Multi Input Intervention Model for Analyzing the Impact of the Asian Crisis and Terrorist Attacks on Tourist Arrivals in Bali

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Abstract

The purpose of this study is to develop multi input intervention model for analyzing the impact of the Asian financial crisis and terrorist attacks Bali on the number of tourist arrivals. This research focuses mainly on the development of a model that could be used to explain the magnitude and periodic impacts of the Asian financial crisis since July 1997 and terrorist attacks referring to the Bali bombings on October 12th 2002 and October 1st 2005, respectively. Monthly data comprising the number of tourist arrivals in Bali via Ngurah Rai airport are used as the data for this case study. The results show that the Asian financial crisis and Bali bombings yield negative impacts on the number of tourist arrivals to Bali. Generally, the Asian financial crisis did give a negative permanent impact after a 10 month delay. The first and second Bali bombings also yield negative impacts which were direct and temporary effects. However, the first attack had longer period effect than the second, i.e. 8 and 5 months after onset attacking, respectively. In addition, this
research also discusses how to assess the effect of an intervention in transformation data.

**Keywords:** Asian crisis, Bali bombing, Tourist arrivals, Intervention model

## INTRODUCTION

International tourist arrivals have been affected due to disruptions caused by a range of events that may occur in the destination itself, in competing destinations, original markets, or they may be remote from either. In recent years, major disruptions that have affected the international tourist arrivals include the Gulf War in 1991, the Asian financial crisis in 1997, the terrorist attack on September 11, 2001 on the US, the SARS and avian flu in 2003 as well as natural disasters such as hurricanes, tsunamis, and earthquakes [8, 9, 12, 14].

The tourism industry in Indonesia is an important component as well as a significant source of foreign exchange revenue for the Indonesian economy. However, tourism in this country is also subject to the effects of natural and man-made disasters. Some of natural disasters that have taken place are: the 26 December 2004 Aceh tsunami, 27 May 2006 and 30 September 2009 earthquakes in Yogyakarta and Padang respectively on, and the bird flu epidemic in 2005. Besides these natural disasters, man-made disasters caused by terrorist attacks and bombings such as the incidents on 12 October 2002 and 1 October 2005 in Bali, 5 August 2003 at the Jakarta’s Marriot Hotel, 9 September 2004 in the Australian embassy in Jakarta and more recently, the 17 July 2009 bomb attacks of JW Marriot and Ritz-Carlton hotels in Jakarta.

Bali as an island is one of the primary destinations in Indonesia for international tourists. Tourism is a vital source of employment in Bali and people have migrated to the resorts and hotels of Bali not only from elsewhere in the island, but also from other parts of Indonesia. The tourism industry does not only generate directly related employment, but also creates a great deal of indirect employment opportunities [3]. From 1989 to 2009, the Balinese tourism industry experienced three major disasters: namely the Asian financial crisis of 1997 and the terrorist attacks of 2002 and 2005. Hitchcock [7] gave a business review about Asian financial crisis and tourism in Bali. More recently, Putra and Hitchcock [10] also made a review about terrorism and tourism in Bali and Southeast Asia.

This paper develops the multi input intervention model and apply it to examine the impact of the Asian financial crisis and terrorist attacks on tourism in Bali as a way to establish a better understanding of how these changes and trends affect international tourism. The paper is organised as follows: a brief
literature review about the impact of the different crisis and terrorism on tourism based on a time series approach, data description and the modeling method, results based on the model, evaluations of the the impact due to the interventions, conclusions and recommendation.

MATERIAL AND METHOD
The relationship between tourism and terrorism or political instability has been investigated extensively by many researchers since 1980s. Sonmez [13] did a comprehensive literature review focusing on the relationship between these phenomena during 18 years, i.e. from 1980-1998.

Generally, researchers have relied on two main approaches for evaluating the effect of crisis or terrorism to the tourism industry by focussing on the impact of these events on micro-tourist preferences using individual tourist data or focussing on estimating the aggregate effects using time series data. The first approach could be seen in Yechiam, Barron and Erev [15] who analyzed the personal experience in contributing to the different patterns of response to rare terrorist attacks. Arana and Leon [1] studied the short-run impacts of the September 11 attacks in New York on tourist preferences for competing destinations in the Mediterranean and the Canary Islands, and Rittichainuwat and Chakraborty [12] who studied about perceived travel risks regarding terrorism and disease in Thailand.

This research focusses on the second approach that utilizes a time series analysis for assessing the impact of crisis or terrorism on tourism. Enders and Sandler [5] and Enders, Sandler and Parise [6] were among the first researchers who used time series approach for analyzing the negative impacts of terrorism on tourism revenues in Spain and other European countries. The research can be used to support substitution effects between these countries as a result of the tourist’s goal of minimizing the risk of facing a terror attack. Similar results were also found by Drakos and Kutan [4] who studied the regional effects of terrorism on tourism in three Mediterranean countries.

MULTI INPUT INTERVENTION MODEL
The multi input intervention model is [1]

\[
Y_i = \sum_{t=1}^{k} \frac{\omega_t (B)B^{k}}{\delta_t (B)} X_{i,t} + \frac{\theta_{t} (B)}{\phi_p (B)(1-B)^{a_r}} a_t .
\]  

Eq. (1) shows that there are \( k \) events that have affected the time series dataset. As an illustration, consider a multi input intervention with two events, namely
a pulse function occurring at \( t = T_1 = 40 \) with \( (b_1 = 1, s_1 = 2, r_1 = 0) \) which is followed by a step function at \( t = T_2 = 60 \) with \( (b_2 = 1, s_2 = 1, r_2 = 1) \), thus

\[
Y_i = \left[ (\omega_{b_1} - \omega_{s_1} B - \omega_{r_1} B^2) \right] P_{1,i} + \left( \frac{(\omega_{b_2} - \omega_{s_2} B)B^1}{1 - \delta_{12} B} \right) S_{2,i} + \frac{\theta(B)}{\phi(B)(1 - B)^{m}} a,
\]

(2)

The impact is

\[
Y^*_i = \omega_{b_1} P_{1,i-1} - \omega_{s_1} P_{1,i-2} - \omega_{r_1} P_{1,i-3} + \omega_{b_2} S_{2,i-1} + (\omega_{s_2} \delta_{12} - \omega_{r_2}) S_{2,i-2} + (\omega_{s_2} \delta_{12} - \omega_{r_2}) \delta_{12} S_{2,i-3} + \cdots
\]

(3)

which can also be written as

\[
Y^*_i = \begin{cases} 
0, & t \leq T_1 \\
\omega_{b_1}, & t = T_1 + 1 \\
-\omega_{s_1}, & t = T_1 + 2 \\
-\omega_{r_1}, & t = T_1 + 3 \\
0, & t = T_1 + k \leq T_2 \text{ and } k \geq 4 \\
\omega_{b_2} \sum_{i=1}^{m} \delta_{12}^{i-1} - \omega_{s_2} \sum_{i=2}^{m} \delta_{12}^{i-2} + \omega_{r_2}, & t \geq T_2 + m, \ m \geq 1.
\end{cases}
\]

The illustration of Eq. (3) and its impact are represented in Figure 1 where \( \omega_{b_1} = -25, \omega_{s_1} = 10, \omega_{r_1} = 5, \omega_{b_2} = -15, \omega_{s_2} = 4, \) and \( \delta_{12} = 0.5. \)

![Figure 1](image-url)

Fig. 1: (a) Simulation of the Intervention Model, (b) Intervention effect of Multi Input Intervention where Pulse Function \( (b_1 = 1, s_1 = 2, r_1 = 0) \) occurred at \( t = 40 \) and followed by the Step Function \( (b_2 = 1, s_2 = 1, r_2 = 1) \) at \( t = 60 \)

The first intervention that affected the data at \( t = 41 \), with a magnitude of \(-25\). The pulse function intervention had an effect that lasted for 3 periods beyond \( t = T_1 = 40 \) with magnitude effects of \(-10\) and \(-5\) on the second and third after the intervention, respectively. After that, the effect of this pulse intervention will be equal to zero. The second intervention began at \( t = T_2 = 60 \). This step intervention was detected at \( t = 61 \) and its impact was \(-15\). From \( t = 62 \) to \( t = 65 \) the impacts of this step intervention were \(-26.5, -32.25, -36.5, \) and \(-37.3, \) respectively. It is noted that the impact did not increase beyond \(-38.\)
PROCEDURE FOR BUILDING MULTI-INPUT INTERVENTION MODEL

Rezeki, Suhartono and Suyadi [11] showed that the intervention response or $Y^*_i$ is easily formulated using the response values chart for determining the order of intervention model using $b$, $s$, and $r$. The intervention response denoted as $Y^*_i$ is basically residual or error which is the difference between the actual data and the ARIMA model forecasts based on the data before the intervention. A complete procedure of the intervention model building can be used to evaluate these $k$ intervention functions at time $T_1, T_2, \ldots, T_k$ as according to the following procedures.

**Procedure 1. Dividing the Dataset into k+1 Parts**

- Part 1 dataset is the data before the first intervention with $n_0$ as the time periods, i.e. $t = 1, 2, \ldots, T_1 - 1$. Denoted as $Y_{i_0}$.
- Part 2 dataset is the data from the first intervention until just before the second intervention based on $n_1$ time periods, i.e. $t = T_1, T_1 + 1, T_1 + 2, \ldots, T_2 - 1$. Denoted as $Y_{i_1}$.
- Part $k+1$ dataset is data from the $k^{th}$ intervention until the end of data analysis based on as many as $n_k$ time periods, i.e. $t = T_k, T_k + 1, T_k + 2, \ldots, n$. Denoted as $Y_{i_k}$.

**Procedure 2. Modeling of the First Intervention**

a. Step 1
- Use the ARIMA model building for time series data before the first intervention occurs ($Y_{i_0}$), so we have
  
  $$ Y_{i_0} = \frac{\theta_s(B)}{\phi_p(B)(1-B)^r} \alpha_t. $$

- Forecasting of Data 2 ($Y_{i_1}$) using the ARIMA model. In this step, we get the forecast data, i.e.
  
  $\hat{Y}_{i_1}, \hat{Y}_{i_1+1}, \ldots, \hat{Y}_{i_1+n_1-1}$.

b. Step 2
- Calculate the response values of the first intervention or $Y^*_i$. These values are the residuals of the data from $t = T_1, T_1 + 1, T_1 + 2, \ldots, T_2 - 1$. This is based on the forecasting method of the ARIMA model as shown in the first step. This step produces response values of the first intervention based on
  
  $Y^*_1, Y^*_1+1, \ldots, Y^*_1+n-1$. 

Multi input intervention model

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• Determine \( b_i, s_t, r_t \) based on the first intervention by using the plot of response values \( Y_t^*, Y_{t+1}^*, ..., Y_{T+m-1}^* \) and a confidence interval of width, i.e. \( \pm 3\hat{\sigma}_{m_j} \), where \( \hat{\sigma}_{m_j} \) is Root Mean Square Error (RMSE) from the previous ARIMA model. These intervals are based on the determination of control chart bounds during the statistical quality control for detecting outlier observations.

c. Step 3
• Estimate the parameter and test the significance for the first intervention model.
• Conduct a diagnostic check to examine the residual assumption inclusive of white noise and normality distribution. In this step, the first input intervention model is

\[
Y_t = \frac{\omega_m(B)B^h}{\delta_m(B)} X_{t+m} + \frac{\theta_m(B)}{\phi_p(B)(1-B)^d} a_t. \quad (4)
\]

Procedure 3. Modeling of the \( m^{th} \) Intervention Model, where \( m = 2, 3, ..., k \).

a. Step 1
• Forecast Data \( m+1 \) (\( Y_m \)) based on the \( m^{th} \) intervention model. In this step, we will obtain the forecasted values from the \( m^{th} \) intervention model

\[
\hat{Y}_{m}, \hat{Y}_{m+1}, ..., \hat{Y}_{m+n_m-1}.
\]

b. Step 2
• Calculate the \( m^{th} \) intervention responses (\( Y_m^* \)) which is the residual of the data for \( t = T_m, T_m+1, ..., T_{m+1} - 1 \). This is based on the forecasting of the \( (m-1)^{th} \) intervention model. These response values are denoted as

\[
Y_{m}^*, Y_{m+1}^*, ..., Y_{m+n_m-1}^*.
\]
• Identify \( b_m, s_m, r_m \) from the \( m^{th} \) intervention model from the plot of response values \( Y_{m}^*, Y_{m+1}^*, ..., Y_{m+n_m-1}^* \), and the confidence interval of width \( \pm 3\hat{\sigma}_{m_n} \).

c. Step 3
• Estimate the parameter and conduct a significance test for the \( m^{th} \) intervention model.
• Conduct a diagnostic check to examine the residual assumption inclusive of white noise and normality distribution. The result of this step is
Multi input intervention model

\[
Y_t = \sum_{j=1}^{\infty} \frac{\alpha_j(B)B^j}{\delta_j(B)} X_{j,t} + \frac{\theta_j(B)}{\phi_p(B)(1-B)^k} \psi_t.
\]

This procedure is done iteratively until the last \((k^{th})\) intervention. As a result of these steps, eventually we would obtain the following multi input intervention model

\[
Y_t = \sum_{j=1}^{k} \frac{\alpha_j(B)B^j}{\delta_j(B)} X_{j,t} + \frac{\theta_j(B)}{\phi_p(B)(1-B)^k} \psi_t.
\]

DATA

The number of tourist arrivals in Bali from January 1989 until December 2009 is used in this study. The data are 252 monthly records of the arrivals. Figure 2 illustrates the data in a time series plot.

\[\text{Fig. 2: Monthly tourist arrivals to Bali from January 1989 – December 2009}\]

During this period, there were three interventions which may have affected the number of tourist arrival in Bali. These interventions are the Asian financial crisis which occurred from July 1997 until December 2009 [9] and the Bali bombings which occurred in October 12, 2002 and October 1, 2005. In this analysis, the Asian financial crisis is the step function intervention variable, whereas the Bali bombings are the pulse functions. From the graph, we could see that the data did not decline dramatically according to the period when the Asian financial crisis occurred which was in July 1997. With that exception, the graph shows that the number of tourist arrivals dropped directly and dramatically during the first and second Bali bombings.
RESULTS

All the results and models reported in this study were estimated using Statistical Analysis System (SAS) and the graphs were produced by MINITAB. The following sections will outline the results of the pre-intervention model using the Box-Jenkins procedure and the first, second and third intervention models.

Pre-intervention Model Results

The Box-Jenkins procedure [2] was utilized for this research which included the identification, parameter estimation, diagnostic checking, and forecasting to find the best ARIMA model before the first intervention, i.e. the Asian financial crisis since July 1997.

The results of the identification step, parameter estimation, parameter significance test, and diagnostic checking show that two models, i.e. ARIMA(0,1,1)(0,1,1)\text{tw} and ARIMA(0,1,1)(1,1,0)\text{tw}, are appropriate as a means for forecasting the monthly tourist arrivals in Bali before Asian financial crisis. The comparison of the mean square errors (MSE) showed that ARIMA(0,1,1)(0,1,1)\text{tw} yielded less MSE than ARIMA(0,1,1)(1,1,0)\text{tw}. Thus, the best ARIMA model for data before the first intervention is ARIMA (0,1,1)(0,1,1)\text{tw}, i.e.

\[
\ln Y_t = \frac{(1 - 0.6865 B)(1 - 0.8617 B^{12})}{(1 - B)(1 - B^{12})} \eta_t. \quad (6)
\]

The First Intervention Model Results

This section present the results of the intervention model by illustrating the impact of the first step function intervention, namely the Asian financial crisis from July 1997 until December 1999 or at the time \( t = 103,104, \ldots, 132 \). Its function could be written as

\[
S_{tw} = \begin{cases} 0, & t \leq 102 \\ 1, & t = 103,104, \ldots, 132. \end{cases}
\]

The first step in this modeling is to determine the order \( b, s, \) and \( r \) for the first step function intervention model. This is done to determine the order of the intervention model and to explain the decrease in the number of tourist arrivals in Bali due to the Asian financial crisis. A residual chart is as in Figure 3 is used to show this step.
Fig. 3: Response Values on the Number of Tourist Arrivals in Bali (in Natural Log) after the First Intervention and Prior to the Second Intervention

The results of estimation parameter and diagnostic checking steps show that the best model of the first step function intervention and prior to the second pulse function intervention is

$$\ln Y_t = -0.17841S_{t-10} + 0.12229S_{t-12} + 0.16342S_{t-13} + \frac{(1-0.48235B)(1-0.62173B^{13})}{(1-B)(1-B^{12})} \alpha_t. \quad (7)$$

Based on the model presented in Eq. (7), the interpretation of the impact of the Asian financial crisis is not direct as it was delayed for 10 months or it started only on May 1998 when there were riots, killings, and destruction of commercial districts in Java, particularly the anti-Chinese sentiment riots in Jakarta.

**Results from the Second Intervention Model**

After modeling the first intervention based on the intervention model due to the Asian financial crisis, another analysis of the second pulse function intervention was conducted. This was based on the October 12, 2002 Bali bombing at which is equated with $t = T = 166$. Thus, the pulse function is written as

$$P_{2,t} = \begin{cases} 0, & t \neq 166 \\ 1, & t = 166. \end{cases}$$

The first step in this analysis is to determine the order of the second intervention model. By applying similar procedure as the first intervention model, the result show that the best intervention model for the number of tourist arrivals in Bali after the second pulse function intervention and prior to the third pulse function intervention is

$$\ln Y_t = -0.15415S_{t-10} + 0.11248S_{t-12} + 0.13260S_{t-13} - 0.38513P_{2,t} - 1.07515P_{2,t-1} +$$
\[-0.45165P_{2,t-2} - 0.43063P_{2,t-3} - 0.29330P_{2,t-4} - 0.31324P_{2,t-5} - 0.55535P_{2,t-6} + \]
\[-0.66742P_{2,t-7} - 0.24179P_{2,t-8} + \frac{(1-0.39670B)(1-0.70666B^{12})}{(1-B)(1-B^{12})} a,
\]

(8)

Results from the Third Intervention Model

The final analysis of the third pulse intervention function based on the second Bali bombing which took place on October 1, 2005 is equated with \( t = T = 202 \). So, the pulse function in this intervention could be written as

\[ P_{3,t} = \begin{cases} 0, & t \neq 202 \\ 1, & t = 202. \end{cases} \]

By using the same procedure as previous intervention, the results show that the final multi input intervention model for the number of tourist arrivals in Bali after the third pulse intervention function can be written as

\[
\ln Y_t = -0.13006S_{1,t-10} + 0.16777S_{1,t-13} - 0.41197P_{2,t} - 1.12580P_{2,t-1} - 0.49669P_{2,t-2} + \\
-0.45215P_{2,t-3} - 0.32306P_{2,t-4} - 0.31957P_{2,t-5} - 0.56362P_{2,t-6} - 0.67357P_{2,t-7} + \\
-0.23740P_{2,t-8} - 0.49181P_{2,t} - 0.57918P_{2,t-1} - 0.43498P_{2,t-2} - 0.28521P_{2,t-3} + \\
-0.32117P_{2,t-4} - 0.23120P_{2,t-5} + \frac{(1-0.35355B)(1-0.72533B^{12})}{(1-B)(1-B^{12})} a_t,
\]

(9)

where \( S_{1,t} \) is the step function of the Asian financial crisis, \( P_{2,t} \) is the pulse function of the first Bali bombing, and \( P_{3,t} \) is the second Bali bombing.

The effect from the reconstruction and the forecast of the final intervention model for transformation data (natural log data) are presented in Figure 4.

![Fig. 4: Effect Reconstruction and Forecasts of the First, Second and Third Intervention models (at Transformation Data)](image-url)
CONCLUSION

Studying the impact due to unexpected disruptions such as the Asian financial crisis and terrorist attacks on tourism is important for forecasters, planners, investors and operators. This paper provides an analysis of the impact of three interventions, namely the Asian financial crisis and the two Bali bombings on the number of tourist arrivals in Bali. The results show that these three interventions have significantly contributed to the decrease in the number of tourist arrivals.

The Asian financial crisis that occurred from July 1997 to December 1999 did not directly affect the decrease of tourist arrivals in Bali but it did cause a delayed reaction after 10 months when the impact was only felt in May 1998. The impact took place due to the riots, killings, and destruction of commercial districts in Java, especially in Jakarta. The decrease of tourist arrivals in Bali was due to these crises and the number of tourists in May, June and July 1998 were 31399, 42822, and 66778 respectively. On the other hand, the first and second Bali bombing had affected directly the decrease of tourist arrivals. The first attack had a negative impact until 8 months after the attack whereas the second one had an impact for only 5 months after the attack. Moreover, the reduced numbers of tourist arrivals due to the first and second attacks were 486043 and 261991 tourists respectively.

We recommend that the Indonesian government refer to the valuable data as the impact of these harrowing experiences and the after effect responses to these crises in Indonesia as well as other countries. It is important that tourism be used as a reference for crisis and disaster management in the future. There is a need for proper evaluations, pre-warnings and responses to disasters as these are important steps that may reduce the impact from such turmoil. This paper has shown us the means to learn from history so that we know how to brace ourselves in preparation for unforeseen future disasters in. To recapitulate, this research shows that the interpretation of an intervention model for transformation data could not be done directly based on estimated model parameters. Further research is needed to understand the precise impact of the interventions on other forms of data transformation.

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