect the returns of the East Asian companies.

Finally, higher intensity of the North Korean missile tests contributes to higher negative cumulated abnormal returns for the Korean companies. The total-event CAR(-5,+5) for the nuclear, category 1 and category 2 missile tests, are respectively -2.13%, -0.62% and 1.58%. In line with the results of Eldor & Melnick (2004), it can be concluded that intensity matters. The intensity change from a missile category 2 test to a missile category 1 test or an intensity change from a missile test to a nuclear test contribute to higher/more negative cumulated abnormal returns for the Kospi-200 companies.

For the Japanese companies, the total-event CAR(-5,+5) for the nuclear, category 1 and category 2 missile tests, are respectively -1.58%, 1.56%, and 1.57%. If the intensity of a test change from a missile test to a nuclear test, the direction of the coefficient changes. This is in line with the results of Eldor & Melnick (2004), as it can be concluded that intensity matters. The difference matters fIf the intensity changes from a missile test to a nuclear test, as the positive cumulated abnormal returns of the Nikkei-225 companies in the event window of a North Korean threat become negative. However, it does not matter if the intensity changes from a category 2 missile to a category 1 missile test, because there are no differences in total-event CARs(-5,+5).

The effect of this on the research question now needs to be considered. It is the conclusion of this research that the nuclear threats from the Kim Jong-Un regime have negative value effects on the Japanese stock market (Nikkei-225) and the South Korean stock market (Kospi-200), as they both drop more than 1% the day after a nuclear test has occurred. However, the missile threats from the Kim Jong-Un regime have no significant negative effect on the East Asian stock markets, which could be evidence of the so-called learning effect, where investors would have learned the "false-alarm effects" of North Korean threats and risks. In line with the market results, there are significant negative cumulated abnormal returns for the Nikkei-225 and Kospi-200 companies in the event window of a North Korean nuclear test. This can be seen as a market overreaction to bad news about North Korea, as the nuclear test does not have the potential to

result in a permanent negative effect. The cumulated abnormal returns of the Korean companies are more negative than that of the Japanese companies because the Japanese stock market is more resilient than the one in South Korea. Despite the fact that there are significant (negative) cumulated abnormal returns for the Kospi-200 companies in the event window of a North Korean missile 1 test, no significant conclusions can be made about the negative effect of the missile threats (category 1, 2, 3 and 4) on the Japanese and South Korean companies.

This research has several limitations. For example, the limitations of overlapping events, as seen in Appendix B1. The launch date of missile test category 1 #51 is in the in estimation period of the 6th Nuclear test, influencing the results. Next to that, only North Korean threat events have been analyzed. There are also other events that could have affected the results, like the 'Fire and Fury' quote from Donald Trump or an announcement of extra economic sanctions for North Korea. Further research could use control variables of these events. The "Korea Discount" described in the literature review (section 2), is influenced by negative news and positive news. This research has only looked at negative events, searching for negative results. However, it would be interesting for further research to look at positive events (like the recent Korean summit), searching for positive results and returns.

Another limitation of this study is company clustering. Samsung Electronics Co. LTD., with a market capitalization exceeding USD 200 billion, accounts for 25% of the Kospi-200 index weight. Further research could remove this company for less influenced results, or could focus purely on Samsung. Also, interesting future research would be an industry-specific approach. Furthermore, the companies used in this research were only publicly traded firms. Unlisted firms, the majority in especially Japan and South Korea, would likely be affected by the North Korean events that are considered here. Future research on the impact on unlisted firms is important, to fully understand the effect of North-South Korea relations. This is, however most likely unachievable due to data limitations.

In addition, also the timing of the tests could have been a problem. The launch time of tests were completely random (4 randomly chosen launch times from Appendix B1: 20:40:00, 0:40:00, 14:42:00, 21:49:00). Because of this, and missile tests happening in the weekend (no trading days), made it difficult to define t=0, resulting in some incomplete results.

Finally, it would be interesting to look at other results, like trading volume, or the trading in safer financial instruments (like gold), as this research only focuses on stock indices and stock prices.

Regarding implications for theory and practice, further monitoring of the development of the Kim Jung-Un regime and the (negative) value effect on the East Asian economy and companies could be beneficial to both. However, personally, I think research on the good news and positive effects of the North-South Korea

relations is more interesting and accurate at the moment. Since November the 27th of 2017 no test has been conducted by the Kim Jong-Un regime in 2018. In contrast, over 20 have been conducted in 2017. Next to that, a lot of events took place in 2018 with the goal of unification. Events like the thraw at the Olympic Winter Games, the first 2018 Inter-Korean Summit and the restored military communication line of South and North Korea on the western part of the peninsula. Therefore, I think it is interesting to research the value effect of these positive North-South Korea relations events. Not only knowing what it means for world peace and unification, but also for the East Asian and global economy.

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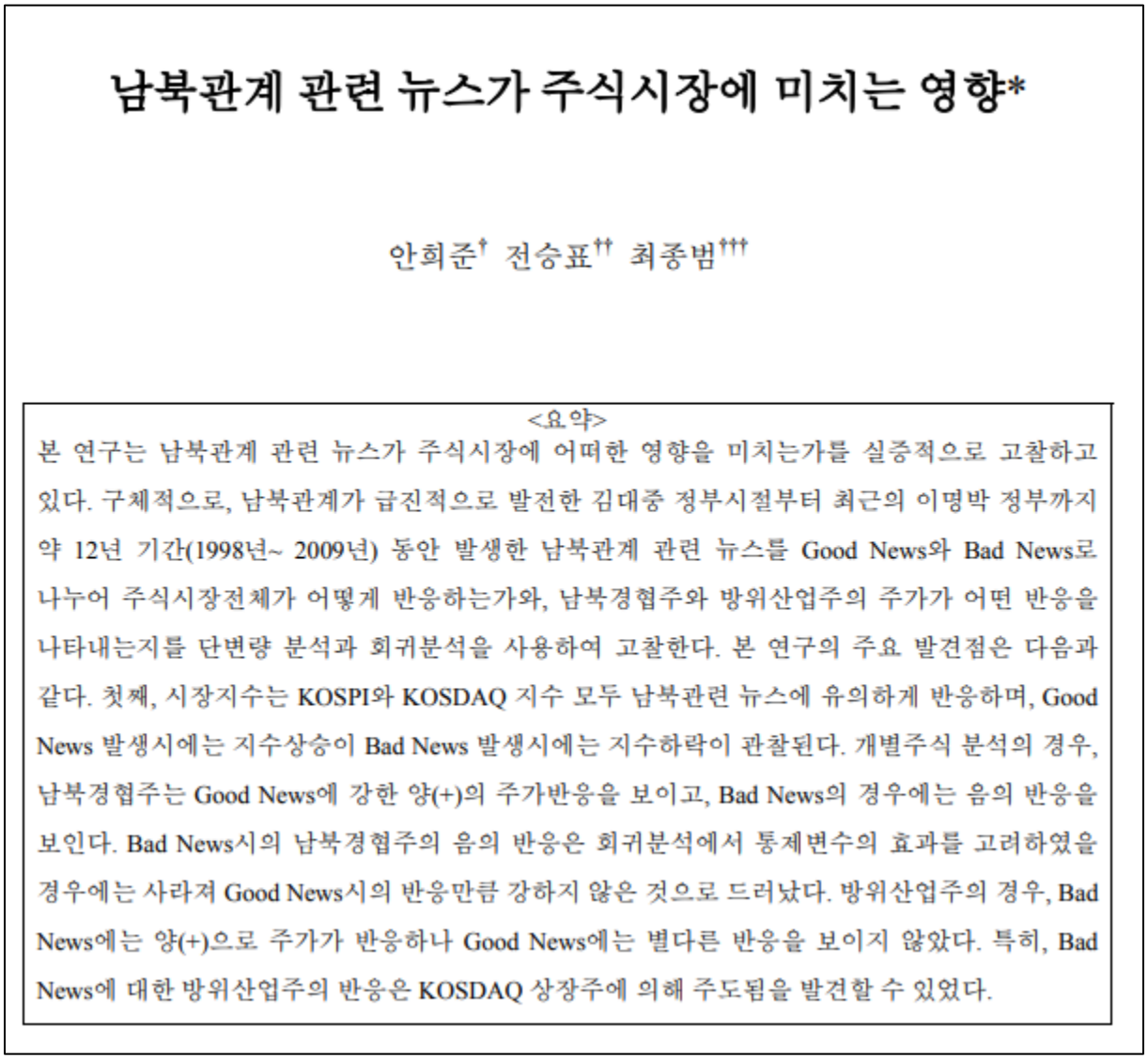

남북관계 관련 뉴스가 주식시장에 미치는 영향*

안희준† 전승표†† 최종범†††

<요약>

본 연구는 남북관계 관련 뉴스가 주식시장에 어떠한 영향을 미치는가를 실증적으로 고찰하고 있다. 구체적으로, 남북관계가 급진적으로 발전한 김대중 정부시절부터 최근의 이명박 정부까지 약 12년 기간(1998년~ 2009년) 동안 발생한 남북관계 관련 뉴스를 Good News와 Bad News로 나누어 주식시장전체가 어떻게 반응하는가와, 남북경협주와 방위산업주의 주가가 어떤 반응을 나타내는지를 단변량 분석과 회귀분석을 사용하여 고찰한다. 본 연구의 주요 발견점은 다음과 같다. 첫째, 시장지수는 KOSPI와 KOSDAQ 지수 모두 남북관련 뉴스에 유의하게 반응하며, Good News 발생시에는 지수상승이 Bad News 발생시에는 지수하락이 관찰된다. 개별주식 분석의 경우, 남북경협주는 Good News에 강한 양(+)의 주가반응을 보이고, Bad News의 경우에는 음의 반응을 보인다. Bad News시의 남북경협주의 음의 반응은 회귀분석에서 통제변수의 효과를 고려하였을 경우에는 사라져 Good News시의 반응만큼 강하지 않은 것으로 드러났다. 방위산업주의 경우, Bad News에는 양(+)으로 주가가 반응하나 Good News에는 별다른 반응을 보이지 않았다. 특히, Bad News에 대한 방위산업주의 반응은 KOSDAQ 상장주에 의해 주도됨을 발견할 수 있었다.

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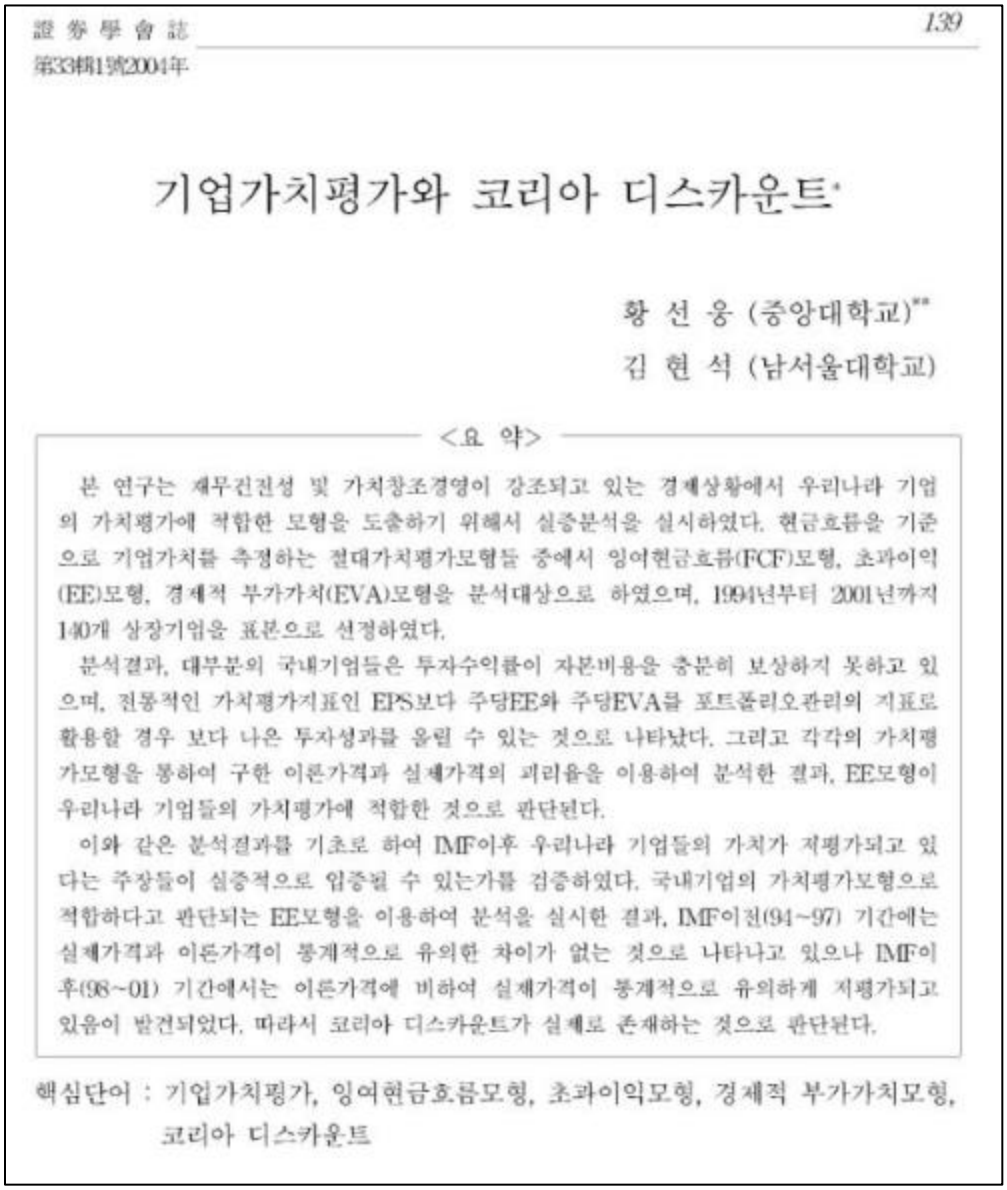

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기업가치평가와 코리아 디스카운트*

황 선 웅 (중앙대학교)**
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<요 약>

본 연구는 재무건전성 및 가치창조경영이 강조되고 있는 경제상황에서 우리나라 기업의 가치평가에 적합한 모형을 도출하기 위해서 실증분석을 실시하였다. 현금흐름을 기준으로 기업가치를 측정하는 절대가치평가모형들 중에서 잉여현금흐름(FCF)모형, 초과이익(EE)모형, 경제적 부가가치(EVA)모형을 분석대상으로 하였으며, 1994년부터 2001년까지 140개 상장기업을 표본으로 선정하였다.

분석결과, 대부분의 국내기업들은 투자수익률이 자본비용을 충분히 보상하지 못하고 있으며, 전통적인 가치평가지표인 EPS보다 주당EE와 주당EVA를 포트폴리오관리의 지표로 활용할 경우 보다 나은 투자성과를 올릴 수 있는 것으로 나타났다. 그리고 각각의 가치평가모형을 통하여 구한 이론가격과 실제가격의 괴리율을 이용하여 분석한 결과, EE모형이 우리나라 기업들의 가치평가에 적합한 것으로 판단된다.

이와 같은 분석결과를 기초로 하여 IMF이후 우리나라 기업들의 가치가 저평가되고 있다는 주장들이 실증적으로 입증될 수 있는가를 검증하였다. 국내기업의 가치평가모형으로 적합하다고 판단되는 EE모형을 이용하여 분석을 실시한 결과, IMF이전(94~97) 기간에는 실제가격과 이론가격이 통계적으로 유의한 차이가 없는 것으로 나타나고 있으나 IMF이후(98~01) 기간에서는 이론가격에 비하여 실제가격이 통계적으로 유의하게 저평가되고 있음이 발견되었다. 따라서 코리아 디스카운트가 실제로 존재하는 것으로 판단된다.

핵심단어 : 기업가치평가, 잉여현금흐름모형, 초과이익모형, 경제적 부가가치모형, 코리아 디스카운트

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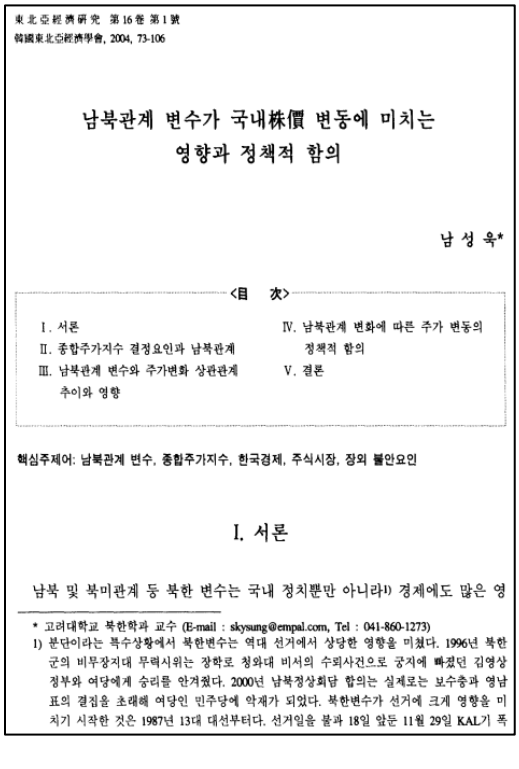

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韓國東北亞經濟學會, 2004, 73-106

남북관계 변수가 국내株價 변동에 미치는 영향과 정책적 함의

남 성 욱*

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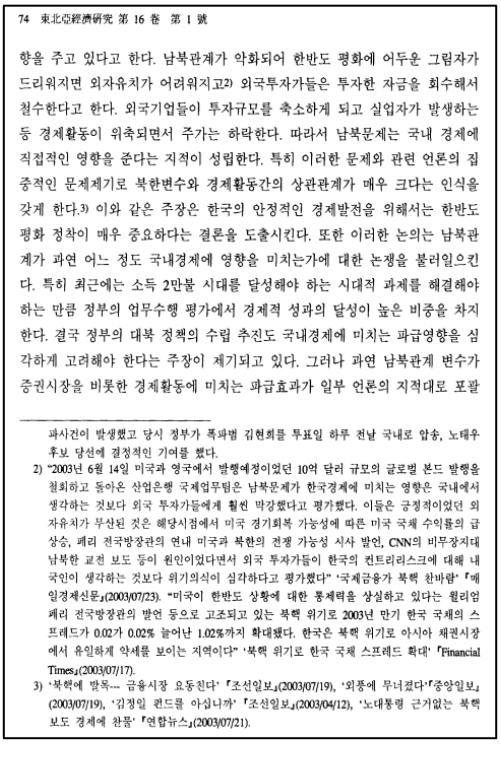
Ⅳ. 남북관계 변화에 따른 주가 변동의 정책적 함의
Ⅴ. 결론

핵심주제어: 남북관계 변수, 종합주가지수, 한국경제, 주식시장, 장외 불안요인

Ⅰ. 서론

남북 및 북미관계 등 북한 변수는 국내 정치뿐만 아니라[1] 경제에도 많은 영

* 고려대학교 북한학과 교수 (E-mail : skysung@empal.com, Tel : 041-860-1273)
1) 분단이라는 특수상황에서 북한변수는 역대 선거에서 상당한 영향을 미쳤다. 1996년 북한군의 비무장지대 무력시위는 장학로 청와대 비서의 수뢰사건으로 궁지에 빠졌던 김영상 정부와 여당에게 승리를 안겨줬다. 2000년 남북정상회담 합의는 실제로는 보수층과 영남표의 결집을 초래해 여당인 민주당에 악재가 되었다. 북한변수가 선거에 크게 영향을 미치기 시작한 것은 1987년 13대 대선부터다. 선거일을 불과 18일 앞둔 11월 29일 KAL기 폭



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향을 주고 있다고 한다. 남북관계가 악화되어 한반도 평화에 어두운 그림자가 드리워지면 외자유치가 어려워지고[2] 외국투자가들은 투자한 자금을 회수해서 철수한다고 한다. 외국기업들이 투자규모를 축소하게 되고 실업자가 발생하는 등 경제활동이 위축되면서 주가는 하락한다. 따라서 남북문제는 국내 경제에 직접적인 영향을 준다는 지적이 성립한다. 특히 이러한 문제와 관련 언론의 집중적인 문제제기로 북한변수와 경제활동간의 상관관계가 매우 크다는 인식을 갖게 한다.[3] 이와 같은 주장은 한국의 안정적인 경제발전을 위해서는 한반도 평화 정착이 매우 중요하다는 결론을 도출시킨다. 또한 이러한 논의는 남북관계가 과연 어느 정도 국내경제에 영향을 미치는가에 대한 논쟁을 불러일으킨다. 특히 최근에는 소득 2만불 시대를 달성해야 하는 시대적 과제를 해결해야 하는 만큼 정부의 업무수행 평가에서 경제적 성과의 달성이 높은 비중을 차지한다. 결국 정부의 대북 정책의 수립 추진도 국내경제에 미치는 파급영향을 심각하게 고려해야 한다는 주장이 제기되고 있다. 그러나 과연 남북관계 변수가 증권시장을 비롯한 경제활동에 미치는 파급효과가 일부 언론의 지적대로 포괄

파사건이 발생했고 당시 정부가 폭파범 김현희를 투표일 하루 전날 국내로 압송, 노태우 후보 당선에 결정적인 기여를 했다.
2) "2003년 6월 14일 미국과 영국에서 발행예정이었던 10억 달러 규모의 글로벌 본드 발행을 철회하고 돌아온 산업은행 국제업무팀은 남북문제가 한국경제에 미치는 영향은 국내에서 생각하는 것보다 외국 투자가들에게 훨씬 막강했다고 평가했다. 이들은 긍정적이었던 외자유치가 무산된 것은 해당시점에서 미국 경기회복 가능성에 따른 미국 국채 수익률의 급상승, 폐리 전국방장관의 연내 미국과 북한의 전쟁 가능성 시사 발언, CNN의 비무장지대 남북한 교전 보도 등이 원인이었다면서 외국 투자가들이 한국의 컨트리리스크에 대해 내국인이 생각하는 것보다 위기의식이 심각하다고 평가했다" '국제금융가 북핵 찬바람' 『매일경제신문』(2003/07/23). "미국이 한반도 상황에 대한 통제력을 상실하고 있다는 윌리엄 페리 전국방장관의 발언 등으로 고조되고 있는 북핵 위기로 2003년 만기 한국 국채의 스프레드가 0.02가 0.02% 늘어난 1.02%까지 확대됐다. 한국은 북핵 위기로 아시아 채권시장에서 유일하게 악세를 보이는 지역이다" '북핵 위기로 한국 국채 스프레드 확대' 『Financial Times』(2003/07/17).
3) '북핵에 발목… 금융시장 요동친다' 『조선일보』(2003/07/19), '외풍에 무너졌다' 『중앙일보』(2003/07/19), '김정일 콘드를 아십니까' 『조선일보』(2003/04/12), '노대통령 근거없는 북핵 보도 경제에 찬물' 『연합뉴스』(2003/07/21).

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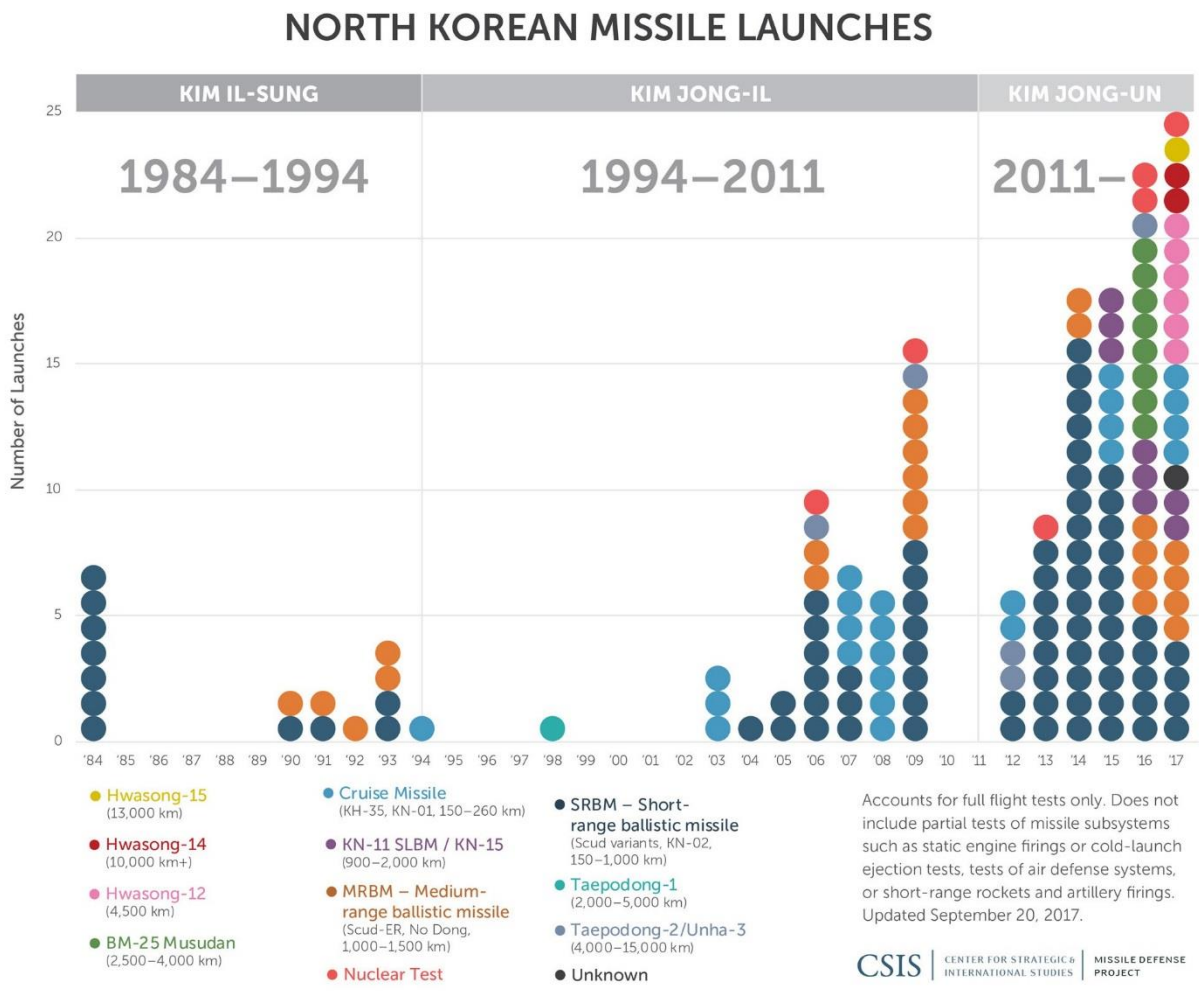
초록(한국어)

이 논문에서는 2004년부터 2012년 말까지 불거진 북한의 핵 관련 리스크 (risk)를 중심으로 북한 리스크가 시간이 지남에 따라 우리나라 금융시장(외환, 채권, 주식 시장)에 각각 어떠한 영향을 미쳤는지를 분석하였다. 북한의 핵실험 및 군사적 도발과 관련된 뉴스를 경제 주체들이 인터넷 검색 엔진을 통해 검색 한 정도를 계량화하여 만든 구글 검색 관련 지표를 소개하여 북한 핵 관련 사 건에 대하여 경제주체들이 민감하게 반응하는 정도를 측정하였고, 측정한 북한 리스크를 외생적인 변수로 가정하고 블록 외생성(Block exogeneity)을 가정한 벡터자기상관 회귀 모형을 설정하여 정량적인 분석을 하였다. 북한핵관련 리스크는 외환시장에서 원화(대 달러)를 평가절하시키는 영향을 주었으나 그 영향 이 크지 않았고, 오히려 주식시장에서 주가를 큰 폭으로 하락시키는 것으로 나타났다. 또한, 2000년대 후반의 반복되는 북한 핵 관련 리스크보다 북한의 1차 핵실험을 비롯한 2000년대 초중반에 발생한 북한 리스크가 우리 금융시장에 더욱 유의한 영향(주가 하락)을 주는 것으로 나타났다.

8. Appendix

Appendix A – North Korean Missile Launches (CSIS, 2017)



Appendix B1

Table 7

Nuclear and missile events Kim Jong-Un regime 2012-2017 including multiple events

Missile Type	*n*	*Category*
Nuclear	**4**	
Nuclear test	4	**Nuclear**
ICBM	**3**	
Hwasong 14	2	1
Hwasong 15	1	1
IRBM	**14**	
Musudan	8	1
Hwasong 12	6	1
MRBM	**18**	
Nodong	9	2
Polaris 2	2	2
ER Scud	7	2
SLBM	**6**	
Polaris 1	6	3
SLV	**3**	
Unha 3	3	3
SRBM	**41**	
Scud B	4	4
Scud C	13	4
KN 02	20	4
Scud-C MaRV	1	4
Scud-B MaRV	3	4

Table 8

Total nuclear and missile events Kim Jong-Un regime per category

Category	**Excluding multiple events**	**Including**
Nuclear	4	4
1	16	17
2	8	18
3	9	9
4	20	41

Appendix B2

Table 9

All events Kim Jong-Un regime 2012-2016 excluding multiple events

F1	*Date*	*Times*	*Missile Name*	*Missile Type*	*Category*	*Test Outcome*
1	13-Apr-12	1	Unha-3	SLV	3	Failure
2	12-Dec-12	1	Unha-3	SLV	3	Success
3	12-Mar-13	3rd Nuclear test	Nuclear	Mag 4.9	Nuclear	Success
4	18-May-13	3	KN-02	SRBM	4	Success
5	19-May-13	1	KN-02	SRBM	4	Success
6	20-May-13	2	KN-02	SRBM	4	Success
7	27-Feb-14	4	Scud-B	SRBM	4	Success
8	3-Mar-14	2	Scud-C	SRBM	4	Success
9	26-Mar-14	2	Nodong	MRBM	2	Success
10	26-Jun-14	1	KN-02	SRBM	4	Success
11	29-Jun-14	2	Scud-C	SRBM	4	Success
12	9-Jul-14	2	Scud-C	SRBM	4	Success
13	13-Jul-14	2	Scud-C	SRBM	4	Success
14	26-Jul-14	1	Scud-C	SRBM	4	Success
15	14-Aug-14	1	KN-02	SRBM	4	Success
16	1-Sep-14	1	KN-02	SRBM	4	Success
17	6-Sep-14	1	KN-02	SRBM	4	Success
18	8-Feb-15	5	KN-02	SRBM	4	Success
19	1-Mar-15	2	Scud-C	SRBM	4	Success
20	2-Apr-15	1	KN-02	SRBM	4	Success
21	3-Apr-15	4	KN-02	SRBM	4	Success
22	8-May-15	1	Polaris-1	SLBM	3	Success
23	28-Nov-15	1	Polaris-1	SLBM	3	Failure
24	21-Dec-15	1	Polaris-1	SLBM	3	Failure
25	6-Jan-16	4th Nuclear test	Nuclear	Mag 5.1	Nuclear	Success
26	7-Feb-16	1	Unha-3	SLV	3	Success
27	10-Mar-16	2	Scud-C	SRBM	4	Success
28	18-Mar-16	2	Nodong	MRBM	2	Failure
29	15-Apr-16	1	Musudan	IRBM	1	Failure
30	23-Apr-16	1	Polaris-1	SLBM	3	Success
31	27-Apr-16	1	Musudan	IRBM	1	Failure
32	28-Apr-16	1	Musudan	IRBM	1	Failure
33	30-May-16	1	Musudan	IRBM	1	Failure
34	21-Jun-16	2	Musudan	IRBM	1	Success
35	9-Jul-16	1	Polaris-1	SLBM	3	Failure
36	18-Jul-16	3	Nodong	MRBM	2	Success
37	2-Aug-16	2	Nodong	MRBM	2	Failure
38	23-Aug-16	1	Polaris-1	SLBM	3	Success
39	5-Sep-16	3	ER Scud	MRBM	2	Success
40	9-Sep-16	5th Nuclear test	Nuclear	Mag 5.3	Nuclear	Success
41	14-Oct-16	1	Musudan	IRBM	1	Failure
42	19-Oct-16	1	Musudan	IRBM	1	Failure

Appendix B2

Table 10

All events Kim Jong-Un regime 2017 excluding multiple events

F1	*Date*	*Times*	*Missile Name*	*Missile Type*	*Category*	*Test Outcome*
43	11-Feb-17	1	Polaris-2	MRBM	2	Success
44	5-Mar-17	4	ER Scud	MRBM	2	Success
45	4-Apr-17	1	Hwasong-12	IRBM	1	Failure
46	15-Apr-17	1	Hwasong-12	IRBM	1	Failure
47	28-Apr-17	1	Hwasong-12	IRBM	1	Failure
48	14-May-17	1	Hwasong-12	IRBM	1	Success
49	21-May-17	1	Polaris-2	MRBM	2	Success
50	28-May-17	1	Scud-C MaRV	SRBM	4	Success
51	4-Jul-17	1	Hwasong-14	ICBM	1	Success
52	28-Jul-17	1	Hwasong-14	ICBM	1	Success
53	25-Aug-17	3	Scud-B MaRV	SRBM	4	Success
54	28-Aug-17	1	Hwasong-12	IRBM	1	Unknown
55	3-Sep-17	6th Nuclear test	Nuclear	Mag 6.3	**Nuclear**	Success
56	14-Sep-17	1	Hwasong-12	IRBM	1	Success
57	28-Nov-17	1	Hwasong-15	ICBM	1	Success

Appendix B3

Table 11

Nuclear and missile events Kim Jong-Un regime 2012-2017 Failure/Success

			Failure	*Success*	*Unknown*	***Total***
Nuclear						
Nuclear	4	Nuclear	0	4		4
Category 1						
Hwasong-14	2	ICBM	0	2		2
Hwasong-15	1	ICBM	0	1		1
Musudan	7	IRBM	6	1		7
Hwasong-12	6	IRBM	3	2	1	6
Category 2						
Nodong	4	MRBM	2	2		4
Polaris-2	2	MRBM	0	2		2
ER Scud	2	MRBM	0	2		2
Category 3						
Polaris-1	6	SLBM	3	3		6
Unha-3	3	SLV	1	2		3
Category 4						
KN-02	10	SRBM	0	10		10
Scud-B	1	SRBM	0	1		1
Scud-C	7	SRBM	0	7		7
Scud-C MaRV	1	SRBM	0	1		1
Scud-B MaRV	1	SRBM	0	1		1
			15	37	1	**57**

Appendix C1

Table 12
Selected companies Kospi-200 (78) and Nikkei-225 (86)

Kospi-200	Nikkei-225
Construction - Building Construction	
HYUNDAI ENGR & CONSTR CO	SHIMIZU CORP
DAEWOO ENGINEERING CONSTRUC	DAIWA HOUSE INDUSTRY CO
HYUNDAI INDL DEV & CONSTR CO	SEKISUI HOUSE LTD
DAELIM INDUSTRIAL CO LTD	TOKYU FUDOSAN HOLDINGS CORP
	HASEKO CORP
	TAISEI CORP
Construction - Heavy Construction	
DOOSAN HEAVY INDS & CONSTR	KAJIMA CORP
	OBAYASHI CORP
Manufacturing - Chemicals and Allied Products	
UNID CO LTD	ASAHI KASEI CORP
FOOSUNG CO LTD	DENKA CO LTD
HUCHEMS FINE CHEMICAL CORP	SUMITOMO CHEMICAL CO LTD
OCI CO LTD	SHOWA DENKO KK
KCC CORP	NIPPON KAYAKU CO LTD
LOTTE FINE CHEMICAL CO LTD	KURARAY CO LTD
KOLON INDS INC	NISSAN CHEMICAL INDUSTRIES
TAEKWANG INDUSTRIAL CO LTD	MITSUBISHI CHEMICAL HLDGS CO
KUMHO PETROCHEMICAL CO LTD	TOKUYAMA CORP
LOTTE CHEMICAL CORP	TORAY INDUSTRIES INC
HANWHA CHEMICAL CORP	TEIJIN LTD
SK DISCOVERY CO LTD	UBE INDUSTRIES LTD
YUHAN CORP	MITSUI CHEMICALS INC
HANMI PHARM CO LTD	DAIICHI SANKYO COMPANY LTD
IL YANG PHARMACEUTICAL CO	KYOWA HAKKO KIRIN CO LTD
DAEWOONG PHARM CO LTD	ASTELLAS PHARMA INC
BUKWANG PHARMACEUTICAL CO	TAKEDA PHARMACEUTICAL CO
DONG A SOCIO HOLDINGS CO LTD	SUMITOMO DAINIPPON PHARMA CO
GREEN CROSS CORP (KOREA)	SHIONOGI & CO LTD
LG HOUSEHOLD & HEALTHCARE	EISAI CO LTD
AMOREPACIFIC GROUP INC	CHUGAI PHARMACEUTICAL CO LTD
ABLE C&C	OTSUKA HOLDINGS CO LTD
AMOREPACIFIC CORP	KAO CORP
LG CHEMICAL LTD	SHISEIDO CO LTD
KOREA PETRO CHEMICAL IND CO	SHIN-ETSU CHEMICAL CO LTD
NAMHAE CHEMICAL CORP	TOSOH CORP
HANWHA CORP	TOKAI CARBON CO LTD
Manufacturing - Petroleum Refining	
SK INNOVATION CO LTD	SHOWA SHELL SEKIYU KK
GS HOLDINGS CORP	JXTG HOLDINGS INC
S-OIL CORP	
HANKOOK SHELL OIL	
Manufacturing - Primary Metal Industries	
KIS WIRE LTD	KOBE STEEL LTD
HYUNDAI STEEL CO	NIPPON STEEL & SUMITOMO META
DONGKUK STEEL MILL CO LTD	NISSHIN STEEL CO LTD
SEAH BESTEEL CORP	SUMITOMO METAL MINING CO LTD
POSCO	MITSUI MINING & SMELTING CO
SEAH STEEL CORP	PACIFIC METALS CO LTD
POONGSAN CORP	NIPPON LIGHT METAL HLDGS CO
KOREA ZINC CO LTD	SUMITOMO ELECTRIC INDS LTD
LS CORP	FURUKAWA ELECTRIC CO LTD
YOUNG POONG CORP	FUJIKURA LTD
	MITSUBISHI MATERIALS CORP

Kospi-200	Nikkei-225
Manufacturing - Industrial	
HYUNDAI ELEVATOR CO LTD	MITSUBISHI HEAVY INDUST LTD
DOOSAN INFRACORE CO	SUMITOMO HEAVY INDUSTRIES
SINDOH CO LTD	JAPAN STEEL WORKS LTD
COWAY CO LTD	CASIO COMPUTER CO LTD
HANON SYSTEMS	CANON INC
Manufacturing - Electronic	
KOREA ELECTRIC TERMINAL CO	SEIKO EPSON CORP
LG ELECTRONICS INC	PANASONIC CORP
LG INNOTEK CO LTD	SONY CORP
SAMSUNG SDI CO LTD	MITSUBISHI ELECTRIC CORP
SAMSUNG ELECTRO-MECHANICS CO	FUJI ELECTRIC CO LTD
SAMSUNG ELECTRONICS CO LTD	SUMCO CORP
Manufacturing - Transportation Equipment	
KIA MOTORS CORP	MITSUBISHI MOTORS CORP
HYUNDAI MOTOR CO LTD	SUZUKI MOTOR CO LTD
HYUNDAI MOBIS	TOYOTA MOTOR CORP
SAMSUNG HEAVY INDUSTRIES CO	NISSAN MOTOR CO LTD
HYUNDAI HEAVY INDS CO LTD	HONDA MOTOR CO LTD
Transportation & Public Utilities - Transportation by air	
KOREAN AIR LINES CO LTD	ANA HOLDINGS INC
Transportation & Public Utilities - Communications	
SK TELECOM CO LTD	SOFTBANK GROUP CORP
KT CORP	NTT DOCOMO INC
	KDDI CORP
Transportation & Public Utilities - Electric, Gas and Sanitary Services	
KEPCO-KOREA ELEC POWER CORP	CHUBU ELECTRIC POWER CO INC
KOREA GAS CORP	TOKYO ELECTRIC POWER CO HOLD
SK NETWORKS CO LTD	KANSAI ELECTRIC POWER CO
	TOKYO GAS CO LTD
	OSAKA GAS CO LTD
Finance, Insurance, Real Estate- Depository Institutions	
KB FINANCIAL GROUP	AOZORA BANK LTD
HANA FINANCIAL HOLDINGS	SHINSEI BANK LTD
INDUSTRIAL BANK OF KOREA	MIZUHO FINANCIAL GROUP INC
BNK FINANCIAL GROUP INC	SUMITOMO MITSUI FINANCIAL GR
WOORI BANK	SUMITOMO MITSUI TRUST HLDGS
SHINHAN FINANCIAL GROUP LTD	MITSUBISHI UFJ FINANCIAL GRP
SAMSUNG CARD CO LTD	RESONA HLDGS INC
	CREDIT SAISON CO LTD
Finance, Insurance, Real Estate - Insurance Carriers	
HANWHA LIFE INSURANCE CO LTD	DAI-ICHI LIFE HOLDINGS INC
SAMSUNG LIFE INSURANCE CO	JAPAN POST HOLDINGS CO LTD
SAMSUNG FIRE & MARINE INS	T&D HLDGS INC
	SONY FINANCIAL HOLDINGS INC
	TOKIO MARINE HOLDINGS INC

Appendix D1

Table 13

Robustness check estimation period [-150;-50] and [-100;-50], category nuclear, Kospi-200 South Korea

Panel A - Abnormal Returns (Mean Adjusted Returns model) - Category Nuclear - Kospi-200 South Korea								
	[-150;-50]				[-100;-50]			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
AR(5)	0.05%	0,016	(-0,503)		-0.04%	0,017	(-0.448)	
AR(4)	0.28%	0,014	(3,540)	***	0.29%	0,015	-3.405	***
AR(3)	-0.20%	0,013	(-2,591)	***	-0.19%	0,013	(-2.545)	*
AR(2)	-0.47%	0,020	(-4,240)	***	-0.47%	0,019	(-4.083)	***
AR(1)	0.03%	0,021	(0,270)		0.04%	0,021	-0.319	
AR(0)	-0.38%	0,023	(-3,015)	***	-0.38%	0,023	(-2.994)	***
AR1	-1.02%	0,018	(-9,987)	***	-1.02%	0,018	(-9.881)	***
AR2	-0.03%	0,023	(-0,246)		-0.03%	0,023	(-0.214)	
AR3	-0.37%	0,019	(-3,440)	***	-0.36%	0,019	(-3.333)	***
AR4	-0.61%	0,014	(-7,592)	***	-0.60%	0,014	(-7.370)	***
AR5	0.64%	0,020	(5,503)	***	0.64%	0,019	-5.645	***
Before-event CAR (-5,…,-1)	-0.40%	0,036	(-19,302)	**	-0.38%	0,041	(-1.683)	**
On-event CAR (0,1)	-1.40%	0,029	(-8,563)	***	-1.40%	0,029	(-8.516)	***
After-event CAR (2,…,+5)	-0.36%	0,038	(-1,705)	**	-0.35%	0,037	(-1.635)	**
Short total-event CAR (-1,…,+1)	-1.38%	0,036	(-6,813)	***	-1.36%	0,035	(-6.787)	***
Medium total event CAR (-3,…,+3)	-2.45%	0,053	(-8,201)	***	-2.42%	0,053	(-7.934)	***
Total-event CAR(-5,…,+5)	-2.18%	0,060	(-6,129)	***	-2.13%	0,066	(-5.677)	***

Appendix E1


Military forces on the Korean Peninsula
Nuclear test & research sites
Main missile launch sites
Main US bases
South Korean bases
THAAD missile base
CHINA
Punggye-ri
Tonaghae
Youngdoktong
NORTH KOREA
Sinpo
Sohae
Sunchon
North Wonsan
Pyongyang
Wonsan Kalma
Kittaeryong
Hwanju
East Sea / Sea of Japan
Camp Casey
Camp Stanley
Seoul
K-16 Air Base
Osan Airbase
Camp Humphreys
SOUTH KOREA
Kunsan Air Base
USAG Daegu
Seonju
Chinhae Naval Base
Source: James Martin Centre for Non-proliferation Studies/Council on Foreign Relations
BBC

Appendix F1

Table 14

(Cumulated) Abnormal Returns for Nikkei-225 (n=86) and Kospi-200 companies (n=78), category Nuclear

Panel B - Abnormal Returns (Market model) - Category Nuclear								
	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
AR(5)	-0.10%	0,013	(-1.477)	*	0.14%	0,016	(-1.478)	*
AR(4)	-0.29%	0,013	(-4.023)	***	0.01%	0,013	(-0.183)	
AR(3)	0.06%	0,013	(-0.891)		-0.13%	0,014	(-1.600)	*
AR(2)	-0.17%	0,018	(-1.688)	**	0.41%	0,019	(-3.854)	***
AR(1)	0.21%	0,017	(-2.276)	**	-0.06%	0,021	(-0.537)	
AR(0)	0.00%	0,014	(-0.027)		0.58%	0,023	(-4.344)	***
AR1	0.12%	0,013	(-1.651)	**	0.07%	0,021	(-0.573)	
AR2	-0.37%	0,014	(-4.803)	***	-0.25%	0,022	(-1.996)	**
AR3	-0.07%	0,015	(-0.791)		0.04%	0,018	(-0.372)	
AR4	0.04%	0,013	(-0.591)		-0.33%	0,015	(-3.932)	***
AR5	-0.26%	0,014	(-3.346)	***	0.13%	0,019	(-1.273)	*
Before-event CAR (-5,…,-1)	-0.29%	0,036	(-1.463)	*	0.37%	0,039	(-1.705)	**
On-event CAR (0,1)	0.12%	0,019	(-1.130)		0.64%	0,033	(-3.409)	***
After-event CAR (2,…,+5)	-0.65%	0,028	(-4.319)	***	-0.40%	0,039	(-1.834)	**
Short total-event CAR (-1,…,+1)	0.33%	0,026	(-2.325)	**	0.58%	0,038	(-2.703)	***
Medium total event CAR (-3,…,+3)	-0.21%	0,043	(-0.892)		0.65%	0,057	(-2.022)	**
Total-event CAR(-5,…,+5)	-0.82%	0,055	(-2.745)	***	0.61%	0,068	(-1.582)	*

Note. AR = abnormal return, CAR = cumulative abnormal return, calculated with the Market-model for the selected companies using different event windows. St. Dev. = standard deviation, ***, ** and * indicate the significance at 1%, 5% and 10% level respectively.

Table 15

(Cumulated) Abnormal Returns for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Category 1

Panel A - Abnormal Returns (Mean Adjusted Returns model) - Category 1

	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
AR(5)	0,006	0,016	(13.513)	***	0,000	0,022	(0.529)	
AR(4)	0,001	0,016	(3.247)	***	-0,002	0,019	(-3.639)	***
AR(3)	0,003	0,019	(5.807)	***	0,001	0,019	(2.156)	**
AR(2)	0,002	0,019	(4.735)	***	0,002	0,017	(5.015)	***
AR(1)	0,004	0,018	(8.294)	***	0,002	0,022	(3.349)	***
AR(0)	-0,002	0,018	(-4.500)	***	-0,002	0,018	(-4.856)	***
AR1	-0,000	0,018	(-0.121)		0,000	0,017	(0.488)	
AR2	0,000	0,019	(1.412)	*	-0,001	0,018	(-2.287)	**
AR3	-0,006	0,024	(-9.488)	***	-0,004	0,021	(-6.444)	***
AR4	0,006	0,016	(12.975)	***	-0,002	0,021	(-2.670)	***
AR5	0,001	0,014	(2.706)	***	-0,002	0,019	(-3.012)	***

Panel B - Abnormal Returns (Market model) - Category 1

	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
AR(5)	0,002	0,014	(4.082)	***	-0,001	0,021	(-1.951)	**
AR(4)	-0,001	0,014	(-1.513)	*	-0,001	0,017	(-1.972)	
AR(3)	0,001	0,015	(1.611)	*	0,002	0,019	(2.934)	***
AR(2)	0,000	0,015	(0.998)		0,002	0,018	(3.148)	***
AR(1)	-0,000	0,014	(-0.489)		0,001	0,023	(1.151)	
AR(0)	-0,001	0,016	(-1.841)	**	-0,001	0,018	(-1.576)	*
AR1	0,001	0,015	(3.171)	***	0,000	0,018	(0.619)	
AR2	0,000	0,014	(0.507)		-0,000	0,018	(-0.448)	
AR3	0,000	0,013	(1.443)	*	-0,001	0,017	(-2.511)	***
AR4	-0,001	0,016	(-3.052)	***	-0,002	0,024	(-2.735)	***
AR5	-0,000	0,013	(-1.190)		0,000	0,017	(0.034)	
Before-event CAR (-5,…,-1)	0.19%	0,041	(1.745)	**	0.21%	0,042	(1.484)	*
On-event CAR (0,1)	0.02%	0,023	(0.857)		-0.03%	0,025	(-0.702)	
After-event CAR (2,…,+5)	-0.06%	0,030	(-1.233)		-0.30%	0,036	(-2.926)	***
Short total-event CAR (-1,…,+1)	0.03%	0,027	(0.473)		0.02%	0,031	(0.168)	
Medium total event CAR (-3,…,+3)	0.21%	0,042	(1.908)	**	0.18%	0,048	(1.377)	
Total-event CAR(-5,…,+5)	0.07%	0,056	(0.927)		-0.17%	0,066	(-0.919)	

Note. AR = abnormal return, CAR = cumulative abnormal return, calculated with the Market-model for the selected companies using different event windows. St. Dev. = standard deviation, ***, ** and * indicate the significance at 1%, 5% and 10% level respectively.

Table 16

(Cumulated) Abnormal Returns for Nikkei-225 (n=86) and Kospi-200 companies (n=78), Category 2

Panel A - Abnormal Returns (Mean Adjusted Returns model) - Category 2								
	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
AR(5)	0,005	0,025	(5.030)	***	0,001	0,018	(1.057)	
AR(4)	0,006	0,023	(6.304)	***	0,000	0,021	(0.523)	
AR(3)	0,001	0,018	(2.064)	**	0,001	0,018	(1.994)	**
AR(2)	0,001	0,021	(0.892)		0,001	0,022	(1.387)	*
AR(1)	0,003	0,019	(3.408)	***	0,004	0,021	(5.236)	***
AR(0)	-0,001	0,015	(-2.474)	***	0,005	0,018	(7.142)	***
AR1	-0,003	0,019	(-4.068)	***	-0,001	0,016	(-1.062)	
AR2	0,005	0,018	(7.199)	***	0,002	0,018	(3.222)	***
AR3	0,001	0,015	(1.092)		0,001	0,020	(0.663)	
AR4	-0,001	0,018	(-0.857)		0,000	0,016	(0.573)	
AR5	0,000	0,016	(0.361)		0,000	0,020	(-0.252)	
Panel B - Abnormal Returns (Market model) - Category 2								
	Nikkei-225 Japan				Kospi-200 South Korea			
Days	Average	St. Dev.	T-Value		Average	St. Dev.	T-Value	
AR(5)	-0,001	0,016	(-1.076)		-0,002	0,017	(-3.501)	***
AR(4)	0,001	0,017	(0.981)		0,000	0,020	(0.136)	
AR(3)	0.000	0,015	(0.215)		0,001	0,018	(1.213)	
AR(2)	0.000	0,018	(-0.622)		0.000	0,022	(-0.478)	
AR(1)	0.000	0,018	(-0.620)		0,002	0,021	(3.061)	***
AR(0)	0,001	0,013	(1.151)		0,001	0,017	(1.804)	**
AR1	-0,001	0,016	(-1.938)	**	-0,001	0,016	(-1.158)	
AR2	0,001	0,157	(1.217)		0,001	0,018	(1.527)	*
AR3	0.000	0,137	(-0.537)		-0,002	0,019	(-3.201)	***
AR4	-0,001	0,142	(-2.084)	**	0,001	0,017	(1.422)	*
AR5	0.000	0,014	(-0.199)		0,000	0,021	(0.609)	
Before-event CAR (-5,…,-1)	-0.12%	0,042	(-0.461)		0.07%	0,045	(0.289)	
On-event CAR (0,1)	-0.07%	0,021	(-0.772)		0.11%	0,024	(0.536)	
After-event CAR (2,…,+5)	-0.06%	0,031	(-0.677)		0.07%	0,040	(0.145)	
Short total-event CAR (-1,…,+1)	-0.08%	0,027	(-1.010)		0.29%	0,031	(2.441)	***
Medium total event CAR (-3,…,+3)	-0.07%	0,043	(-0.548)		0.16%	0,049	(1.070)	
Total-event CAR(-5,…,+5)	-0.16%	0,057	(-0.989)		0.13%	0,067	(0.473)	

Note. AR = abnormal return, CAR = cumulative abnormal return, calculated with the Market-model for the selected companies using different event windows. St. Dev. = standard deviation, ***, ** and * indicate the significance at 1%, 5% and 10% level respectively.