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Ripple effects of the 2011 Japan earthquake on international stock markets

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ABSTRACT

This paper provides a comprehensive analysis of the impacts of Japan's 2011 earthquake on 19 stock market sector returns in Japan and its trading partners both in the short and long run. Using an event study methodology, we find that the impact of this event was not limited to Japan or industries directly hit by the earthquake. Our short-run analysis indicates that all sector indices in Japan and many in its trading partners were affected by the earthquake. The direction of the impact on trading partners, however, was not the same for all sectors; while the earthquake adversely affected the majority of the sectors analyzed, some sectors benefited. Further, we find that the magnitude of the abnormal returns did not systematically vary across trading partners according to their shares in Japan's trade flow. The long-run analysis reveals how the consequences of the earthquake unfolded beyond the event date.

1. Introduction

The March 11, 2011 Tohoku-Oki earthquake and tsunami in Eastern Japan and the resulting Fukushima Daiichi nuclear accident had a significant negative impact on the economy of Japan (Nanto et al., 2011). Direct damages were estimated at $211 billion (Kajitani et al., 2013) making it one of the largest disasters on record (CRED, 2011). The earthquake hit the home of the automobile and semiconductor manufacturing industries, destroying not only factories but also disrupting the supply of raw materials, leading to a suspension of the workflow in many large-scale automobile manufacturers, such as Toyota, Nissan, and Honda (Khazai and Daniell, 2011). Japan's manufacturing sector faced an additional challenge due to power shortages, resulting in disruption and temporary closings of manufacturing plants, even those that were not directly damaged by the earthquake (Kachi and Takahashi, 2011).

In this age of just-in-time production processes, even a small disruption in the supply of a single component can cause turmoil in the entire production line (Nanto et al., 2011). This is particularly important in high-tech industries such as automobiles, telecommunications, and consumer electronics. Considering that Japan is a central hub for international supply chains (JETRO, 2011), interruptions in the Japanese industrial activity can have adverse impacts on global supply chains. Thus, the 2011 Japan's earthquake might have affected different industries in other countries either negatively due to supply chain distortions or positively because of a potential rise in the market share for domestic firms as a result of Japan's reduced competitiveness.

These possible impacts on both Japanese and global industries can be explored through an analysis of stock market behavior around the date of the earthquake (i.e., an event study analysis) as stock prices of publicly traded companies indicate how investors value firms' current performance and future earnings potential, provided that stock markets are relatively efficient. Specifically, we

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seek to answer the following questions. First, which specific sectors in the stock markets of Japan and its trading partners were affected by the 2011 earthquake and how strong were the effects and in which direction? Second, were the stock markets of Japan's major trading partners more affected than those of minor trading partners?

Earlier studies examining the reaction of stock markets to natural disasters have focused on stock returns of companies aggregated at the state level (e.g., Bourdeau-Brien and Kryzanowski, 2017), entire stock market indices (e.g., Worthington and Valadkhani, 2004; Worthington, 2008; Ferreira and Karali, 2015), and single sector indices, such as insurance (e.g., Shelor et al., 1992; Aiuppa et al., 1993; Lamb, 1995; Cagle, 1996; Angbazo and Narayanan, 1996; et al., 2002Yamori and Kobayashi, 2002; Krämer and Schich, 2008; Wang and Kutan, 2013), and real estate (e.g., Shelor et al., 1990). We know of only one study, by Worthington and Valadkhani (2005), that investigates the impacts of several natural disasters, industrial accidents, and terrorist attacks on different market sector indices, such as energy, healthcare, financial, technology, telecommunication services, and utilities, of the Australian capital market. Perhaps not surprisingly, results from this study indicate that the effects of these events depend on the business sector in question.

Another strand of the literature examines the existence of contagion in international financial markets following financial crises and natural disasters. However, the empirical research has been more concentrated on financial crises, such as the Mexican Peso crisis of 1994 (e.g., Ahlgren and Antell, 2010), the Asian crisis of 1997 (e.g., Rodriguez, 2007), the Russian bond market crash of 1998 (e.g., Ahlgren and Antell, 2010), and the financial crisis of 2007–2008 (e.g., Boubaker et al., 2015; De Angelis and Gardini, 2015; Lehkonen, 2015), because stock markets have been the first to react in every financial crisis (Kontonikas et al., 2013; Chevapatralul and Tee, 2014; Jayech, 2016). Applied to natural disasters, there are only a limited number of studies. For instance, Lee et al. (2007) employ a sample of 26 international exchange rates and stock indices and find that although the foreign exchange markets of some countries suffered from contagion in the aftermath of the 2004 Southeastern Asia tsunami, no single country's stock market reacted. On the contrary, Asongu (2012) finds that while the foreign exchange markets in 33 countries did not reveal contagion effects in the immediate aftermath of the Japan's 2011 earthquake, the stock markets of several countries (Taiwan, Bahrain, Saudi Arabia, and South Africa) suffered from a contagion effect. Ferreira and Karali (2015), analyzing the impact of major earthquakes on the return and volatility of aggregate stock market indices in 35 financial markets between 1994 and 2014, conclude that global financial markets were resilient to earthquake shocks.

Evidently, the results from these earlier studies are not conclusive about the impacts of natural disasters (and specifically earthquakes) on international stock markets. One possible explanation could be due to differences in the severity and the geographical location of the disasters they consider. For instance, the Southeastern Asia tsunami occurred in the western part of Indonesia. Although it also affected other countries, none of these countries are as important and influential as Japan in the world economy. Therefore, disruptions in these economies probably have fewer consequences compared to disruptions in highly industrialized economies such as Japan. Further, the analysis of the response of aggregated market indices, such as in Ferreira and Karali (2015), cannot shed light on which specific sectors are driving the results, and may mask very negative abnormal returns in specific sectors if these are compensated with positive returns in others.

Regarding the 2011 Japanese earthquake, except for Asongu (2012), the majority of earlier studies have investigated the implications of the Fukushima accident for the stock returns of conventional and alternative utilities and nuclear energy both at domestic and international levels (e.g., Kawashima and Takeda, 2012; Lopatta and Kaspereit, 2014; Ferstl et al., 2012; Betzer et al., 2013; Mama and Bassen, 2013). We are aware of only one study, by Takao et al. (2013), that analyzes the impact of the earthquake on other stock prices (specifically those of non-life insurance companies in Japan). However, the impact of the earthquake was not restricted just to the insurance and energy sectors; automobile, semiconductor, electronics, food, and even tourism industries were also affected (Nanto et al., 2011). These impacts could be transferred to industries in other countries, as well. For instance, the US banned imports of certain types of food from several regions in Japan following the Fukushima incident; and the European Union, China, and many other countries increased the surveillance of food products from Japan (Nanto et al., 2011). Thus, the food industry in the US and other countries could be influenced. As another example, damages to Japanese automobile industry could have consequences for companies in other countries that rely on Japan for critical components required in the production line.

This motivates us to provide the first comprehensive analysis of the impacts of the 2011 Japanese earthquake on all business sectors in stock markets of Japan as well as some of its trading partners. Our analysis seeks to open the "black box" of aggregate market indices to help policymakers and investors thoroughly understand the economic implications of natural disasters. Because these implications are potentially different in different sectors and countries, a disaggregated analysis can assist in better preparing for and responding to disasters. Our study contributes to the existing literature in several ways. First, we use sector-level indices instead of aggregate stock market prices in contrast to previous studies. This increases the power of our study to detect reactions of stock markets to natural disasters; by disaggregating the stock market's broad price index, we can detect possible asymmetries in the effects of the disasters on different sectors. If natural disasters affect different sectors in different directions then when these impacts are aggregated they may offset each other and the entire stock market index may not react.[1] Second, using a sample of Japan's major and minor trading partners, we analyze possible links between trade linkages and contagion effects across international stock markets. We do this because international trade linkages are a channel through which country-specific crises can spread over international financial markets (Forbes, 2002). Third, our approach allows us to compare the magnitudes of the impacts on different

[1] It should be noted a similar aggregation issue might arise from using sector-level indices. While some of the companies included in a given sector index might exhibit positive abnormal returns in their stocks, the others might have negative abnormal returns. These positive and negative impacts might offset each other, and therefore a reaction in the entire sector index might not be observed. A commonly used alternative is to conduct the analysis at firm-level stock prices. However, a firm-level analysis for all the sectors and all the countries is beyond the scope of this paper. Therefore, we take an intermediate approach between aggregate stock market indices and firm-level prices and focus on sector-level indices to shed light on the dynamics across sectors and countries.