Global Financial Crisis and the Impact of the Food Crisis on the Great Depression Based on Agricultural Technology Iteration: A 15-year Population-Based Time-Series Study

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Abstract

Published studies have indicated that global financial crisis may result in more depression or psychiatric disorders. However, the evidences investigating such phenomena derived from a long-term large-scale population-based studies are still limited. As a bridge and link between agricultural education, scientific research and farmers, as well as between government and farmers, Agricultural Technology Extension plays an important role in agricultural development. Most governments will support agricultural technology extension as an important policy measure to improve agricultural productivity. Since the reform and opening up, China's agricultural technology extension organizations have made considerable progress, and established a system of agricultural technology extension throughout the country, which has played a great role in promoting the technological progress of agriculture, the growth of grain production and the improvement of quality.

This study was aimed to study the impacts of two famous global financial crises on depression by using a population-based database. This study used the Longitudinal Health Insurance Database (Cohort 2005), which was a subset of Taiwan National Health Insurance Research Database, and comprised 1,000,000 beneficiaries randomly drawn from the Taiwanese population in 2005 and followed them from 1996 January to 2010 December. The Autoregressive Integrated Moving Average (ARIMA) with intervention (or interrupted) model was used, and two famous global financial crises were taken into account: 2007-08 Global Financial Crisis and 2008-09 Lehman Brothers Bankruptcy in United States. All data were analyzed based on incidence-based estimations.

A Seasonal ARIMA model, SARIMA(1,0,0)(1,1,0), was identified. 2007-08 Global Financial Crisis resulted in a statistically significant increase of depression incidences for 42 persons (p-value=0.017, per 1,000,000 people), and the following 2008-09 Lehman Brothers Bankruptcy in United States resulted in a statistically significant increase of depression incidences for 78 persons (p-value<0.001, per 1,000,000 people) in Taiwan.

By using outliers detection techniques, the severe acute respiratory syndrome (SARS) epidemic in 2003 also resulted in a statistically significant increase of depression incidences for 81 persons (p-value<0.001, per 1,000,000 people). The impacts resulted from global events (for example, SARS, global financial crises…etc.) are multi-dimensional. The population-based empirical results of this study showed that the global financial crises did result in significant increases of depression. The health authorities need to re-allocate more health resources for the depression prevention, especially for encountering global events.

Key words: Time Series, Depression, Global Financial Crisis, Lehman Brothers Bankruptcy, ARIMA Model, Agricultural Technology.

1. Introduction

As the development of global economy, some countries’ economy improved and some countries’ economy went down in recent years. Especially for huge companies or globally invested companies, once such international companies encountered the bankruptcy, which may result in area even global financial crisis. In recent ten years, there were two major consecutive global financial crises: the first one was 2007 Financial Crisis which was resulted from a serious sudden falls of housing prices and other economic events that began in the July of 2006 and then spread through many countries [1]; the second one was the Lehman Brothers’ bankruptcy in United States. In 2008, an ever so-called “biggest holding company in the world”, Lehman Brothers holding Inc., filed for bankruptcy, which was with USD$639 billion in assets and USD$ 619 billion in
debt. The Lehman’s bankruptcy filing was the largest bankruptcy event in history, as its assets much higher than those of previous bankrupt giants. Lehman Brothers holding Inc. was the fourth-largest U.S. investment bank at that time of its collapse, with 25,000 employees worldwide [2]. The Lehman's bankruptcy filing also resulted in globally financial crisis in many countries, including Greece [3], Spain [4], Canada [5], United Kingdom [6]. Published studies found global financial crisis also resulted in many health-related problems, including coronary artery disease [7], cancer mortality [8], psychiatries diseases [9, 10, 11]. Published studies have indicated that global financial crisis may result in more depression or psychiatric disorders [12, 13, 14, 15]. However, studies regarding the long term investigation of the impacts of these two major global financial crises are still lack. Therefore, this study was aimed to study the impacts of these two famous global financial crises on depression by using the time series analysis for 15 years .

2. Materials and Methods

2.1 Study Database

This study used the Longitudinal Health Insurance Database (Cohort 2005), which was a subset of Taiwan National Health Insurance Research Database, and comprised 1,000,000 beneficiaries randomly drawn from the Taiwanese population in 2005 and followed them from 1996 January to 2010 December. The time series plot of depression incidences from 1996 January to 2010 December was showed in Figure 1.

![Figure 1. Time series of depression incidences from 1996 January to 2010 December](image)

2.2 Methods

The Autoregressive Integrated Moving Average (ARIMA) with intervention model was used, and two famous global financial crises were taken into account: 2007-08 Global Financial Crisis resulted from Subprime Mortgage Crisis, and followed with Lehman Brothers Bankruptcy in United States in 2008-09. This study used an ARIMA with intervention analysis to evaluate the impacts of two events on monthly depression incidence time series. To perform ARIMA-intervention analysis, the intervention variables need to be established in advance. The first intervention variable corresponds to the 2007-08 Global Financial Crisis resulted from Subprime Mortgage Crisis, the second was the Lehman Brothers Bankruptcy in United States in 2008-09. Although the occurrence time of both financial crisis events were known, they may not affect the time series data exactly on the occurrence date. For detecting the real affecting time points of these two intervention events, in this paper, we first tested the time point settings of these two intervention events on their occurrence month. Then we detected the actual occurrence months by incorporating the joint estimation method of model parameters and outlier effects proposed by Chen and Liu (1993) into the ARIMA-intervention model both intervention events on depression time series data. For ARIMA-intervention analysis have shown that the presence of outliers in a time-series would inflate the estimate of residual standard error, resulting in the t-statistics of the intervention effects biased toward insignificant. Besides, they also have shown that intervention effects sometimes can be seriously confounded by outlier effects. Consequently, outlier detection and adjustment are essential in ARIMA-intervention analysis, as shown in recent published papers using such analysis. Without outlier adjustment in intervention analysis, some intervention effects may become statistically insignificant when, in fact, they should be statistically significant [16].
Besides, when using the joint estimation method of model parameters and outlier effects proposed by Chen and Liu (1993) [17], four basic types of outliers are usually introduced. They are additive outlier (AO), level shift (LS), temporary change (TC), and innovational outlier (IO). Other types of outliers can typically be represented through a combination of these four basic types. An additive outlier (AO) is an event that affects a series for one time period only. A level shift (LS) is an event that affects the series at a given time and whose effect becomes permanent thereafter. A temporary change (TC) is an event having an initial impact and whose effect decays exponentially according to some dampening factor. Unlike the other three types of outliers, an innovational outlier (IO) is an event whose effect is propagated according to the ARIMA model of the process. Because of this property, the effect of an IO is more intricate than the effects of other types of outliers. For a stationary series, an IO will produce a temporary effect. For a nonstationary series, however, an IO may produce an effect similar to level shift (LS) or trend change depending on the nonstationary model. More details are discussed in Chen and Liu (1993) [18].

The ARIMA-intervention model and the settings of the intervention variables are presented as follows:

$$Y_t = \omega_1 I_{1t} + \omega_2 I_{2t} + \frac{\theta(B)\Theta(B^s)}{(1-B)(1-B^s)^d\phi(B)\Phi(B^s)} a_t,$$

(1)

where $Y_t$ is the monthly depression counts derived from NHIRD, B is the backshift operator ($BY_t = Y_{t-1}$), s is the seasonality or periodicity (in this study, $s=12$ months), d and D are the number of differencing, and $\phi(B)$, $\Phi(B^s)$, $\theta(B)$, $\Theta(B^s)$ are polynomials of B and Bs respectively. The random errors $a_t$'s are assumed to be independently and normally distributed with identical mean zero and variance $\sigma_a^2$. The intervention variables $I_{1t}$ and $I_{2t}$ are two dummy variables defined as:

$I_{1t} = 1$, Global Financial Crisis (2007, October~2008, September)

$I_{1t} = 0$, else period of time

$I_{2t} = 1$, Lehman Brothers' bankruptcy (2008, October~2009, November)

$I_{2t} = 0$, else period of time

The first two terms on the right hand side of equation (1) are associated with the two financial crisis events while the third term is the rational form of a general seasonal ARIMA model. Using the modeling procedure described in Box and Jenkins (1970) [19], the following seasonal ARIMA model with interventions is found to be appropriate:

$$Y_t = \omega_1 I_{1t} + \omega_2 I_{2t} + \frac{(1-\theta_2 B^s)(1-\phi B^s)}{(1-B)(1-B^s)(1-B^2)} a_t,$$

(2)

Parameter estimation and diagnostic checking were conducted by using the SCA Statistical System [20].

3. Results

A Seasonal ARIMA model, SARIMA(1,0,0)(1,1,0), was identified. According to the Table 1, on average, the 2007-08 Global Financial Crisis resulted in a statistically significant increase of depression incidences for 42 persons (p-value=0.017, per 1,000,000 people), and the following 2008-09 Lehman Brothers Bankruptcy in United States resulted in a statistically significant increase of depression incidences for 78 persons (p-value<0.001, per 1,000,000 people) in Taiwan. By using outliers detection techniques, the severe acute respiratory syndrome (SARS) epidemic in 2003 also resulted in a statistically significant increase of depression incidences for 81 persons (p-value<0.001, per 1,000,000 people).

<table>
<thead>
<tr>
<th>Parameter Type</th>
<th>Estimate</th>
<th>SE</th>
<th>t-value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Constant)</td>
<td>71.041</td>
<td>4.832</td>
<td>14.701</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AR(1)</td>
<td>.471</td>
<td>.075</td>
<td>6.276</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>AR(1)seasonal</td>
<td>-.465</td>
<td>.082</td>
<td>-5.670</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Global Financial Crisis</td>
<td>42.380</td>
<td>17.484</td>
<td>2.424</td>
<td>.017</td>
</tr>
<tr>
<td>Lehman Brothers' bankruptcy</td>
<td>78.237</td>
<td>15.420</td>
<td>5.074</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Outlier detection</td>
<td>81.133</td>
<td>15.420</td>
<td>4.704</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>

Table 1. Parameter estimates of the SARIMA(1,0,0)(1,1,0) model in this study

*peak period of SARS epidemic
Regarding the goodness-of-fit, the observed time series of depression incidences and predicted time series was displayed in Figure 2.

![Graph showing goodness-of-fit](image)

**Figure 2.** The goodness-of-fit of this study

4. Discussion

In comparison with published studies, one study conducted in Cyprus showed that an increasing demand for utilization of mental health services in Cyprus during global financial crisis, also in Greek. Besides, a systematic literature review also showed that there was an increasing trend of suicides and mental health deteriorated during the global financial crisis. The crisis did not seem to reverse the trend of decreasing overall mortality [21]. According to the results of this study, although the 2007-08 Global Financial Crisis and 2008-09 Lehman Brothers Bankruptcy did not happen in Asia area, the depression incidences time series was really influenced by these two serious financial crises.

This study still had some limitations. First, although the coverage rate of National Health Insurance program was more than 99% of the Taiwanese population, the NHIRD does not include the potential confounders such as smoking, alcohol consumption, and diet, which may be associated with the risk of depression or depressive disorders. Second, some patients with psychiatric disorders did not consult psychiatrists, they may go to the temples or other spiritual counseling rather than psychiatrists; therefore, the number of patients with depression or depressive disorders may be underestimated. Third, because the patients with depression enrolled in this study were primarily of Han or Chinese ethnicity, the results may not generalize to other ethnicity groups.

5. Conclusions

The impacts resulted from global events (for example, SARS, global financial crises…etc.) are multi-dimensional. The population-based empirical results of this study showed that the global financial crises did result in significant increases of depression. The health authorities need to re-allocate more health resources for the depression prevention, especially for encountering global events.

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References


324