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The contagious effects on economic development after resuming construction policy for nuclear power plants in Coastal China

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ABSTRACT

This paper investigates the impact of China's 2005–2020 nuclear expansion policy on the stock prices of nine major economic sectors in China, Japan and the US. Contagion tests based on changes in co-volatility and both forms of co-kurtosis are applied to identify how policy shocks impact markets and sectors. Monte Carlo experiments show that all of these tests perform well in power and that the co-kurtosis test performs better than the co-volatility test. Results for 2011 through 2016 show that China's nuclear expansion policy has the most impact on sectors in China, with less significance in Japan, and with the least effect in the US. The most significant effects are coincident with major events that occurred in the post-announcement period when the 13th Five Year Plan was implemented. Sectors which are closely related to nuclear power are the most sensitive to policy announcements.

1. Introduction

Due to the rapid growth in electricity demand and rise in environmental awareness, China has looked to nuclear energy to help address those issues. The development of nuclear power began in the 1980s, but it took until 1991 for the first nuclear power plant to go into commercial operation [54,74]. Since 2000, China has shifted from "moderate" to "aggressive" nuclear energy development [75]. In 2006, China's State Council approved the national plan for medium- and long-term nuclear power development (2005–2020) [49]. Before January 2016, China's nuclear industry had 30 operating plants with a capacity of 27 Gigawatts (GW) and 24 sites under construction with a capacity of 27 GW. By 2020, China will have 58GW in operation and 30 GW under construction. This will constitute 6% of the national installed energy capacity [26,31,65,75].

China's nuclear energy program is a key component of economic development [5,34,39]. According to the Nuclear Energy Institute, the Ginna nuclear power plant in Ontario, New York State, US, illustrates the economic effect [50]. It contributed $450 million to the economy, and supported 2000 jobs in 2014. Being a large contributor means that the industry may be more sensitive to changes in energy policy (e.g., the long-term nuclear power development plan, the closure of nuclear power plants, etc.). Nuclear expansion policy can have a significant economic impact on the domestic economy and markets in other countries. The transmission of policy shocks from the nuclear sector to neighboring sectors, markets or countries is described as the "contagion effect" [21,24].

This paper investigates the impact of the 2005–2020 Chinese nuclear expansion policy on the stock prices of nine major economic sectors across three countries. This policy is part of a major national development plan involving hundreds of billions of RMB [75], and provides an excellent opportunity to study the interaction between nuclear policy and sector performance. We investigate the impact of expansion on sector performance in China and other countries. Furthermore, we develop three contagion tests: i) the co-volatility change test, ii) the first form of co-kurtosis change test, and iii) the second form of co-kurtosis tests. Here, contagion is a significant change in co-volatility and co-kurtosis between two markets observed after the policy announcement and during the pre-announcement period [23]. An extensive set of linkages are investigated for spillover effect by testing contagion linkages between nuclear power sector and nine major sectors in China, Japan and the US.

Despite of the close relationship between market performance and policy, surprisingly, very little research has been focused on the influence of nuclear expansion on market sector performance. Market performance research in the energy literature has focused on: i) the impact of the Fukushima accident on housing market [7,9,20,76] as well as the power sector [36], ii) the impact of nuclear retirement and phase-out on the power sector [51,52,55,72], iii) the impact of an increase in power rate on the manufacturing sector

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[40], and iv) the impact of the global financial crisis on the energy sector [41]. It is only in recent years that the impact of nuclear expansion on market performance has begun to attract attention from academic and policy makers.

Previous works focus on the effect of the Fukushima disaster, nuclear power phase-out, the global financial crisis, and nuclear power development and safety [1,37,46,54,61,67]. Studies on the impact of China's nuclear expansion on market performance are scarce. This paper fills the research gap in the literature in the following ways. First, three types of contagion tests developed by Fry-McKibbin and Hsiao [23] are applied to identify how policy shocks affect international market sectors by capturing changes in asset return relationships such as cross-market volatilities (co-volatility) and cross-market mean and skewness (co-kurtosis). Second, these tests can capture more co-movement than the traditional linear dependence test developed by Forbes and Rigobon [21] and they provide better results for high frequency data like the daily stock returns analyzed in our study. Third, Monte Carlo experiments show that the tests perform reasonably well in power and that the co-kurtosis test performs better than the co-volatility test. Finally, the announcement sensitivity index is constructed to examine which market sector is more likely to be affected by the nuclear power announcement.

The contagion tests based on changes in co-volatility and co-kurtosis are applied to investigate the spillover effect of China's nuclear expansion on nine major economic sectors across three countries. Results for 2011 through 2016 reveal that China's nuclear expansion has most significantly impacted sectors in China, followed by Japan, with the least impact on the US. Significant contagion from China's nuclear sector to the nine major sectors of commerce, energy, finance, healthcare, industrials, information technology, materials, telecommunication services, and utilities are seen in our results. Closely related energy, industrials and materials sectors exhibit a high rate of announcement sensitivity, while unrelated sectors like commerce and healthcare exhibit low rates.

Our paper provides a review of the literature involving China's nuclear power industry in Section 2, outlines our methods in Section 3, discusses data and empirical results in Section 4 and provides conclusion in Section 5.

2. Literature reviews

The spillover effect of nuclear energy policy on market performance has been of great concern to academics and policy makers because of its important consequences on the national economy [5,34,39,48,69]. In the energy literature, most of researchers focus on studying the impacts of nuclear phase-out, relevant energy policies and unexpected nuclear events. Energy policies and unexpected events have significant impacts on market performance around the world.

A number of studies have explored the impacts of phasing out nuclear power on the housing market [7], power sector [51,52], energy and environmental systems [28,47,55,72] and the national economy [11]. Bauer et al. [7] used a difference-in-differences approach to analyze the effect of the Fukushima accident on the German housing market. They found that the closure of nuclear power plants has negative economic effects. Bretschger and Zhang [11] used a computable general equilibrium (CGE) model to analyze the economy-wide effects of phasing out nuclear power. They found that full phase-out can lead to welfare losses of 0.4% in the US. Li et al. [41] found that longer nuclear lifetimes had a negative impact on the gas industry in China. Ochoa [51] found that closing down nuclear plants led to an increase in electricity price in Switzerland. Richards and Cole [55] used the Regional Energy Deployment System (ReEDS) model to analyze the impacts of nuclear retirement on energy and environmental systems. They found that longer nuclear lifetimes resulted in lower carbon emissions, lower costs for transmission, and more efficient usage of energy and water.

Energy literature has included investigating the effects of energy policy on sector performance such as the electricity exchange scheme [52] and the increase in power rate [38,40]. Ochoa and Ackere [52] studied the impact of electricity imports and exports policy in Switzerland. They found that international electricity exchanges help to lower costs and to increase the income of the utility companies. Lee [40] found that an increase in electricity rate has a negative influence on the Korean manufacturing sector. Kwon et al. [38] found that an increase in electricity price adversely affected the manufacturing output in South Korea.

Studies have examined issues related to the impact of unexpected events and shocks such as nuclear disasters, oil price shocks, weather factors, and global financial crises on sector performance around the world. The nuclear disasters had a negative impact on the housing market in China [76], Germany [8], Sweden [2], Switzerland [9] and the US [20], as well as energy and power sector in China [73], Japan [15,19,29,36] and around the world [17]. For example, Boes et al. [9] tested the influence of the Fukushima nuclear disaster on rental prices in Switzerland. They found a significant price discount for rental apartments near nuclear power plants after the accident. Fink and Stratmann [20] used a difference-in-differences approach to investigate the change in home prices in the US after the Fukushima event. They found that home prices close to nuclear reactor sites did not fall relative to home prices at other locations. The oil and energy shocks had a significant effect on energy sector in China [25,35,63] and Kenya [33]. Moreover, the global warming and weather conditions had a significant effect on the electricity market in Brazil [58], Hong Kong and Singapore [4], and the European countries [45], as well as energy markets in the Southeast Asian countries [56] and the US [18,32]. Furthermore, the global financial crisis also had a negative impact on the energy sector in China [41,70,71], the European countries [3,7], Lebanon [10] and the US [57,59]. Li et al. [41] found that exports decreased in the energy-related and raw material sectors during the global economic crisis. Wang and Guo [62] found that the European debt crisis caused asymmetric spillover effect between two types of energy markets. Yuan [68] found that the global financial crisis led to a decrease of 7.33% in GDP and a reduction of 9.21% in energy consumption in China.

3. Constructing the mathematical models

Contagion tests and the announcement sensitivity index are used in this research to model the effects of China's nuclear expansion on nine major sectors across three countries. Three types of contagion tests are used to determine how individual sectors were affected by nuclear expansion. This is followed by a description of how we calculate the announcement sensitivity index to evaluate each industry's performance over the entire post-announcement period. Finally, a range of Monte Carlo experiments are conducted to evaluate the performance of three types of contagion tests in terms of power property.

3.1. Contagion tests

In the economic literature, "contagion" refers to the spread of market disturbances to neighboring markets, sectors or countries [21]. Several methods of testing for financial market contagion have been developed [6,14,24,53]. In this study, contagion tests based on changes in co-kurtosis and co-volatility are developed to examine the impact of nuclear policy announcements. These tests capture