

The impact of The Great East Japan Earthquake to Japan Economy

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Abstract. On March 11, 2011, Japan witnessed a devastating earthquake, which is examined in this article along with the likely short-term economic consequences. The center of Great East Japan Earthquake was close to Tohoku, Japan's northeastern shore. It triggered a massive tsunami and the subsequent Fukushima nuclear accident, which resulted in extensive damage and several casualties. The earthquake had a major impact on economic development not just in the areas directly affected by the earthquake, but also in other parts of Japan. This tragedy claimed the lives of more than 23,000 people (as of May 23) and inflicted damage estimated around \$200 billion in Japan. This article focuses on evaluating effects of this natural disaster on the economy of Japan. There are two aspects included by this analysis-the real private residential investment and consumption expenditures. The ARIMA model analysis of the data prior to the earthquake and the comparison of the actual data with the estimated data from following months show that the earthquake had a detrimental effect on Japan's economy. According to the ARIMA model analysis, The Great East Japan Earthquake have different influence on the Japan economic. For consumption expenditure, the earthquake exerts a negative impact on it, while the real private residential investment is increased after this earthquake.

Keywords: The Great East Japan Earthquake, consumer consumption, real residential investment.

1. Introduction

On March 11th, 2011, The Great East Japan Earthquake, with a magnitude of 9.0, was the strongest ever recorded in Japan and the fourth most powerful in the world since 1900 [2]. This seismic earthquake originated close to Tohoku's northeastern shore. The Japan Meteorological Agency (JMA) Seismic Intensity Scale provide seismic intensity shows that the Kurihara, Miyagi is the strongest prefecture place which is 7 [3]. Then, the Tomeshi, Osaki, Yamamotocho and those place recorded 6+ on the Japan Meteorological Agency (JMA) Not only the influence of the earthquake, but this earthquake also happened along with the huge tsunami. Strong tsunami waves were caused by the earthquake at Miyako, and they may have reached heights of up to 40.5 meters (133 feet) [4]. In this major calamity, Japan Over 23,000 people in Japan have been dead or missing, and more than 400,000 buildings have been completely or partially destroyed [2]. In addition to the influence of the earthquake and tsunami, the nuclear accident influences the hundreds of residents and their life, as a result of electrical grid damage that almost completely destroyed the power plant's backup energy sources [3]. This seismic upheaval caused thousands of deaths and forced towns to relocate, but it also had a lasting impact on Japan's economy.

The eastern coast of Japan is home to a concentration of vital industries, including steel, petrochemicals, manufacturing, and nuclear power. According to local media's incomplete statistics as of noon on the 12th, in areas affected by the earthquake, at least 21 major Japanese enterprises with dozens of factories have suspended operations [5]. Numerous businesses were forced to halt production due to the earthquake, which will have an immediate impact on corporate performance and reducing employee the willingness to consume. For example, the automobile industry -As one of the main economic pillars of Japan-also get influenced. Toyota, Honda, Nissan, and other auto giants have announced a halt. The production capacity of enterprises is damaged, and the export capacity is reduced, which will inevitably affect the operating profits of enterprises, and further affect the expansion of investment.

Natural catastrophes may be causing the negative or positive influence on economic growth. These kinds of catastrophes include earthquakes, floods, tornadoes, winter storms, and other forms of extreme weather. Some of the articles long-term economic influence of a large earthquake. Yasuhide Okuyama uses models in this article to examine the long-term economic effects of the Kobe earthquake. According to the author, earthquakes have a detrimental influence in the year they occur [7]. There are many different articles that discussed the natural disaster, such as flood and earthquake, impact on the consumer behavior of different area. The earthquake in Mexico, the article called The Effect of Natural Disasters on Consumption and Prices: Evidence from Mexico. The article presents by Using a differences-in-differences approach, authors find strong decreases in consumption at the intensive and extensive margin [8]. Alatrasta-Salas H and colleges analysis the influence of an extreme weather event through the combination of fine-grained analysis and Coarse-grained analysis. They show that there was a short amount of time when consumers adjusted the order in which they made purchases to consider new requirements or limitations [9]. According to Naohito Abe and Chiaki Moriguchi's study household expenditure on storable foods increased dramatically in the week after the great earthquake [11]. The articles also investigated that the number of big earthquakes encountered by households had a detrimental impact on the chance of making any purchases in the week after March 11 [11]. Natural disasters similarly impact a country's exports and imports. The paper by Osberghaus, D. explain influence related with international trade. According to the report, Exports seem to be negatively impacted by the frequency and severity of disasters in the exporting nations. Disasters caused by nature may reduce, increase, or have no effect on imports. [12]. The article by Aekapol Chongvilaivan investigates the degree to which interruptions in the supply chain result in declines in export and production performance [13].

To obtain the earthquake had a big effect more effectively on the real estate market. The essay measures the degree of disruption in the economic by looking through the real private residential investment, a significant economic indicator that encompasses home construction and other activities. In addition to the real private residential investment, it also measures the consumer expenditure, which tracking customer spending patterns and whether they conserve money as opposed to spending it under the influence of such natural disaster. This offers a glimpse into the demand for goods and services.

The rest paper is organized as follow: The part 2 is the research design, which include the data resources and the weak stationarity test. Part 3 contains a comprehensive explanation of the outcomes of the ARIMA model, as well as further study on the influence of the earthquake to Japan economic through the analysis two data set--- Real Private Residential Investment and Consumption expenditures.

2. Research Design

2.1. Data Resources

Quarterly Real Private Residential Investment data was obtained from the Federal Reserve Economic Data (FRED) in order to enhance the economic analysis [6]. FRED—a reliable platform that offers access to a wealth of economic data—contributes crucial information on Japan's real estate market and private residential investment. Data of monthly statistics on consumer spending in Japan from the Dashboard system was applied [7]. The statistics data from commercial businesses and national government organizations are stored in this system. Based on these two data sets, analysis The Great East Japan Earthquake impact on the Japan economic.

2.2. Weak Stationarity test

The first step is to assess the stationarity of the time series data, which is crucial for applying statistical models and analyses. The table 1 show the result of the weak stationarity test of the real estate investment and consumption. When the p-value is 0.3853, it means that the first-order differences of real private residential investment and consumption are weakly stationary. However,

the natural logarithm values of real private residential investment are not, and the natural logarithm values of consumption are weakly stationary. Then this part applies the first order difference as data for building model.

Table 1 Weak stationarity test

	t	p
Real Private residential investment		
Ln value	-2.389	0.3853
1st order difference	-7.850	0
Consumer Consumption		
Ln value	-13.802	0
1st order difference	-18.530	0

2.3. ARIMA Model

The equation (1) shows that the general equation of the ARIMA model. The $\phi_0 + \sum_{i=1}^p \phi_{i-1}X_{t-1}$ is the part of the AR model. The rest part which is $\alpha_i - \sum_{i=1}^q \phi_i\alpha_{t-1}$ represents the MA model. While the MA model indicates the link between the current and past prediction errors, the AR model demonstrates the historical amounts of real residential investment and consumer consumption in the series that are used to estimate the present.

$$y = \phi_0 + \sum_{i=1}^p \phi_{i-1}X_{t-1} + \alpha_i - \sum_{i=1}^q \phi_i\alpha_{t-1} \quad (1)$$

3. Empirical Results and Analysis

3.1. ARIMA Specification

In order to get the order of the real residential investment and consumer consumption, which is the first step to analysis the data. The PACF and ACF plot can help to identify the order of the MA model and AR model.

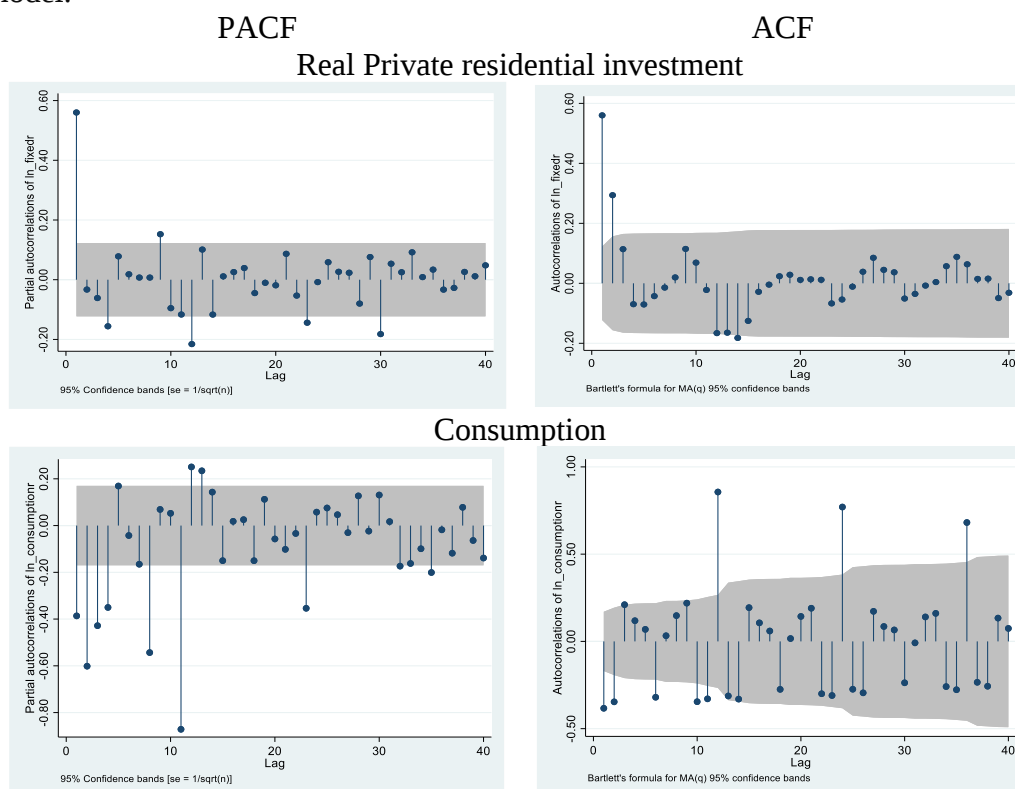


Figure 1 ARMA (p, q) identification
Photo credit: Original

In the figure 1, the first column has two figures of the Real estate investment. The order of the autoregressive (AR) model can be determined as 9 from the partial autocorrelation function (PACF) graph, while the order of the moving average (MA) model can be identified as 2 from the autocorrelation function (ACF) graph. The rest two graphs show the order of autoregressive model of consumption is 8, and the order of MA model is 6.

3.2. Residual Test

To ensure that the chosen model is appropriate, and capable of capturing the essential characteristics of the data, we do the residual test to test the building model. As showing in the table 2, the real private residential investment model, the high p-value (0.9440) suggests that the residuals do not show significant auto-correlation, indicating a good fit of the ARIMA (9,1,2) model to the data. Conversely, for the Consumption model, the low p-value (0.0000) indicates significant auto-correlation in the residuals. Although, it shows the low p-value, we still can use this model, because there are many other orders that we can chose in the figure 1 of the consumption and this will not influence the outcome of trend prediction.

Table 2 Checking Residual

Name	Portmanteau (Q) statistic	Prob > chi2
Real private residential investment-ARIMA (9,1,2)	26.8882	0.9440
Consumption-ARIMA (8,1,6)	350.9592	0.0000

3.3. Trend Prediction

The Figure 2 and supported by Table 3 is related with real and expected values for real private residential investment. The blue line is real investment changes. The orange line shows the predicted value based on the year before the earthquake. It represents the without the Great East Japan Earthquake happened, the real private residential investment changing trend. There is clearly a decreasing for the actual value especially in the period following of the earthquake. This also showed by the Table 3, the predicted value at Jan 2011 is 376.44777 dollar, while the actual value is 368.767 dollar. The different between actual value and predicted is -7.68. Then the actual line is higher than the predicted line after Apr 2011. Nonetheless, the discrepancy between the actual and predicted values for October 2012 and January 2013 is exaggerated.

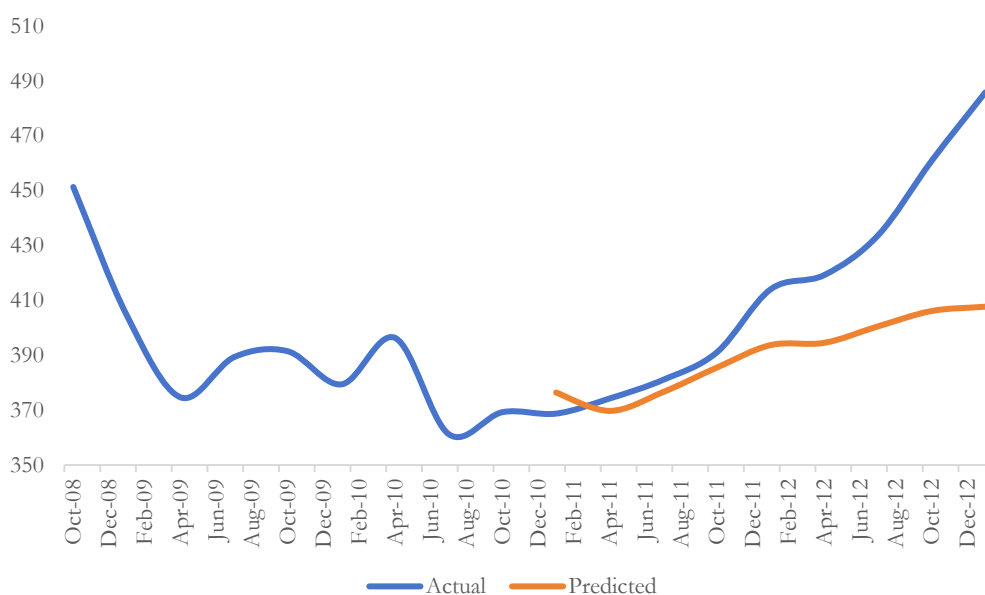


Figure 2 Actual value and predicted value, Real private residential investment

Photo credit: Original

Table 3 Actual and predicted value, Real private residential investment in dollar

	Actual	Predicted	Difference	Difference (%)
Oct-08	451.391			
Jan-09	404.473			
Apr-09	374.685			
Jul-09	389.385			
Oct-09	391.472			
Jan-10	379.435			
Apr-10	396.341			
Jul-10	361.234			
Oct-10	369.289			
Jan-11	368.767	376.44777	-7.68077	-2.04%
Apr-11	374.296	369.75534	4.54066	1.23%
Jul-11	381.117	376.67328	4.44372	1.18%
Oct-11	391.162	385.58293	5.57907	1.45%
Jan-12	414.107	393.75482	20.35218	5.17%
Apr-12	419.287	394.57627	24.71073	6.26%
Jul-12	433.74	400.57224	33.16776	8.28%
Oct-12	460.926	406.16554	54.76046	13.48%
Jan-13	485.878	407.74453	78.13347	19.16%

The trend prediction of consumer consumption, depicted in Figure 3, provides a visual representation of the actual and predicted values over time. The observed decline in consumer spending, especially in March 2011, corresponds with the following months of the earthquake. This result emphasizes how the earthquake had a significant influence on economic activity, affecting consumer spending and behavior. As showing in the graph, the blue line from Mar 2011 to Oct 2011 is always lees than the orange. In addition to the graph, the Table 4 also show the negative difference between the actual value and predicted value.

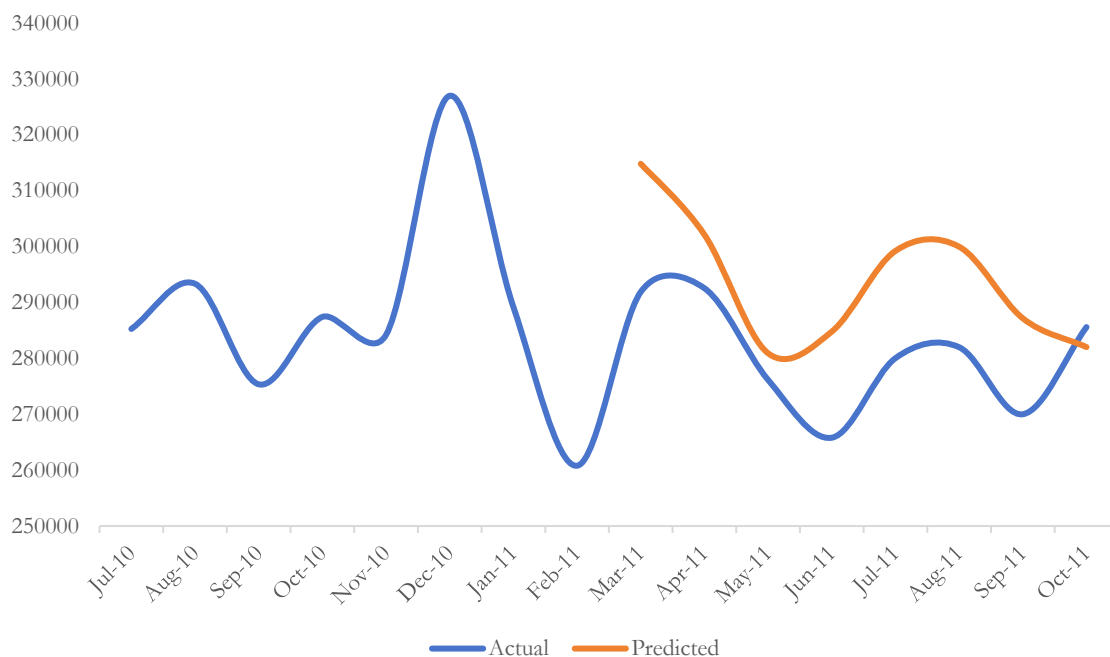


Figure 3 Actual value and predicted value, Consumption

Photo credit: Original

Table 4 Actual and predicted value, Consumption in yen

	Actual	Predicted	Difference	Difference (%)
Jul-10	285274			
Aug-10	293361			
Sep-10	275367			
Oct-10	287433			
Nov-10	284212			
Dec-10	327006			
Jan-11	289191			
Feb-11	260793			
Mar-11	291900	314838.55	-22938.55	-7.29%
Apr-11	292559	302140.1	-9581.1	-3.17%
May-11	276159	280917.44	-4758.44	-1.69%
Jun-11	265807	284799.54	-18992.54	-6.67%
Jul-11	280046	299239.44	-19193.44	-6.41%
Aug-11	282008	299992.3	-17984.3	-5.99%
Sep-11	270010	287172.23	-17162.23	-5.98%
Oct-11	285605	282025.35	3579.65	1.27%

4. Conclusion

The objective of this paper is to exam the influence of the Great East Japan Earthquake on Japan economic though the analysis Real estate investment and consumer consumption. Through constructing the model to predict the trend after the earthquake and comparing the real trend and predicted trend, the graph shows the different results. There a decreasing trend of consumer consumption values following the Great East Japan Earthquake, which show it will impose a negative impact on consumer consumption. Except for the month after the earthquake, the expected line for real private residential investment is lower than the actual. The earthquake has a negative impact on consumer spending, but it increases real private residential investment.

Unfortunately, due to data access constraints, analyzing real private residential investment using quarterly data does present certain limitations. Certainly, conducting a comprehensive analysis of an economy requires a multi-faceted approach that goes beyond just real private residential investment and consumer expenditure. There should be more examination of other factors that play an important part in economic analysis. While the emphasis is on short-term effects, a more in-depth analysis of long-term economic consequences might improve knowledge of the earthquake's long-term impact on Japan's economy. Furthermore, the ARIMA model for real private residential investment is not well suited to analyzing long-term data, hence the predicted value obtained in January 2013 is not credible.

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