Repetitive Threats and Strained Peace: Understanding the Effect of North Korean Nuclear Tests on South Korean Currency Value and Tourist Inflows

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1 Introduction

North Korea has initiated a series of nuclear crises in the last decade for multiple purposes, but one of the most central is to "rock the boat" and bring the U.S. and other regional states to the negotiation table. In addition to their effect on regional security and balance of power, these events also have a significant impact on non-security realms. For instance, in financial circles, the term "Korea discount" is used to describe foreign investors' reluctance to pay for the South Korean stocks,[1] South Korea's low equity valuations,[2] and economic activities in the country that have been affected by the threat of instability from North Korea. From a financial expert survey, some conclude that "North Korea's provoking acts have been the most important factor in producing the long- and mid-term uncertainty in the Korean market."[3]

While North Korea's brinkmanship strategy requires nuclear tests to be perceived as threatening, the consistent and repetitive pattern of these tests presents a puzzle: As people

[1] Andrew Salmon. "Dissecting the 'Korea discount' " The Korea Times. March 3rd, 2014. accessed March 15, 2017 http://www.koreatimes.co.kr/www/news/opinon/2015/10/351_152627.html

[2] The Economist. "The Korea discount: Minority report" February 12th 2012, accessed March 15, 2017. http://www.economist.com/node/21547255

[3] Deok Ryong Yoon, "Toward a Northeast Asian Security Community: Implications for South Korea's Economic Growth" in Bernhard Seliger and Werner Pascha, eds. Towards a Northeast Asian Security Community: Implications for Korea's Growth and Economic Development. Springer Science & Business Media.

accumulates information and intention of North Korea as well as outcomes of each previous tests, to what extend is a new test shocking compared to previous tests? In this article, we present a psychological approach and argue that the level of threat perception towards North Korean nuclear tests is moderated by the number of its iterations. Due to human's tendency to use recognizable patterns and historical analogies to understand current situation, we expect the amount of uncertainty and level of shock caused by North Korean nuclear tests to diminish after each new iteration.

To test our theory, we use daily currency exchange rate of South Korean Won and monthly tourist inflow data between 2003 and 2016 as a proxy of the degree of fear and uncertainty over each North Korean nuclear test and adopt time-series models to capture autocorrelations associated with time. In this case, we expect heightened threats and uncertainties are supposed to cause a severe depreciation of both Korean currency and inflow of tourists.

2 Literature

There is, in fact, no literature that exclusively examines the continuous yet individual impact that each one of DPRK's repetitive nuclear tests carries about. Instead, a dominant stream of literature is motivated to answer why DPRK is so obsessed with possession of nuclear weapons. Sagan (1997) has originally introduced three frameworks applicable to the situation: security model, domestic politics model, and symbol/norms model. Security model speculates that countries rely on nuclear development in order to sustain its national security by balancing against external threats.[4] Domestic politics model, on the other hand, finds a root cause from internal maneuvering of politicians who intend to maximize their interests via using nuclear capabilities. Contrarily from these materialistic perceptions, symbol/norms model stresses symbolic meaning of nuclear weapons, such as modernity and pride. In addition to these

[4]Scott D. Sagan, "Why Do States Build Nuclear Weapons? Three Models in Search of a Bomb," International Security 21, no. 3 (Winter 1996/97): pp. 55.

three large frames, leverage model contends that nuclear capabilities function as bargaining chips to increase leverage,[5] while many scholars believe that nuclear weapons are developed based on multiple aims (multipurpose basis argument).[6] In addition to an examination on causal mechanism to why DPRK desires to acquire nuclear power, another prevailing research theme has been on evaluation of foreign policies toward DPRK as a way to navigate future policy goals and strategies.[7]

Besides these studies, some scholars shed light on North Korean nuclear threats' financial impacts on neighboring countries. The financial markets usually react to important political events and incidents because of the potential risks and uncertainty.[8] This tendency occurs to be even more abrupt and severer when the event takes place unexpectedly.[9] Taking this feature as given, previous studies believe that DPRK's nuclear threats may cause negative impacts on its neighboring countries, such as currency depreciation, asset price declines, and reductions in investment, due to contagious regional effect. Thus, existing studies frequently select Japan and South Korean financial markets as their cases of investigation, and their results seem to be mixed. Based on scenario analysis, Noland (2006) argues that economic markets of the two countries are critically affected by North Korean nuclear threats.[10] On the other hand, Kim and Roland's (2014) event-based analysis on 26 nuclear threats between 2000 and 2008 finds that the events did not lead to statistically significant effect on Korean financial markets.[11] Dibooglu and Cevik (2016) apply North Korean Threat Index (NKTI)

[5]Jeffrey Goldstein, "The North Korean Nuclear Test: A Perilous Path Back to the Negotiating Table," Bulletin of the Atomic Scientists, May 26, 2009, accessed December 4, 2016, http://thebulletin.org/north-korean-nuclear-test-perilous-path-back-negotiating-table.

[6]Gregory J. Moore, "America's Failed North Korea Nuclear Policy: A New Approach," Asian Perspective 32, no. 4 (2008): pp. 12; Andrew Mack, "The Nuclear Crisis on the Korean Peninsula," Asian Survey 33, no. 4 (1993): pp. 343.

[7]Scholars and policy analysts compare policy outcomes across past US presidents. For example, Bolton (2007), Difilippo (2008, 2014), Sigal (2009), and Wit and Town (2011) evaluate policies during Bush and Obama administrations.

[8]Jedrzej Bialkowski, Katrin Gottschalk, and Tomasz Wisniewski, "Stock Market Volatility Around National Elections," Journal of Banking and Finance 32, no. 9 (2008): pp. 194.

[9]Peren K. Arin, Davide Ciferri, and Nicola Spagnolo, "The Price of Terror: The Effects of Terrorism on Stock Market Returns and Volatility," Economics Letters 101, no. 3 (2008): pp. 164.

[10]Marcus Noland, "The Economic Implications of A North Korean Nuclear Test," Asia Policy 2, no. 1 (2006): pp. 26.

[11]Byung-Yeon Kim and Gerard Roland, "How Credible Is the North Korean Threat?" Economics of

with causality-in-variance test and show no significant impact on any of the countries.[12]

While appreciating these findings, this paper conceptualizes DPRK's nuclear threats in two distinctive ways. First, nuclear threats and tests need to be separated. In other words, a nuclear test can be certainly categorized as a type of nuclear threats. However, DPRK's nuclear tests since 2006 clearly carry out dissimilar impacts compared to these by nuclear threats that North Korea more dominantly used during earlier years. Indeed, North Korean nuclear threat itself is not a recent phenomenon. Since its establishment of Yongbyon nuclear complex in 1962,[13] international community constantly speculated that DPRK clandestinely developed nuclear weapons. This distrust led to multiple conflicts, ranging from DPRK's declaration of a "state of semi-war" against the West in 1993.[14] to US sanctions aiming for DPRK's complete, verifiable, and irreversible dismantlement (CVID) in 2005.[15] Still, this nuclear problem was not viewed as insoluble largely due to DPRK's vacillation between revisionist and conciliatory attitudes. In 1994 Agreed Framework,[16] DPRK agreed to dismantle 5ME(e) graphite reactor in Yongbyon and related sites. However, this framework fell apart in 2002, leading back to past hostile condition. Even after US sanction in 2005, DPRK agreed to dismantle the North Korean nuclear program and to normalize diplomatic relationship, although this agreement did not proceed at the end. Under such a circumstance, deliberation of actual nuclear tests has set a sharp departure from previous ambiguous stage. These tests clarified that DPRK physically possessed nuclear weapons and that it may use this tool to target against neighboring countries, including the United States.

Transition 22, no. 3 (2014): pp. 433.

[12]Sel Dibooglu and Emrah I. Cevik, "The Effect of North Korean Threats on Financial Markets in South Korea and Japan," Journal of Asian Economics 43 (2016): pp. 18.

[13]North Korea's nuclear program started under a nuclear cooperation agreement with the Soviet Union in 1959. This agreement initially intended to allow North Korea developing nuclear energy technology. However, after Kim Joing-il was appointed as a successor in the 1980 Sixth Congress, his government rapidly increased resources geared toward Yongbyon complex.

[14]DPRK was under a suspicion of extracting 10 kilograms of plutonium (Huntley 2007, pp. 457). Along with this declaration of semi-war, DPRK refused to comply with the special inspection requested by the International Atomic Energy Agency (IAEA) and withdrew from the Nuclear Non-Proliferation Treaty (NPT).

[15]The United States froze DPRK's funds, which amounted to $25 million in Macao on September 16, 2005.

[16]The US agreed to provide extensive economic aid, the lifting of economic sanctions, and the supply of two light water reactors scheduled to be established by 2003 (Ahn 2011, pp. 180).

Second, existing literatures treat North Korean nuclear tests or threats in an aggregate manner, assuming that each event holds uniform impact shared with the rest. Thus, these literatures draw a conclusion that the nuclear threats yield either an impact or no impact. We disagree with this conceptualization, and instead assume that each nuclear test would hold different degree and direction of impacts because they are auto-correlated to their previous nuclear tests.

3 Theory

We argue that when North Korea conducts nuclear tests repetitively, the shock of new tests on neighboring currency markets is expected to diminish compared to the shocks of previous tests. While earlier tests might have elicited regional security tensions and the population's high level of uncertainty over future events, additional iterations can lower such response through two mechanisms. First, humans are psychologically inclined to draw on historical analogies to interpret new events. As none of the previous tests led to war, observers are likely to infer that the present case would be similar to the past. Second, even if a new test is perceived as equally dangerous or even escalating concerning technological sophistication or scale, its shock might still diminish due to habituation: "repeated applications of the stimulus result in decreased response."

In regard to the first mechanism, the human tendency to draw on analogies or "past actions"[17] to understand a current situation has received attentions from many researchers. Most notably, Khong (1992) argues that leaders are often trapped in analogical reasoning and incapable of differentiating new situation from influential historical events that only remotely resemble the present one.[18] In the early 1960s, for instance, most U.S. policymakers were convinced

[17]See Yarhi-Milo, Keren and Alex Weisiger (2015) Revisiting Reputation: How Do Past Actions Matter in International Politics. International Organization 69(2) and Mercer, Jonathan (1996) Reputation and International Politics. Ithaca: Cornell University Press.

[18]Khong, Yuen-Foong (1992) Analogies at War: Korea, Munich, Dien Bien Phu, and the Vietnam Decisions of 1965. Princeton: Princeton University Press.

that what worked in Malaya would also work in South Vietnam and were eager to imitate Britain's counter guerrilla operations, known as the "strategic hamlet," to a place that was vastly different in terms of geography and food conditions. The program failed miserably as a result. Analogical reasoning can play an even greater role in the shock of North Korean nuclear tests on regional currency markets. The establishment of a pattern is crucial in this context. As Schelling wrote about the U.S.-China interactions during the Korean War; "Bomb once across the Yalu, and the enemy will expect more bombs across the Yalu the next day; keep bombs this side of the Yalu for several months, and the enemy will suppose that, though you may change your mind at any time, the odds are against your bombing north of the Yalu tomorrow" (2008, 132). Even if North Korea might in fact be aggressive and indeed had the resolve to use force, the pattern of previous tests can strongly prime us towards non-conflictual outcomes and lead us to believe that nuclear tests are instead symbolic or used as strategic mean for North Korea to obtain bargaining leverage for sanction relief or foreign aids.

Furthermore, the second mechanism speculates that one might also expect a new North Korean nuclear test to have a smaller shock due to the psychological process of "habituation" (Thompson and Spencer 1966). Humans can become habituated to natural stimuli such as heat and cold,[19] or to new information such as in language acquisition. However, we are also able to become habituated with social phenomenon such as violence[20] and wars[21] Among the ten common characteristics summarized by Rankin (2009), below are five most relevant ones to the present case:[22]

1) Repeated application of a stimulus results in a progressive decrease in some parameter

[19]Zimny, G. H. and Miller, F. L. (1966), Orienting and Adaptive Cardiovascular Responses to Heat and Cold. Psychophysiology, 3: 81–92.

[20]Mangelsdorff, A. David. and Zuckerman, Marvin. (1975) Habituation to Scenes of Violence. Psychophysiology, 12: 124–129.

[21]Ziferstein Isidore (1967) Psychological Habituation to War: A Sociopsychological Case Study. The American Journal of Orthopsychiatry 37:3.

[22]Rankin, C. H., Abrams, T., Barry, R. J., Bhatnagar, S., Clayton, D., Colombo, J., ... Thompson, R. F. (2009). Habituation Revisited: An Updated and Revised Description of the Behavioral Characteristics of Habituation. Neurobiology of Learning and Memory, 92(2), 135–138.

of a response to an asymptotic level.

2) If the stimulus is withheld after response decrement, the response recovers at least partially over the observation time.
3) After multiple series of stimulus repetitions and spontaneous recoveries, the response decrement becomes successively more rapid and/or more pronounced
4) Other things being equal, more frequent stimulation results in more rapid and/or more pronounced response decrement, and more rapid spontaneous recovery
5) Within a stimulus modality, the less intense the stimulus, the more rapid and/or more pronounced the behavioral response decrement. Very intense stimuli may yield no significant observable response decrement.

In a context of North Korean nuclear tests, we argue that the process of habituation also leads to a diminishing impact of each new test. Even if each test induces the same level of danger or instability, the repetition itself can lead to weaker responses. It is worth noting that there is more than one way to operationalize and test whether the impact of new nuclear tests on financial markets is indeed diminishing. In this article, we look at whether the effect (i.e. coefficient) of a new test is expected to be smaller (i.e. closer to zero) compared to the old ones. Since nuclear tests can also induce uncertainty, however, we also look at how the variance of a new test is smaller compared to the old tests. The hypotheses are specified as below:

H1: In a comparison of North Korea's nuclear tests, the impact of a new test on South Korea's currency value is expected to be smaller compared to all the earlier tests.

H2: In a comparison of North Korea's nuclear tests, the impact of a new test on the number of incoming tourists to South Korea's is expected to be smaller compared to all the earlier tests.

In assessing people's perception, some may raise concerns that exchange rate is not an optimal instrument. This is because exchange rate reflects an agglomeration of various macro-

and micro-level factors, and therefore, its fluctuation inevitably captures non-DPRK-related events. In this sense, our statistical results may be unintentionally capturing effects arising from different factors. While this concern can never be fully addressed, we believe that this threat to construct validity is minimized when we limiting our scope to South Korea Won but not other regional currencies such as Japanese Yen or New Taiwan Dollars. In other words, our research mainly focuses on exchange rate fluctuation of South Korean won in relation to North Korean nuclear tests.

We claim that studying South Korean exchange rate is justifiable due to the country's geographical proximity and its unique historical, social, and ethnic ties with the North. Korean peninsula has been divided into two parts only after the end of Japanese occupation. Hence, they still share common ethnic ancestral origins, culture, and language (although the latter two traits seem to diverge) This sense of sharing the same origin is still prevalent among people in the South, and thus, South Korean policies toward the North has been relatively engaging for many times. Furthermore, because North and South Korean territories are directly attached to each other, the South carries out the highest probability to receive direct consequences from the North's aggressive behaviors. In essence, South Korea is inevitably vulnerable to acts of North Korea due to political, social, and geographical closeness, and hence, it seems reasonable enough to assume that Korean exchange rate receives a considerable effect from North Korean nuclear tests.

In the Appendix, we provide a chronology of important events in postwar South Korea. Some of the events are purely domestic, such as sinking of Sewol ferry in April 16, 2014, while other events are international, such as Global Recession from 2007 to 2009. While it is difficult to assess real impact of the Global Recession (due to its long-term effect), Korean won declined by 0.019 percent on April 16, 2014 and 0.063 percent on April 17, 2014 when Sewol ferry sank (2014). However, it increased by 0.117 percent on the following day. Thus, this event surely negatively impacted South Korean exchange rate, but the magnitude seems to be minimal

and the negative impact did not stay longer than two days. Most importantly, almost all significant events listed in Appendix are North Korea related. Therefore, we claim that at least Korean exchange rate is heavily influenced by North Korea.

One may wonder why then this research sheds light on nuclear tests, but not on missile tests. While we believe that missile test can also be a useful measure, frequency of this test is too high, especially for past few years. It raises a concern whether this feature would allow us to realize an accurate picture, because a high frequency increases a probability to capture unrelated effects. Based on these considerations, we focus on nuclear test.

4 Statistical Analysis

4.1 Data and Operationalization

Our hypothesis yields that their impact on people's sense of threat that is reflected in currency volatility will be ameliorated as North Korea repeats its nuclear tests. In order to test this claim, we use the time series of South Korean won's daily exchange rates and monthly tourist inflows between 2003 and 2016. For Korean won, we re-generated the currency values based on South Korea's consumer price index (CPI) in order to take inflation into account.[23] The initial dataset on absolute values of exchange rate records Korean currency fluctuation(s) vis-à-vis US dollar. Thus, the higher (lower) value indicates depreciation (appreciation) of Korean currency. We have converted this dataset into growth rate (%) in order to better capture how stronger or weaker Korean currency has become. Here, positive (negative) value refers to depreciation (appreciation) of the currency. Additionally, we converted initial tourist inflow dataset into growth rate (%).

Our independent variable is North Korean nuclear tests:

[23]For exchange rate value, we multiplied it by hundred and divided it by respective consumer price index (Ex c 100 / CPI). Korean CPIs were initially based on currency value of 2015.

- First test (October 9, 2006)
- Second test (May 25, 2009)
- Third test (February 12, 2013)
- Fourth test (January 6, 2016)
- Fifth test (September 9, 2016)

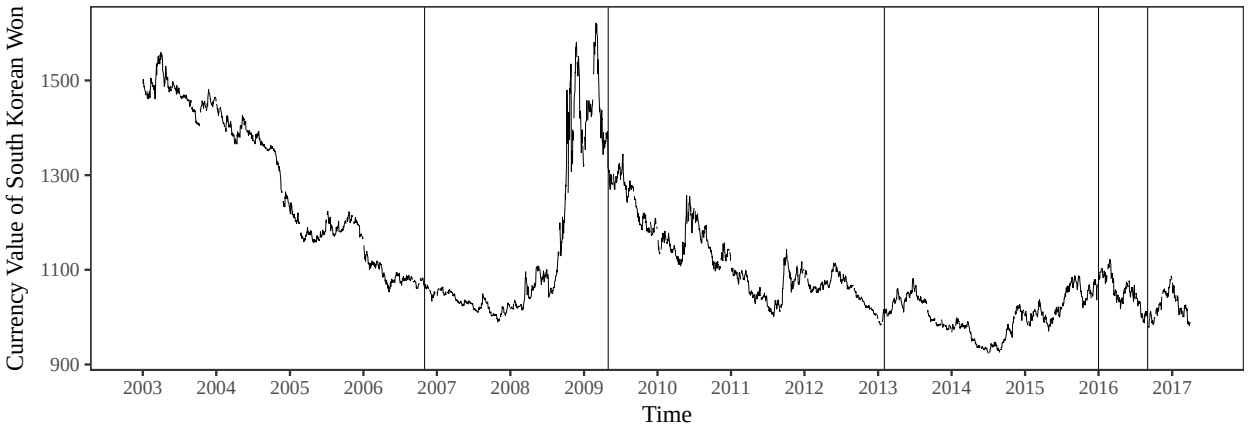


Figure 1: Daily Values of South Korean Won (2003-2017)

For this variable, we created five dummy variables: each dummy variable representing respective nuclear test (1 if nuclear test took place, 0 if otherwise). Because our main interest is a short-term effect of DPRK's nuclear test on dependent variables, we designed these dummy variables differently according to Korean won and tourist inflow. For exchange rate, we created dummy variables as follows: 1 since the day the test took place for next 30 days, and 0 if not (monthly span dummy). For tourist inflow, we generated dummy variables as follows: 1 since the day the test took place for next 6 months, and 0 if not (6-months span dummy). The best scenario would have been to obtain daily data for tourist inflow as well as unifying nuclear test dummy variables to monthly span dummies. However, we were unable to obtain such data, and monthly data was the best one we could gather (**Table 1**).

Table 1: Summary of Variables

DV1	Daily exchange rate (Growth rate, %) Source: Federal Reserve Economic Data
DV2	Tourist monthly inflow (Growth rate, %) Source: Korea Tourism Organization
IV	North Korean nuclear tests (5 dummy variables to represent each nuclear test) For DV1: Monthly span (1 if one month from the deployment of each nuclear test) For DV2: 6-months span (1 if 6 months from the deployment of each nuclear test)

4.2 Model Specification

Time-Series variables always involve autocorrelations within signal and noise since they are correlated by times, thus violating the IID assumption. In order to remove systemic variation in the noise and to confirm that the remaining variation is white noise (no systemic variation with respect to time), we rely on an autoregressive integrated moving average (ARIMA) model to observe whether and how variables and their residuals are lagged.

ARIMA model generally assumes that past events have perfect memory while there is a long-term mean where the value eventually returns (Box-Steffensmeier 2014). This process is composed of three main parts. First, an autoregressive process (AR) functions under an assumption that past values have an effect on current values. For instance, $AR(1)$ process, which is based on one lag, specifies that the current value is based on the immediately preceding value. Second, a moving average process (MA) operates under a premise that errors in the linear models are shocks to a stable system that may take a while to stop being influential. $MA(1)$, which is based on one lag, specifies that the current residual is based on the immediately preceding random shock. Simply put, $AR(p)$ represents lagged dependent variable and $MA(q)$ does for lagged residuals. Third, a letter "I" stands for whether the equation is integrated, meaning that the series is not stationary and does not hold a long-term

Table 2: Results for Dicky-Fuller Tests

Variable	Optimal lags	p-value (chi^2)	t-statistics	Critical value at 5%	Observations	Conclusion
Exchange Rate	1	0	-43.071	-1.645	3306	Stationary
Tourist Inflow	1	0	-15.397	-1.654	168	Stationary

mean.

In order to estimate these parameters, we implement Dicky-Fuller test. This test allows us to estimate not only how many lags are required for the value (AR) but also whether this value is integrated (I). It does so by examining if a unit root is present in an autoregressive model for each dependent variable.[24] Because the variables increase or decrease over time, we added drift term. The hypotheses we test here are as follows:

H_0: There is a unit root around a deterministic trend H_1: The series is stationary around a deterministic trend

The result shows that we can reject null hypothesis for both Korean won and tourist inflow (**Table 2**).[25] In other words, for both variables, p-value for z-score is 0.000. Thus, we reject the null hypothesis of a unit root at the 99% significance level. This means that these variables are stationary with long-term mean. In sum, we have assessed that the most suitable model for both Korean currency and tourist inflow is ARIMA$(1, 0, 0)$.

4.3 Results

Based on the models that we have specified for exchange rate and tourist inflow, we now add an exogenous independent variable – in this case, North Korean nuclear tests – generating ARIMAX model (ARIMA with X variable). This setting allows us to test two aspects: 1) the

[24] Unit root is a feature that describes stochastic part of the model, which is usually assumed to be randomly distributed but may be autocorrelated in time-series data. There is a unit root when there is autocorrelation (the correlation between a time-series variable and itself with one or more lags).

[25] To determine optimal number of lags, we run DF-GLS unit root test prior to Dicky-Fuller test. It performs a modified Dickey-Fuller t-test for a unit root in which the series has been transformed by a generalized least-squares regression.

effect of an independent variable on the long-term mean of Y, and 2) the impact of current changes, shocks, or trends of an independent variable on future changes, shocks, or trends on the dependent variable. However, instead of focusing on long-term dynamics, what we are more interested in scrutinizing is the effect of recent changes in an independent variable. In other words, instead of testing whether nuclear tests have effects on long-term mean, we are more interested in whether each nuclear test has any immediate or temporal effect on the rates. To do so, we implement Granger causality and vector autoregression (VAR) tests. The former test lets us to take the time trends of both independent and dependent variables into account. The latter test is an extension of the former. VAR helps us to capture omitted variable bias and to speculate an order of causality for the variables. These tests are suitable since both dependent variables hold AR structure without MA processing while their series are stationary.

4.3.1 Results on Exchange Rate

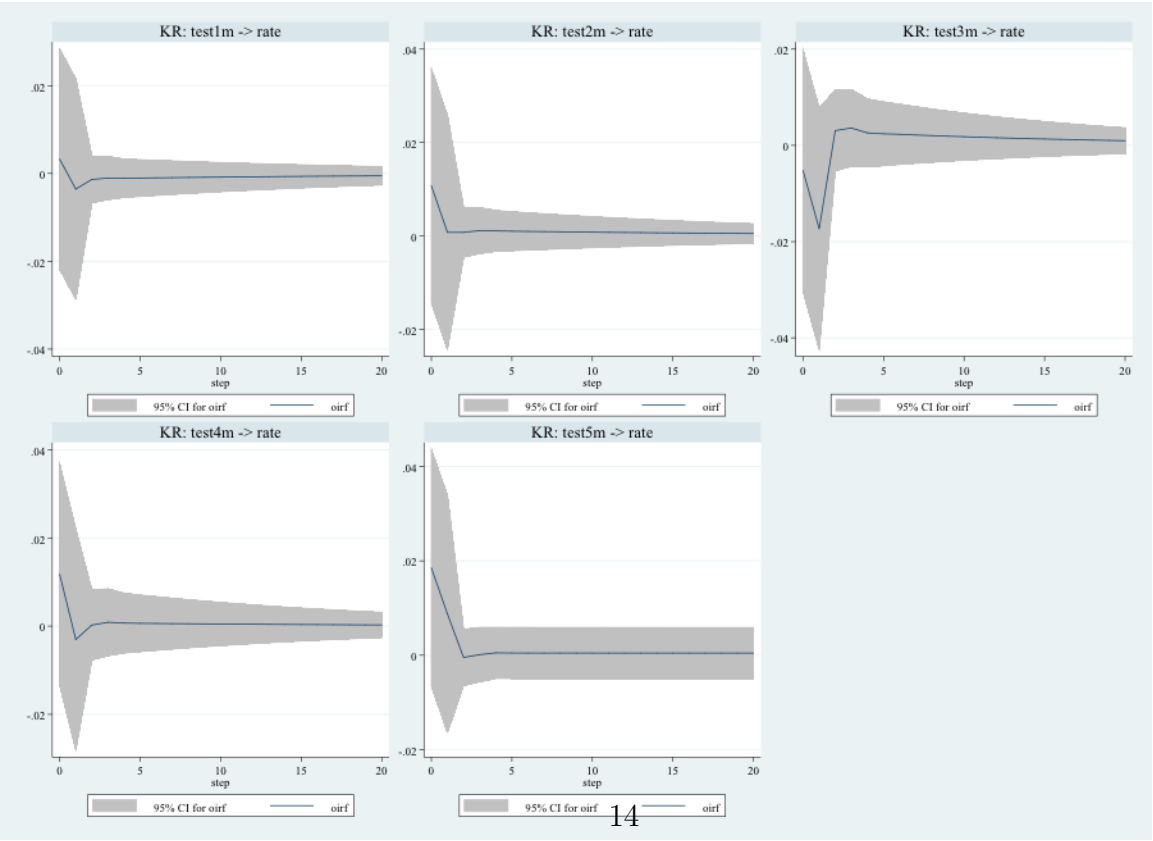
We first test impact on exchange rate by running ARIMAX model. As shown in Table 3, none of the measures on nuclear tests turns out to be statistically significant. This indicates that nuclear tests do not yield an effect on long-term mean of exchange rates. Still, there are some noticeably dissimilar tendencies across five tests. Except for the first test, the rest of tests hold positive coefficients. In other words, only the first nuclear test strengthened Korean currency while the other tests caused currency depreciation. This is quite different from our initial expectation that the first test would yield the greatest depreciation. The second observable tendency is that this first nuclear test yields the weakest impact while the second test seemed to have the strongest impact.

Table 3: ARIMAX Results of the Effect of North Korean Nuclear Tests on Exchange Rate

	Dependent variable:	
	Korean Won (Growth Rate)	
	(1)	(2)
AR1	-.020*	-.020*
	(-0.008)	(-0.008)
Test1		-0.027
		(-0.335)
Test2		0.163
		(-0.159)
Test3		0.016
		(-0.344)
Test4		0.047
		-0.149
Test5		0.094
		(-0.225)
Constant	-0.009	-0.01
	(-0.012)	(-0.013)
Sigma	.755***	.754***
	(-0.002)	(-0.002)
Obs	3580	3580
Log-Likelihood	-4071.371	-4070.593

***p <0.001, **p <0.01, *p <0.05, #p<0.1; standard errors in parentheses.

Figure 2: Comprehensive Effects of Nuclear Tests on Exchange Rates (IRF)



Nonetheless, due to large standard errors of coefficients of nuclear tests, it is difficult to rely on these results. Instead of focusing on long-term dynamics, what would be more appropriate to scrutinize is their short-term effects. Thus, we apply Granger causality along with vector autoregression (VAR) tests. For a better visual presentation, we only report results based on Impulse-Response Function (IRF), which is generated based on VAR results, to graphically present the comprehensive effect from nuclear tests to exchange rates over time. The figures compiled in Figure 2 show short-term impact of each nuclear test on Korean won. The most conspicuous trend here is that the impacts disappear immediately (regardless of directions or magnitudes of impacts) and the mean returns to zero. However, what is still puzzling though is that the short-term impact for each nuclear test turns out to be downward or negative, implying that currency values appreciate after the irruption of the tests. This observation demands further investigation.

4.3.2 Results on Tourist Inflow

In order to examine the impact of nuclear tests on tourist inflow, we first apply ARIMAX (Table 4). As what we have observed from exchange rate, we do not find any test statistically significant, indicating that these tests do not yield a long-term effect. Furthermore, what is surprising is that coefficients of the tests, except for the fifth one, are positive. This implies that these previous four tests increased number of tourists. Although this tendency seems puzzling, we further proceed to Granger causality and VAR tests to shed light on short-term impacts.

As can be seen in Figure 2, the mean again returns to zero after an immediate effect after each test. Although confidence intervals seem to be quite large, there is a noticeable trend. After the first and second tests, the incoming tourists decreased, although the numbers increased afterwards. In contrast, for the rest of tests (third, fourth, and fifth), the tourist numbers increased, followed by a decrease in these flows. It is questionable why tourist volumes

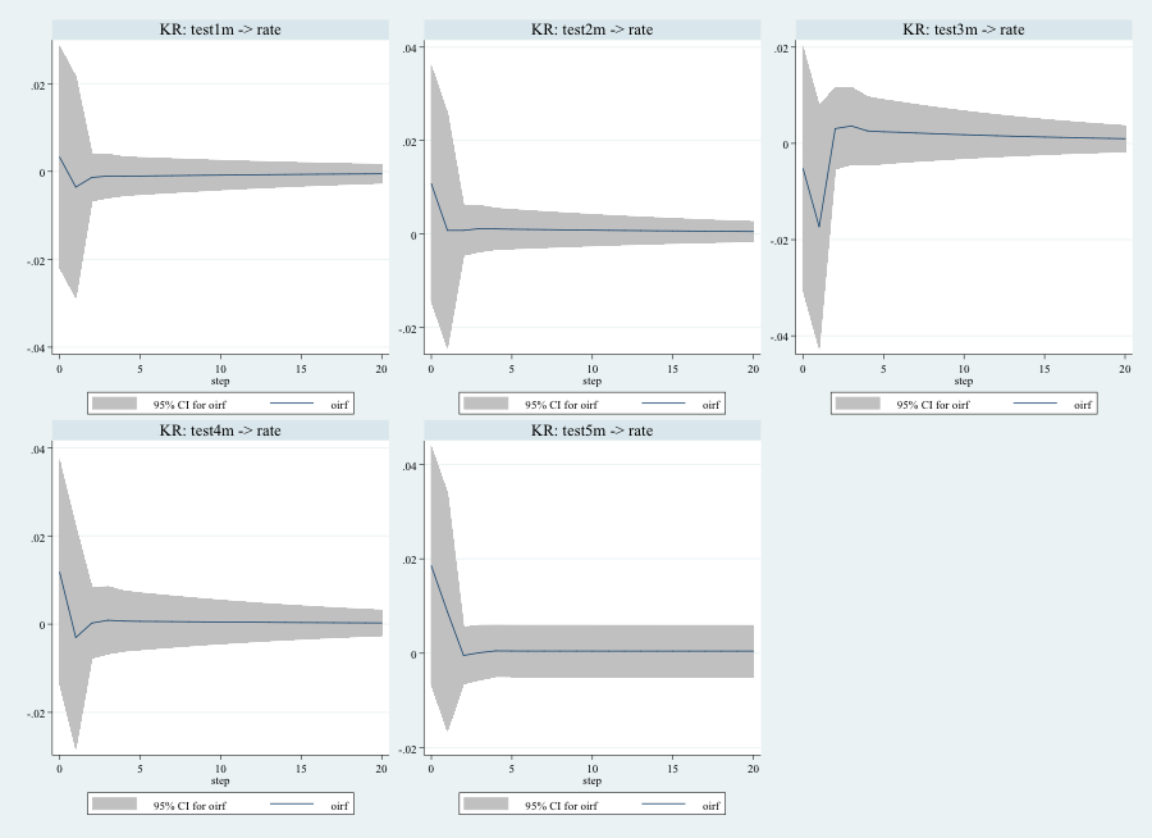
increased for these last three tests. Overall, it seems that negative impacts from nuclear tests have been diminished after two rounds. Still, it will be worthwhile to further scrutinize why these effects become positive since the third test.

Table 4: ARIMAX Results of the Effect of North Korean Nuclear Tests on Tourist Inflow

	Dependent variable:	
	Tourist Inflow (Growth Rate)	
	(1)	(2)
AR1	-.223**	-.225**
	(-0.064)	(-0.065)
Test1		0.7
		(-7.703)
Test2		1.94
		(-2.981)
Test3		4.862
		(-9.17)
Test4		0.684
		(-13.162)
Test5		-0.918
		(-7.109)
Constant	1.980*	1.722#
	(-0.898)	(-0.968)
Sigma	14.153***	14.106***
	(-0.653)	(-0.662)
Obs	170	170
Log-Likelihood	-691.7399	-691.1564

***p <0.001, **p <0.01, *p <0.05, #p<0.1; standard errors in parentheses.

Figure 3: Comprehensive Effects of Nuclear Tests on Tourist Inflow (IRF)



5 Conclusion

In this article, we present a theory that the destabilizing effect of North Korean nuclear tests should be diminishing due to (1) the establishment of a particular pattern and (2) the habituation process that results in decreased response after repeated shocks. Using time series analysis, we test the implication of this theory on two separate variables: the exchange rate of South Korea Won and the tourist inflows to South Korea. Since both tests suggest that the effect of each nuclear test tend to be substantively small and statistically indistinguishable from zero, they do not provide empirical support for our theory.

The results are counterintuitive when compared with other studies about North Korean nuclear threats. For instance, using an alternative measurement, Dibooglu and Cevi (2016) find that

North Korean threats has a significant effect on South Korean stock market exchange. One reason that might explain this difference is how the independent variables are operationalized in our approach. While we conceptualize nuclear tests as equal shocks to a time series with ARIMA disturbance that only differs in their order, perhaps it is necessary to consider the details of each test and take other factors such as the sophistication of the technology being tested and the implications on DPRK nuclear capability into account.

Another possibility is that the ARIMA processes of exchagne rate and tourist inflows are not correctly identified and more sophisticated models that take additional time dependences such as seasonality into consideration is necessary. We have conducted several preliminary tests using a SARIMA model instead, but the results do not change significantly from the ones being presented in this study. Finally, as we pointed out in the earlier sections, it is possible that exchange rate and tourist inflows are weak proxies of "perceived North Korean threat" as they might have a stronger correlation with economic factors. In this case, a better measurement approach or a more fine-grained data of our dependent variable might be able to resolve this issue.

Ultimately, it is also possible that our theory is not sufficient to explain the disturbance caused by North Korean nuclear tests. While the general public might indeed have a sense of "habituation" and become used to the uncertainty caused by North Korea, perhaps it is not perceived in the same way by the international financial community or tourists from other countries in the world. More empirical works need to be done to clarify which one is the case.

6 Appendix

6.1 Chronology of Key Events in South Korea (2003~)

2003 October - Biggest mass crossing of demilitarised zone since Korean War: Hundreds of South Koreans travel to Pyongyang for opening of gymnasium funded by South's Hyundai conglomerate.

2004 February - Parliament approves controversial dispatch of 3,000 troops to Iraq.

2004 June - US proposes to cut its troop presence by a third. Opposition raises security fears over the plan.

2005 June - Kim Woo-choong, the fugitive former head of Daewoo, returns and is arrested for his role in the industrial giant's $70bn-plus collapse. In May 2006 he is sentenced to 10 years in jail.

2005 December - South Koreans are shocked by revelations that cloning scientist and national hero Dr Hwang Woo-suk faked landmark research on stem cell research.

2006 October - Foreign Minister Ban Ki-moon is appointed as the UN's new secretary-general. He takes office in January 2007.

2007 February - South and North Korea agree to restart high-level talks suspended since July 2006 in wake of North's nuclear test. Head of the largest South Korean car maker, Hyundai, is jailed for three years for embezzlement.

2007 April - South Korea and the US agree on a free-trade deal after 10 months of talks, although US Congress only ratifies it in 2011.

2007 May - Passenger trains cross the North-South border for the first time in 56 years.

2007 December - Conservative Lee Myung-bak wins landslide victory in presidential election.

2008 February - The country's greatest cultural treasure, the Namdaemun Gate, is destroyed by fire.

2008 October - Government announces $130bn financial rescue package to shore up banking system and stabilise markets amis global financial crisis.

2009 January - North Korea says it is scrapping all military and political deals with the South.

2009 August - Former South Korean president Kim Dae-jung dies; North Korea sends a senior delegation to Seoul to pay its respects.

2009 October - North Korea expresses "regret" for unleashing dam water that drowned six campers downstream in South Korea in September. The two sides hold talks aimed at preventing flooding on the Imjin River which spans their militarised border.

2009 November - South and North Korean warships exchange fire across a disputed sea border, and again in January.

2010 January - North accepts an offer of food aid from South, the first such aid in two years.

2010 May - South Korea breaks off all trade with the North after naval ship Cheonan was sunk by a North Korean torpedo in March. Pyongyang describes the findings as a "fabrication" and cuts all diplomatic ties with Seoul.

2010 November - Cross-border clash near disputed maritime border results in death of two South Korean marines. South Korea places its military on highest non-wartime alert after

shells land on Yeonpyeong island. Further exchange of fire in August.

2012 July - South Korea begins move of most ministries to "mini capital" at Sejong City, 120km south of Seoul. Key ministries will remain in Seoul.

2012 August - Lee Myung-bak becomes first president to visit the Liancourt Rocks, which Japan also claims. Tokyo recalls its ambassador in protest.

2012 October - South Korea strikes deal with the US to almost triple the range of its ballistic missile system to 800km as a response to North Korea's test of a long-range rocket in April.

2012 December - South Korea elects its first female president, Park Geun-hye, of the conservative Saenuri party. She takes office in February.

2013 January - South Korea launches a satellite into orbit for the first time using a rocket launched from its own soil. Comes weeks after a North Korean rocket placed a satellite in orbit.

2013 March - South Korea accuses North of a cyber-attack that temporarily shuts down the computer systems at banks and broadcasters.

2013 September - North and South Korea reopen Kaesong joint industrial complex and hotline.

2013 December - South Korea announces expansion of air defence zone, two weeks after China unilaterally announced its own extended air defence zone in East China Sea to include disputed Socotra Rock.

2014 March - North and South Korea exchange fire into sea across the disputed western maritime border during largest South-US military training exercise in region for 20 years.

2014 April - Sewol ferry sinks off west coast, killing at least 281 people, mainly high-school students.

2014 October - North and South Korea engage in rare exchange fire across their land border as South Korean activists launch balloons containing leaflets condemning North Korean leader Kim Jong-un. Gun fire also exchanged when Northern patrol ship crossed disputed western maritime border. US and South Korea again postpone transfer of control over troops in South in event of war with North, citing "intensifying threat" from Pyongyang. Transfer due in 2012, and delayed until 2015. No new date set.

2014 December - Constitutional Court bans left-wing Unified Progressive Party, accused of being pro-North Korean. President Park calls for cyber security at key facilities to be strengthened after data on its nuclear reactors is leaked.

2015 March - North Korea fires short-range surface-to-air missiles into the sea in an apparent show of force against annual military drills between South Korea and the United States.

2015 November-December - Mass protests in Seoul against government's economic policy and insistence on schools' using state-approved history books.

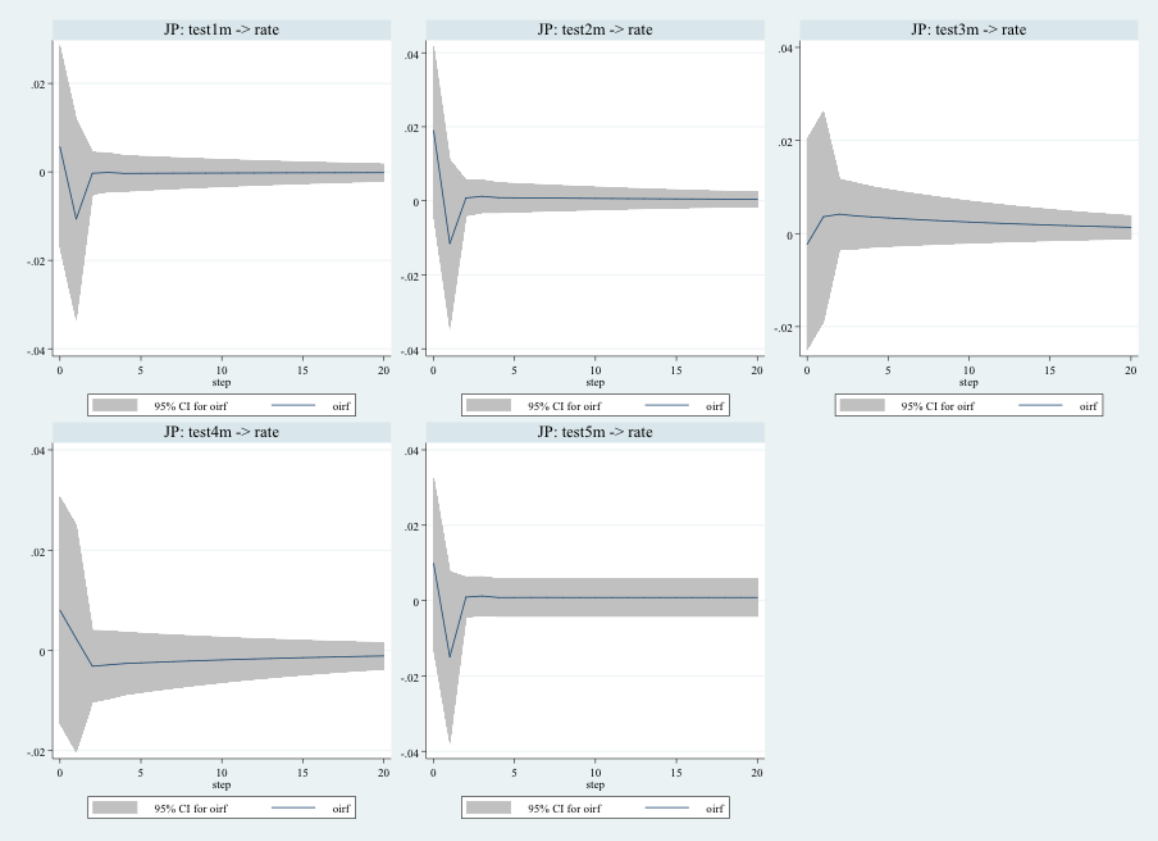
2016 October - President Park Geun-Hye is embroiled in a political crisis over revelations that she allowed a personal friend, with no government position, to meddle in affairs of state. She is later impeached.

2016 December - South Korea's military says its cyber command came under attack by North Korean hackers.

2017 May - The centre-left candidate Moon Jae-in is elected president in a landslide, and pledges to solve the North Korean crisis by diplomatic means.

6.2 IRF Results on Japan

Figure 4: Comprehensive Effects of Nuclear Tests (Monthly Span) on Exchange Rates (Growth Rate %)



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