Very Preliminary

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Preliminary Estimation of Impact of Bali Tragedy on Indonesian Economy

- Analysis by ARIMA, State Space and Input-Output Models -

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Shinji YOSHIOKA*

BAPPENAS (National Development Planning Agency)
Main Building 2nd Floor, JICA-TSQ Room,
Jl. Taman Suropati No.2, Jakarta 10310, Indonesia
TEL & FAX: +62-21-391-5223
E-Mail: yoshioka@link.net.id

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* The author is a JICA (Japan International Cooperation Agency) Expert to BAPPENAS (National Development Planning Agency of Indonesian Government) from CAO (Cabinet Office of Japanese Government). But the opinions expressed in the paper are derived from the author's study results and are not the official views of JICA, BAPPENAS, CAO, or any government. The author is grateful to the colleagues at BAPPENAS for their insightful feedback to this study and also thankful to Mr. Ramli Ripai, BAPPENAS, for his assistance in data processing.

Summary

In recent years, some investigations and researches on tourism have been developed employing time series models. I also employ two time series methodologies for evaluating Bali tragedy in mid-October 2002. An ARIMA model approach and a state space model approach are employed. Both models indicate that the tragedy brings the sizable post-bomb damages on Bali visitor arrivals. According to these forecasts, I also employ an input-output model for evaluating its nationwide economic impact. The results show that this negative impact reaches at around 0.2 percent of GDP in 2002 and around 0.3-0.6 percent in 2003.

JEL Classifications: C22, C32, C53, C 67 and O11
Key Words: ARIMA Model, State Space Model, Time Series Model, Kalman Filter, Input-Output Table, Forecast, Tourism

I. Introduction

Tourism is expected to play a very important role in economic development. Brundenius (2002), *e.g.*, reports a good example in Cuba. Balaguer and Cantavella-Jordá (2002) tests whether or not the tourism-led growth hypothesis is confirmed in Spain through the cointegration and the causality testing and reveals positive results for recent three decades. Also, some institutes and universities have developed their investigations and researches on tourism employing time series methodology. One of the most significant examples is completed at Umeå University in Sweden. We can pick up Brännäs *et al.* (2002),[1] Brännäs and Nordström (2001), Brännäs and Nordström (2000), Coenen and van Eekeren (2001) and Nordström (2002) for good references.

In Indonesia, the tourism is also regarded very important for economic development. Indonesia seems to contain a lot of tourism resources. Among those, Bali tragedy was happened in mid-October 2002. Nearly two hundreds people were killed by this terrorist bomb attack. As known well, Bali is one of the biggest tourism places in the region and many are afraid that this brings quite significant negative influence on Indonesian economy, both directly and indirectly. Since Japan has a lot of concern in the region, this paper is also written to provide some preliminary basis for Japanese official and private activities.

This paper aims to contribute to Indonesian recovery, providing some preliminary assessments of the impact of Bali tragedy on visitor arrivals at Bali and also on Indonesian national economy. This paper employs two time series model approaches such as an ARIMA model and a state space model. After forecasting visitor arrivals at Bali, I employ an input-output model approach to evaluate its impact on Indonesian national economy. Since the latest statistics of visitor arrivals at Bali in November 2002 has just been published, and there is not enough statistical evidence, assessment of this paper should be regarded as very preliminary.

This paper consists of five chapters including this introduction. The following two chapters focus on forecast of visitor arrivals at Bali; the second chapter adopts one of the most typical univariate approaches, such as an ARIMA model; the third chapter employs a state space model approach, where unobservable "Bali Preferable Index" will be estimated; the fourth chapter estimates impact on Indonesian national economy in 2002 and 2003 based on estimates of forecast at the second and third chapters, utilizing Leontief-type input-output table analysis; and the final and fifth chapter briefly concludes the paper.

I mainly employ TSP for an ARIMA model and EViews for a state space model.[2]

II. ARIMA Model Approach

Box and Jenkins (1976) introduced a very useful model of a univariate time series analysis called ARIMA model. This method consists of three steps for utilization, such as identification, estimation and forecast. Before identifying the ARIMA model,

[1] Brannas *et al*. (2002) was published as a journal article but it was issued as Umeå Economic Studies No. 503 in 1999 by Umeå University.
[2] TSP is a registered trade mark of TSP International and EViews is of Quantitative Micro Software.

however, we have to check the data generating process (hereafter, DGP) of visitor arrivals at Bali because DGP must be stationary for these types of stochastic time series model analysis.

II.1. Data Generating Process (DGP) of Visitor Arrivals at Bali

The statistics of monthly visitor arrivals at Bali is released by the Statistics Indonesia (BPS). We have to check the DGP of this statistics before identifying an ARIMA model. For this purpose, usually, some unit root tests are employed.[3] Table 1 shows the results.

Table 1: Results of Unit Root Tests for Visitor Arrivals at Bali

Unit Root Test		D-F		P-P		W-S	
		P-Value	lags	P-Value	lags	P-Value	lags
Original	Level	0.074152	12	0.358510	12	0.095649	12
	First-Order Differential	0.013981	12	0.029346	12	0.008001	12
Log	Level	0.070363	12	0.238300	12	0.120900	12
	First-Order Differential	0.011630	12	0.016506	12	0.006409	12

Notes: 1. The lag length is determined subject to AIC2 criterion with acceptance of maximum 12 months lag.
2. The first-order differential is taken by twelve months.
3. The estimation periods are from January 1995 up to September 2002.
4. Both constant term and time trend are included.
5. The results of D-F are those of augmented Dickey-Fuller test, those of P-P are of Phillips-Perron test, and those of W-S are of weighted symmetric test.

Source: Author.

The results of unit roots tests reveal that the non-logged first-order differential data satisfy five percent statistical significance to reject existence of unit roots.

II.2. Identification of ARIMA Model

The autoregression (AR) model, which is one of the most typical stochastic models, can be expressed as follows:

(EQ2-1) $$y_t = f_1 y_{t-1} + f_2 y_{t-2} + \cdots + f_p y_{t-p} + a_t$$

or $$(1 - f_1 L - f_2 L^2 - \cdots - f_p L^p) y_t = f(L) y_t = a_t$$

where y_t time series data (here, visitor arrivals at Bali)
f parameter
L lag operator $(L^i y_t = y_{t-i})$

The auto-covariance (g_k) can be obtained by multiplying y_{t-k} on both hands of AR(p) model and taking the expected value and the auto-correlation (r_k) can be then obtained by dividing it by variance (g_0) as follows:

(EQ2-2) $$g_k = f_1 g_{k-1} + f_2 g_{k-2} + \cdots + f_p g_{k-p} \qquad (k > 0)$$

[3] Yoshioka (2002a) provides more detailed information on unit roots tests.

$$r_k = f_1 r_{k-1} + f_2 r_{k-2} + \cdots + f_p r_{k-p} \qquad (k > 0)$$

where g_k auto-covariance

g_0 variance

r_k auto-correlation

According to Yule-Walker equation, k^{th}-order partial auto-correlation function is given as follows:

(EQ2-3) $$y_t = f_{k1} y_{t-1} + f_{k2} y_{t-2} + \cdots + f_{kk} y_{t-k}$$

The partial auto-correlation function (PACF) of autoregression (AR) process will be given as follows:

(EQ2-4)

AR(1)	$f_{11} = r_1 = f$	$f_{kk} = 0$	$(k > 1)$
AR(2)	$f_{11} = r_1$ and $f_{22} = \dfrac{r_2 - r_1^{\ 2}}{1 - r_1^{\ 2}}$	$f_{kk} = 0$	$(k > 2)$
AR(p)	$f_{11} \neq 0, \cdots, f_{pp} \neq 0$	$f_{kk} = 0$	$(k > p)$

On the other hand, another typical stochastic model, which is a moving average (MA) model, can be expressed as follows:

(EQ2-5) $$y_t = a_t - q_1 a_{t-1} - q_2 a_{t-2} - \cdots - q_q a_{t-q}$$

or $$y_t = (1 - q_1 L - q_2 L^2 - \cdots - q_q L^q) a_t = q(L) a_t$$

where q parameter

The auto-covariance of the time series data (y_t) is also given as follows:

(EQ2-6) $$g_k = \frac{-q_k + q_1 q_{k+1} + q_2 q_{k+2} + \cdots + q_{q-k} q_q}{1 + q_1^{\ 2} + q_2^{\ 2} + \cdots + q_q^{\ 2}} g_0 \qquad (k = 1, 2, \cdots, q)$$

$$g_k = 0 \qquad (k > q)$$

The auto-correlation of the data is given as follows:

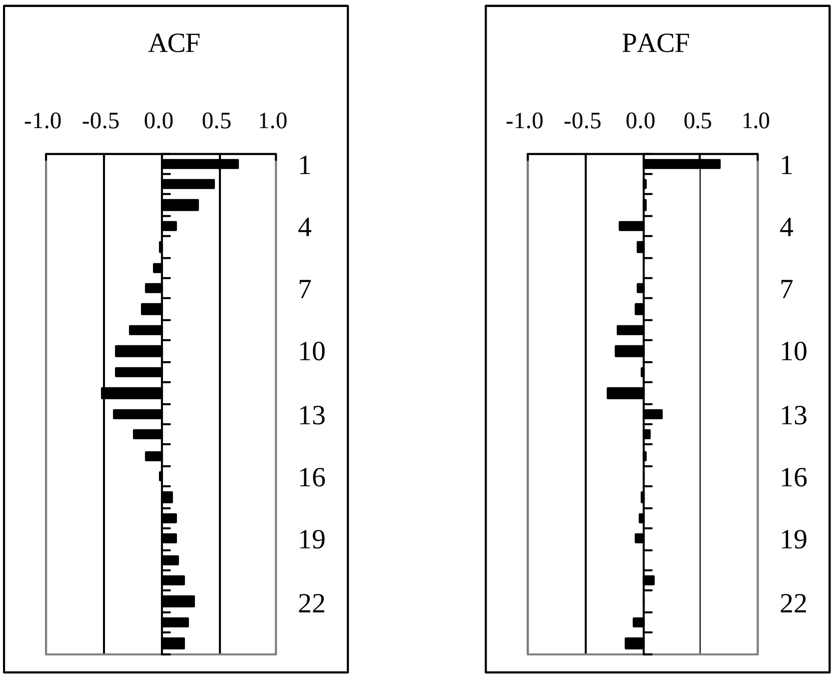
(EQ2-7) $$r_k = \frac{-q_k + q_1 q_{k+1} + q_2 q_{k+2} + \cdots + q_{q-k} q_q}{1 + q_1^{\ 2} + q_2^{\ 2} + \cdots + q_q^{\ 2}} \qquad (k = 1, 2, \cdots, q)$$

$$r_k = 0 \qquad (k > q)$$

These are very well-established methodology among economists although this is not based on any specific economic theory. We can rely on this methodology since there are not a lot of data reliable for evaluating and forecasting visitor arrivals at Bali.

According to above, we have to check the DGP of visitor arrivals at Bali. Chart 1 reports the results of correlogram of the data.

Chart 1: Auto-Correlation Function (ACF) and Partial Auto-Correlation Function (PACF) of Visitor Arrival at Bali



Source: Author.

The ARIMA model for visitor arrival at Bali is then identified as ARIMA(2,1,4). However, a deep attention must be paid that I do take one for a differential order but this is by twelve months. Theoretically, it is expected that this way of taking differential removes a seasonal factor.

II.3. Estimation of ARIMA Model

According to above identification, Table 2 reports the results of ARIMA model estimation.

Table 2: ARIMA Model Estimation Results

parameters	estimates	standard error	t-statistics
const.	331.56800	139.17900	2.38232
f_1	1.59178	0.15559	10.23080
f_2	-0.66156	0.15298	-4.32449
q_1	0.95591	0.16924	5.64840
q_2	-0.00805	0.15082	-0.05340
q_3	-0.25540	0.14730	-1.73380
q_4	0.30754	0.11843	2.59688
RR		0.527603	

Notes: 1. The estimation period is from January 1995 up to September 2002.[4]

2. ϕ 's are parameters for autoregression.

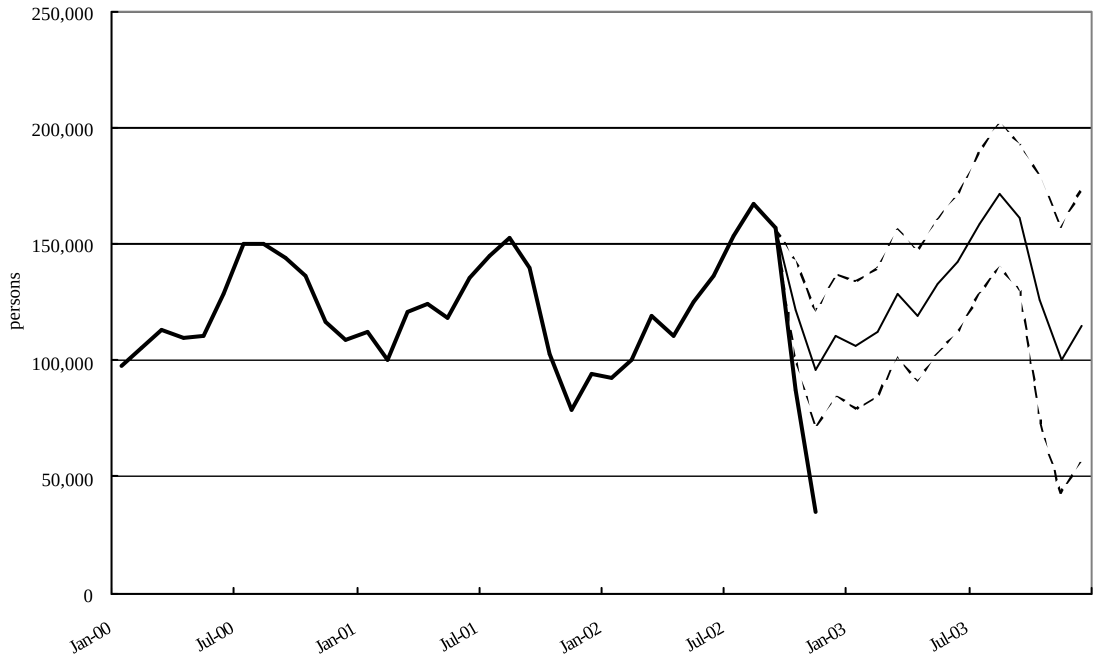
3. θ 's are parameters for moving average.

Source: Author.

II.4. Forecast by ARIMA Model

Based on the above ARIMA model, I simulated it until December 2003. Chart 2 reports the results.

Chart 2: Forecast of Visitor Arrival at Bali Until 2003



Notes: 1. Bold continuous line is actual.

2. Small continuous line is mean forecast.

3. Small broken lines are lower and upper 95 percent confidence bounds.

Source: Author.

The results indicate that the actual numbers of visitor arrivals at Bali in October and November 2002 are far below than the mean non-tragedy (pre-bomb) forecast and the lower bound of 95 percent confidence interval. The ratio of actual number over the mean forecast is around 0.71 in October 2002 and 0.37 in November.

I then call this ratio "damage ratio." I take two types assumption for the future damage ratio until December 2003, such as gradual recovery case (Case 1) and rapid recovery case (Case 2). At Case 1, this damage ratio recovers to 1.0 in December 2003 and at Case 2, it gets back to 1.0 in July 2003.

I then multiply these damage ratios on the mean pre-bomb forecast value obtained by an ARIMA model. Chart 3 and Table 3 report the development of visitor arrivals forecasted

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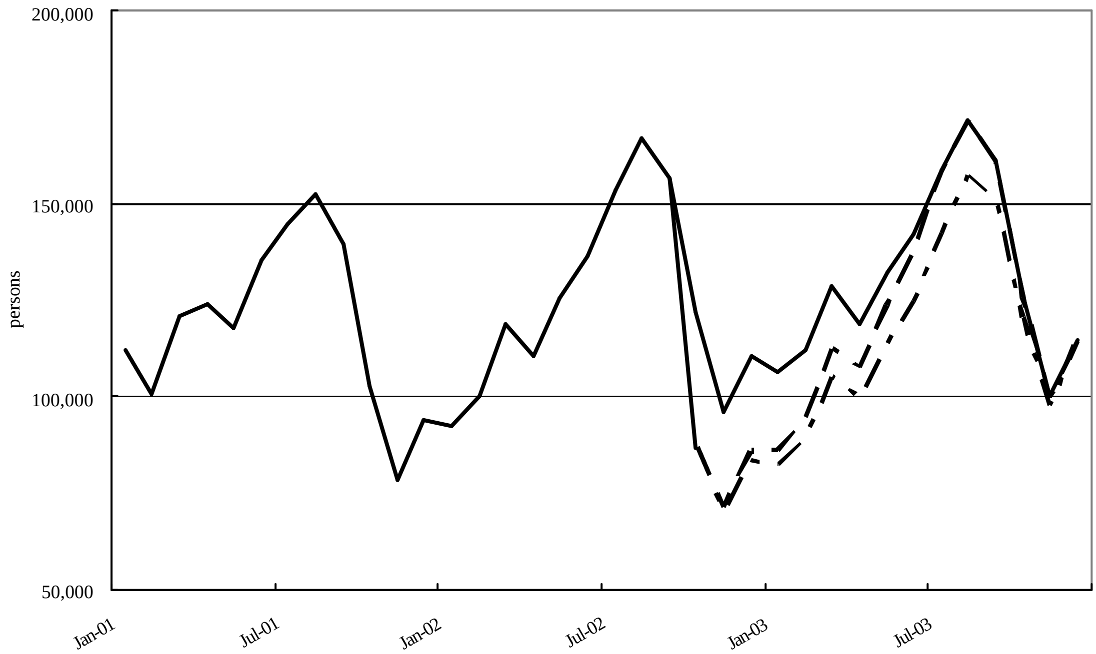
[4] This estimation period implies that I excluded the data after the tragedy in mid-October.

with two damage ratios over mean pre-bomb forecast by ARIMA model of both cases.

Chart 3: Forecast of Visitor Arrivals at Bali by AIMA Model



Notes: 1. Continuous line is mean of ARIMA pre-bomb forecast.
2. Upper dotted line indicates Case 2.
3. Lower dash-dotted line indicates Case 1.

Source: Author.

Table 3: Forecasted and Lost Visitor Arrivals at Bali by ARIMA Model

Year	pre-bomb forecast	Case 1			Case 2		
		forecast	deviation		forecast	deviation	
2002	1,489,394	1,328,988	160,406	10.77%	1,332,359	157,034	10.54%
2003	1,572,507	1,158,075	414,433	26.35%	1,376,113	196,394	12.49%

Note: Due to rounding numbers, the final digit is not necessarily correspondent to results of simple calculations.

Unit: Persons, otherwise mentioned.

Source: Author.

III. State Space Model Approach

III.1. Framework of State Space Model and Kalman Filter

Kalman filter of Kalman (1960) originates in the engineering literature and was imported into econometrics later. It plays a very important role for providing methodologies of an optimal forecast and estimation for unknown parameters in a state space model, *etc.* Kalman filter provides a generic analytical framework of likelihood functions for very complicated models.[5] In economics literatures, this methodology is

[5] Harvey (1981) focuses on further theoretical aspect of a state space model while Yoshioka (2002b) is concentrated on a practical field. Snyder and Forbes (1999) deals with some computational treatment of the state space model.

often employed for estimating latent variables. Kuttner (1994), Gerlach and Smets (1999) and Yoshioka (2002b) estimate the output gap in the United States, Euro area and southeast Asia respectively while Hyndman *et al.* (2000) employs a state space model for forecasting.

One of the most advantageous points of this methodology is that any of latent variables is necessarily restricted to follow a random walk, an autoregressive, or other specific stochastic processes. However, we face a difficulty of determining data generating process (DGP) of latent variables such as Bali preferable index. Including DGP of another data, I then assume as follows:

(1) The number of visitor arrivals at Bali is defined by an observation equation that consists of foreign consumption in the United States, Japan and Australia and Bali preferable index.[6]
(2) Bali preferable index is apparently unobserved (latent) and follows AR(3) process.

According to data availability in the United States, Japan, Australia and Indonesia, I implicitly assume two important points in above assumptions. One is data basis of foreign consumption data. That is while data of the United States and Japan are consumption per household, those of Australia are total (not per household). The basis of data is not necessarily consistent. This fact implies that I assume Australian number of household is constant during the estimation period. Accounting the presence of Australia in Bali and considering the number of Australian victims in Bali tragedy, it is inevitable to include Australian data. The constant number of Australian household is then plausible to be accepted since data are limited. The other is treatment of Indonesian visitors. That is, of course, visitor arrivals at Bali include Indonesian but I assume their behavior in the same manner of foreigners. Indonesia consumption (or income) is thus excluded in explanatory variables. It seems quite plausible because Indonesian who visits Bali appear rich.

According to above assumption a state space model for visitor arrivals at Bali could be expressed as follows:

(EQ3-1) $$y_t = a_0 + a_1 c_t + a_2 b_t + {}^{y}e_t$$

(EQ3-2) $$b_t = \sum_{k=1}^{3} l_k b_{t-k} + {}^{b}e_t$$

where

y	visitor arrivals at Bali
c	foreign consumption in the U. S., Japan and Australia
b	Bali preferable index
${}^{i}e$	error of item i (i=y, b)
a , l	parameters

Or this state space model could be expressed with matrices as follows:

[6] Since the statistics of visitor arrivals at Bali includes those domestic, this assumption implies that Indonesian visitor fluctuates in the same manner of those foreign.

(EQ3-3) observation equation

$$y_t = \begin{bmatrix} a_0 & a_1 \end{bmatrix} \begin{bmatrix} 1 \\ c_t \end{bmatrix} + \begin{bmatrix} a_2 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} b_t \\ b_{t-1} \\ b_{t-2} \\ b_{t-3} \end{bmatrix} + \begin{bmatrix} {}^{y}e_t \end{bmatrix}$$

(EQ3-4) transit equation

$$\begin{bmatrix} b_t \\ b_{t-1} \\ b_{t-2} \\ b_{t-3} \end{bmatrix} = \begin{bmatrix} l_1 & l_2 & l_3 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} b_{t-1} \\ b_{t-2} \\ b_{t-3} \\ b_{t-4} \end{bmatrix} + \begin{bmatrix} {}^{b}e_t \\ 0 \\ 0 \\ 0 \end{bmatrix}$$

III.2 Estimation Procedures for State Space Model

I practically employ the following estimation procedures:

(1) Both data for visitor arrivals at Bali and composite consumption expenditure in the United States, Japan and Australia are taken first-order differential.[7]
(2) The composite consumption expenditure in the United States, Japan and Australia are simply averaged in a multipliable manner after adjusted to Indonesian Rupiah domination.
(3) The estimation period is from January 1995 up to November 2002 according to the data availability.
(4) I did not employ time-varying parameter methodology but fixed the parameter.

III.3. Estimation Results of State Space Model

Table 4 reports estimation results of parameters, standard errors, and t-statistics of an observation equation, and those of variances of residuals of both observation and transit equations.

Table 4: State Space Model Estimation Results

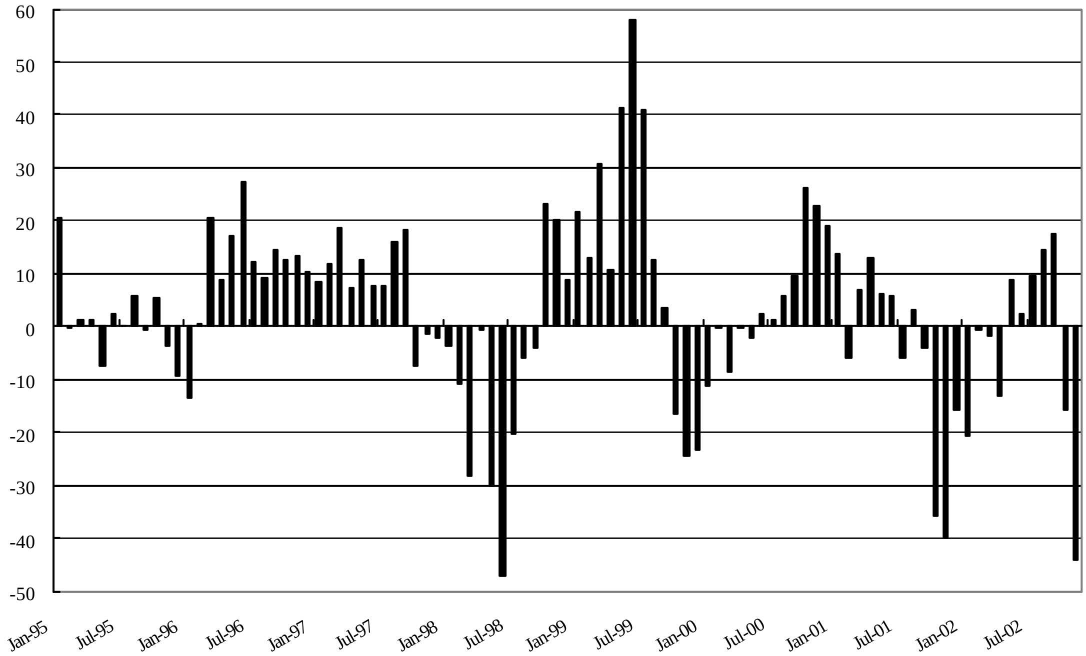
dependent variable	independent variables	coefficient	standard error	t-statistics	RR
visitor arrivals	constant	-0.00276	0.00276	-0.99889	1.000
	consumption expenditure	15.31283	0.00003	594308.8	
	preferable index	967.23340	0.00015	6307849.0	
preferable index	1-month lag	0.78051	0.10973	7.11316	0.482
	2-month lag	-0.08639	0.13662	-0.63235	
	3-month lag	0.01174	0.11187	0.10496	
variance of residuals	visitor arrivals	0.00055655	preferable index	160.84479	

[7] This is the same practice when we estimated an ARIMA model.

Note: The estimation period is from January 1995 up to November 2002.
Source: Author.

The observation equation indicates quite satisfactory results while the transit equation does not. This might be due to incorrect assumption for DGP of this latent variable, "Bali Preferable Index," which might not follows AR(3) process, but I regret so much that it is almost impossible to be checked. Cart 4 reports the estimated Bali preferable index (hereafter, BPI).

Cart 4: Bali Preferable Index (BPI) Estimates by a State Space Model



Unit: None.
Source: Author.

According to the estimates of the state space model, BPI[8] shows cyclical movements from 1995 to 2002. In mid-1990's, the index continued positive for a sizable number of months. Synchronized with the Asian currency crisis, it began to drop and hit the bottom in June 1998. It soon recovered and marked its peak in June 1999. One of the most plausible reasons why this peak is so high is that the deeper the preceding bottom was, the higher the following peak would be.

Recently after marking a negative index in April 2002, BPI had continued positive value until the Bali tragedy in mid-October and it sank suddenly and sizably in October. In November, it dropped more. AT present, however, we cannot find out any evidence that BPI in November is the bottom or not. The bottom after Bali bomb might come with some months lag.

[8] We have to pay a deep attention that BPI possibly includes other factors that foreign consumption (or income) and Bali preferable degree. Due to a state space model's nature, these miscellaneous factors cannot be excluded in estimates.

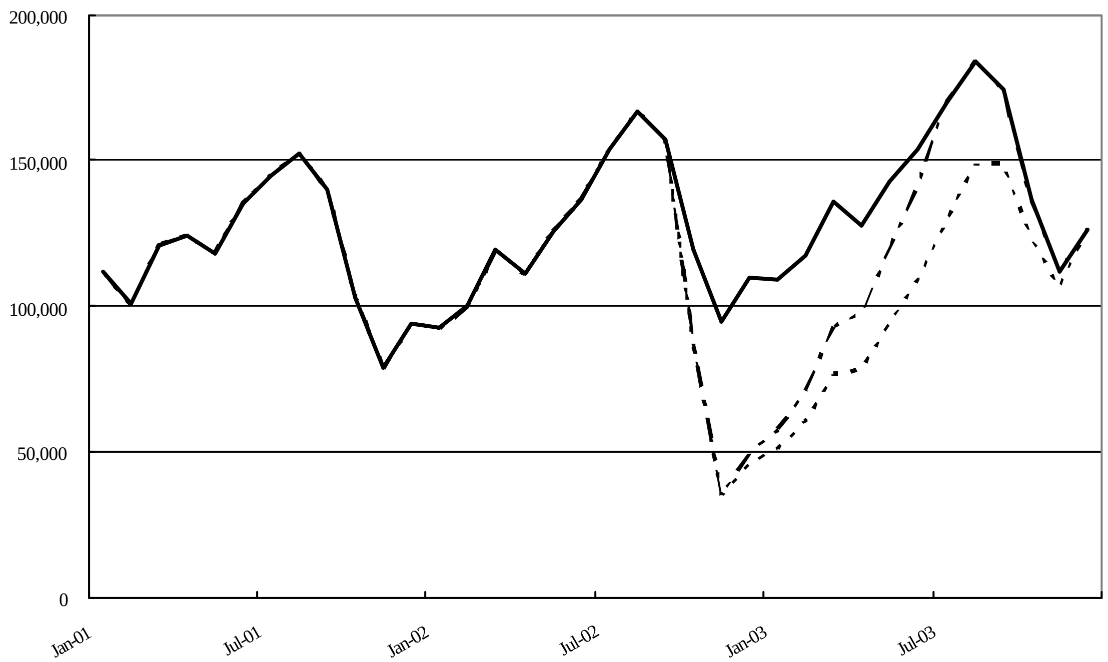
III.4. Forecast by State Space Model

Since an ARIMA model is based on a univariate approach and does not include any exogenous variable, we do not have to assume anything. A state space model, however, requires some assumption for the future forecast. This paper does not aim to forecast visitor arrivals at Bali accurately but to evaluate the impact of Bali tragedy. I then do not have to concentrate myself so much on assuming some exogenous variables. I therefore assume following points:

(1) Consumption expenditure in the United States, Japan and Australia is assumed to continue the same level in November 2002. At least in the United States and Japan, there could not be observed any evidence that consumption would grow significantly in 2003.
(2) For non-tragedy (pre-bomb) case, BPI is also assumed to continue the same level in September 2002. This implies that a quite favorable circumstance for Indonesian tourism would keep without Bali bomb.
(3) On the other hand, I assumed two "damage ratios" for post-bomb cases as same as ARIMA model forecast.

According to these assumptions, I then estimate some forecast value obtained by a state space model. Chart 5 and Table 5 report the development of visitor arrivals forecasted with two damage ratios over mean pre-bomb forecast by a state space model of both cases.

Chart 5: Forecast of Visitor Arrivals at Bali by State Space Model



Notes: 1. Continuous line is pre-bomb state space model forecast.
2. Upper dash-dotted line indicates Case 2.
3. Lower dotted line indicates Case 1.

Source: Author.

Table 5: Forecasted and Lost Visitor Arrivals at Bali by State Space Model

Year	pre-bomb forecast	Case 1			Case 2		
		forecast	deviation		forecast	deviation	
2002	1,484,587	1,329,050	155,536	10.48%	1,332,364	152,223	10.25%
2003	1,688,555	1,251,720	436,835	25.87%	1,483,816	204,738	12.13%

Note: Due to rounding numbers, the final digit is not necessarily correspondent to results of simple calculations.
Unit: Persons, otherwise mentioned.
Source: Author.

IV. Estimates on Indonesian National Economy

IV.1. Framework of Input-Output Table

Leontief (1951) and Leontief *et al.* (1953) introduced analysis on input-output table model to economic literatures. Leontief himself made a large contribution to this model by Leontief (1970). This methodology is now widely employed for economic analysis and other topics including environmental evaluation. This originated in static analysis but was later developed dynamic economic assessment such as Szyld (1985). Recently, it is developed for multi-regional analysis[9] and provides theoretical and practical basis for computable general equilibrium (CGE) models. On the other hand, we have to pay a deep attention for the limitation of this methodology.[10]

Following Figure provides example of structure of *n* by *n* input-output table:

Figure: Structure of Input-Output Table

Sector	1	2	……	j	……	n	final demand	output
1	$a_{11}X_1$	$a_{12}X_2$	……	$a_{1i}X_i$	……	$a_{1n}X_n$	D_1	X_1
2	$a_{21}X_1$	$a_{21}X_2$	……	$a_{2i}X_i$	……	$a_{2n}X_n$	D_2	X_2
:	:	:		:		:	:	:
i	$a_{i1}X_1$	$a_{i2}X_2$	……	$a_{ii}X_i$	……	$a_{in}X_n$	D_i	X_i
:	:	:		:		:	:	:
n	$a_{n1}X_1$	$a_{n2}X_2$	……	$a_{ni}X_i$	……	$a_{nn}X_n$	D_n	X_n
value added	V_1	V_2	……	V_j	……	V_n		
output	X_1	X_2	……	X_i	……	X_n		

Source: Author.

According to the concept of input-output table, the output consists of intermediate and final demand. The former is divided into a sizable number of sectors and expressed with input coefficients. The input-output table analysis assumes that these input coefficients are stable.

We can also write input-output table in a matrix expression instead of above tabular expression as follows:

[9] Campisi (1996) employs multi-regional input-output table for analyzing economic growth.
[10] Simonovits (1975) and Roland-Holst (1989) provide further view points.

(EQ4-1)

$$\begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_i \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1i} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2j} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix} \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_i \\ \vdots \\ X_n \end{bmatrix} + \begin{bmatrix} D_1 \\ D_2 \\ \vdots \\ D_i \\ \vdots \\ D_n \end{bmatrix}$$

Or it is also possible to express the equation of (EQ4-1) in short as follows:

(EQ4-2) $\boldsymbol{X} = \boldsymbol{AX} + \boldsymbol{D}$

where $X = \begin{bmatrix} X_1 \\ X_2 \\ \vdots \\ X_i \\ \vdots \\ X_n \end{bmatrix} = \begin{bmatrix} X_1 & X_2 & \cdots & X_i & \cdots & X_n \end{bmatrix}^T$

$$A = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1i} & \cdots & a_{1n} \\ a_{21} & a_{22} & \cdots & a_{2j} & \cdots & a_{2n} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{i1} & a_{i2} & \cdots & a_{ij} & \cdots & a_{in} \\ \vdots & \vdots & & \vdots & & \vdots \\ a_{n1} & a_{n2} & \cdots & a_{nj} & \cdots & a_{nn} \end{bmatrix}$$

$$D = \begin{bmatrix} D_1 \\ D_2 \\ \vdots \\ D_i \\ \vdots \\ D_n \end{bmatrix} = \begin{bmatrix} D_1 & D_2 & \cdots & D_i & \cdots & D_n \end{bmatrix}^T$$

From the equation of (EQ4-2), we can obtain the famous inverse matrix as follows:

(EQ4-2)

$$\boldsymbol{X} - \boldsymbol{AX} = \boldsymbol{D}$$
$$[\boldsymbol{I} - \boldsymbol{A}]\,\boldsymbol{X} = \boldsymbol{D}$$
$$\boldsymbol{X} = [\boldsymbol{I} - \boldsymbol{A}]^{-1}\,\boldsymbol{D}$$

where $I = \begin{bmatrix} 1 & 0 & \cdots & 0 \\ 0 & 1 & \cdots & 0 \\ \vdots & \vdots & \ddots & \vdots \\ 0 & 0 & \cdots & 1 \end{bmatrix}$ (unit matrix)

As well-known, of course, $\boldsymbol{I}$ is called a unit matrix. The Central Bureau of Statistics (BPS[11]) of Indonesian Government provides a generic input-output table of 19 sectors that describe comprehensive Indonesian macro economy in 1995. Table 6 reports the classification of this input-output table.

Table 6: Classification of Indonesian Input-Output Table

19 Sector I-O Code	Sector
1	paddy
2	other food crops
3	other agriculture
4	livestock and its product
5	forestry
6	fishery
7	mining and quarrying
8	manufacture of food, beverages and tobacco
9	other manufacturing
10	petroleum refinery
11	electricity, gas and water supply
12	construction
13	trade
14	restaurant and hotel
15	transport and communication
16	financial intermediaries, real estate and business service
17	general government and defense
18	other services
19	unspecified sector

Source: Central Bureau of Statistics, Government of Indonesia

IV.2 Assumptions for Estimation

For estimating preliminarily the impact of Bali tragedy on Indonesian national economy, I take following very simple assumptions:

(1) According to the forecasts of an ARIMA model and a state space model, maximum and minimum lost visitor arrivals are assumed as Table 7.

Table 7: Assumption for Lost Visitor Arrivals at Bali

Year	Minimum Damage	Maximum Damage
2002	152,223	160,406
2003	196,394	436,835

Unit: Persons.
Source: Author.

(2) The economic value lost per a visitor for Bali is assumed US$ 2,500, which is equivalent to Rupiah 5,770,000 in 1995 prices and exchange rate. Among those, 1) 4

[11] BPS is also called Statistics Indonesia.

percent of this amount, which is equivalent to US$ 100 and Rupiah 230,800 per a visitor is lost at the 9th sector of other manufacturing; 2) 80 percent, equivalent to US$ 2000 and Rupiah 4,616,000 per a visitor, is lost at the 14th sector of restaurant and hotel; and 3) rest, 16 percent, equivalent to Rupiah US$ 400 and Rupiah 932,200 per a visitor, is at the 15th sector of transport and communication.

(3) Statistical discrepancy between GDP and value added at input-output table are adjusted.

IV.3 Results of Estimation

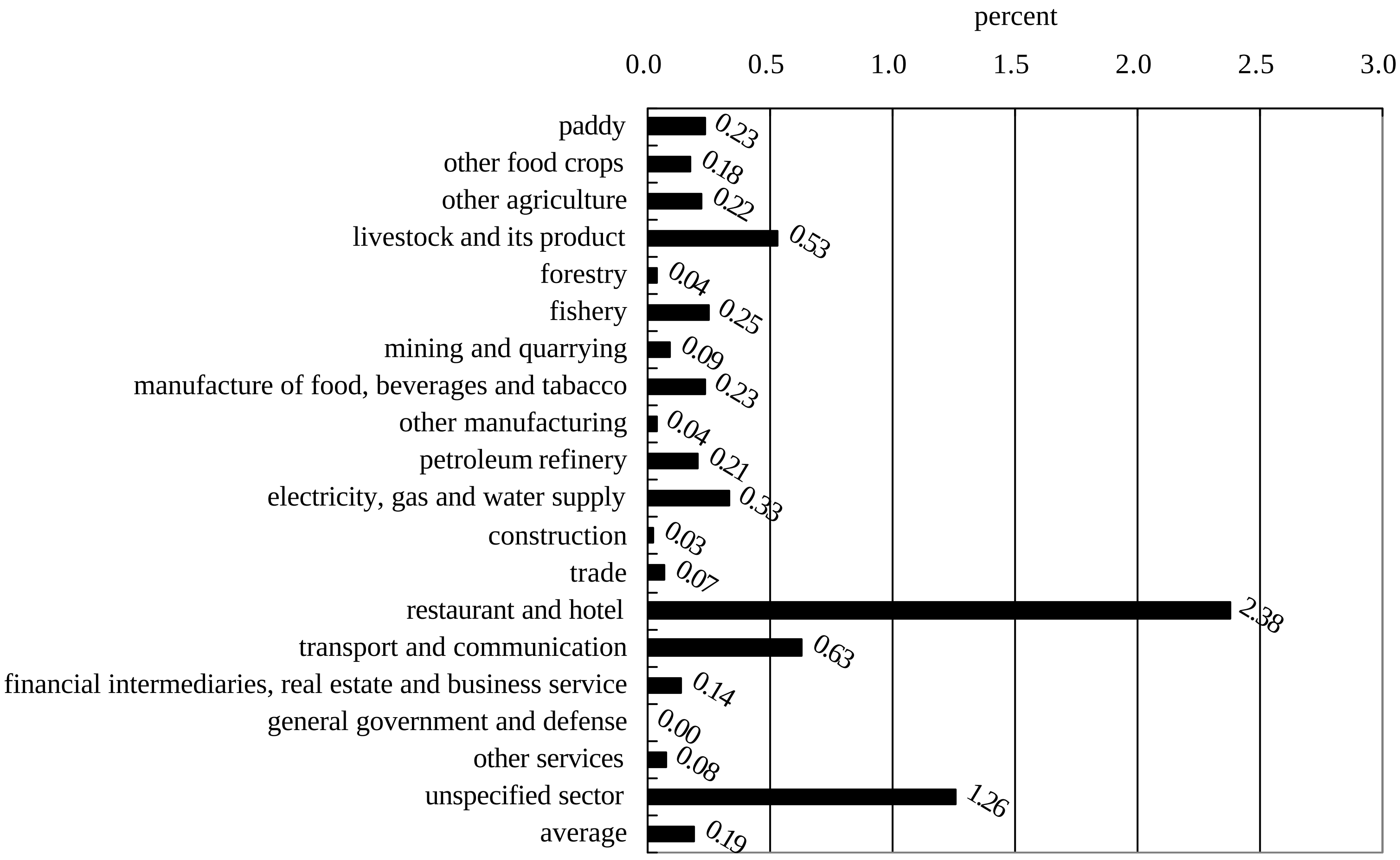
Table 8 and Charts 6 summarize the estimates of negative impact of Bali tragedy on Indonesian national economy by sector. Results are reported at percent deviation from non-tragedy (pre-bomb) cases.

Table 8: Sector-Specific Results of Estimation by Input-Output Model

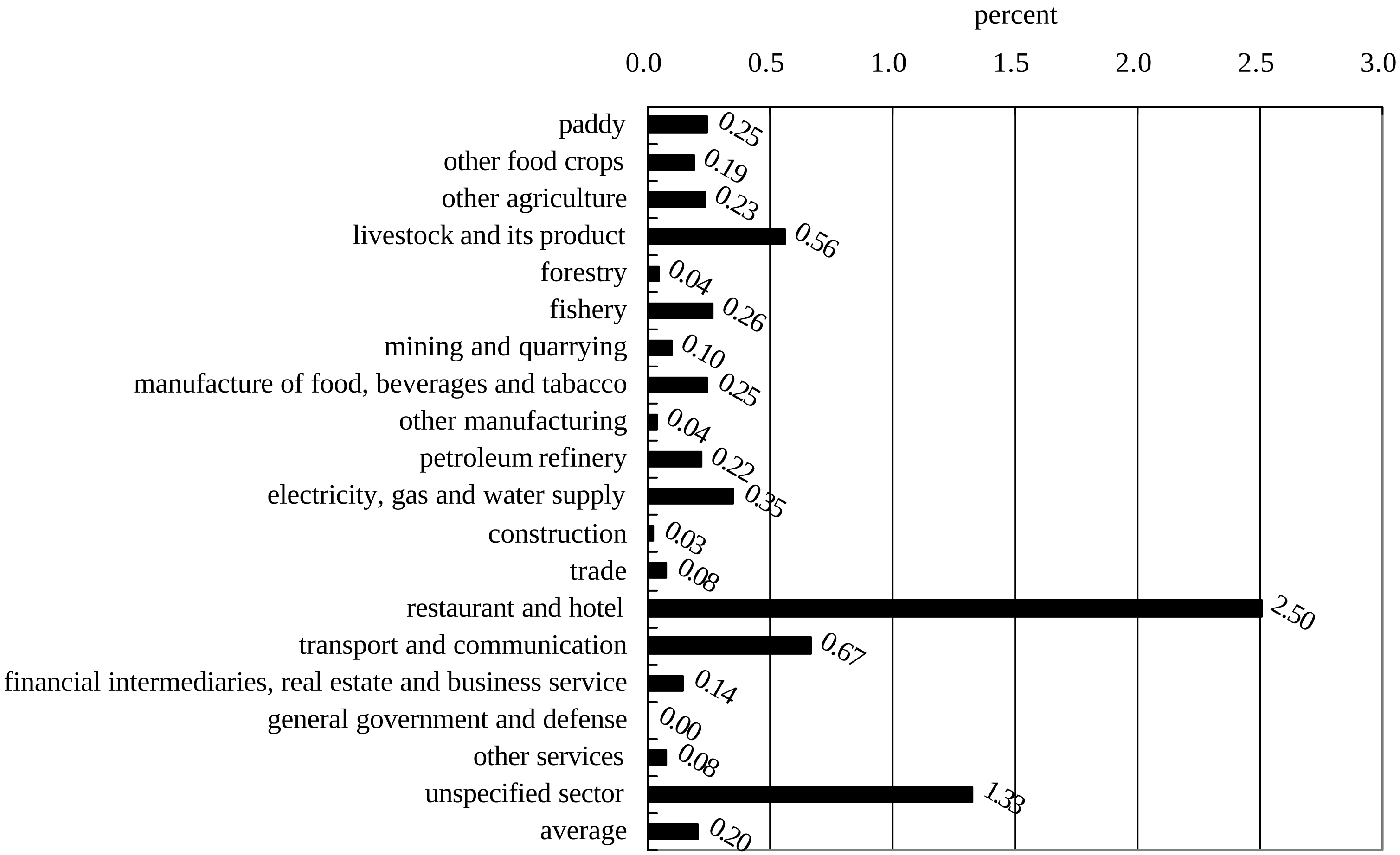
Sector	2002		2003	
	Min. Case	Max. Case	Min. Case	Max. Case
paddy	0.23	0.25	0.30	0.67
other food crops	0.18	0.19	0.23	0.51
other agriculture	0.22	0.23	0.29	0.64
livestock and its product	0.53	0.56	0.69	1.53
forestry	0.04	0.04	0.05	0.12
fishery	0.25	0.26	0.32	0.72
mining and quarrying	0.09	0.10	0.12	0.26
manufacture of food, beverages and tabacco	0.23	0.25	0.30	0.67
other manufacturing	0.04	0.04	0.05	0.10
petroleum refinery	0.21	0.22	0.27	0.60
electricity, gas and water supply	0.33	0.35	0.43	0.95
construction	0.03	0.03	0.03	0.07
trade	0.07	0.08	0.09	0.21
restaurant and hotel	2.38	2.50	3.07	6.82
transport and communication	0.63	0.67	0.81	1.81
financial intermediaries, real estate and business service	0.14	0.14	0.18	0.39
general government and defense	0.00	0.00	0.00	0.00
other services	0.08	0.08	0.10	0.22
unspecified sector	1.26	1.33	1.62	3.61
average	0.19	0.20	0.25	0.56

Note: Figures are percent deviation from non-tragedy (pre-bomb) cases on value added.
Unit: Percent deviation.
Source: Author.

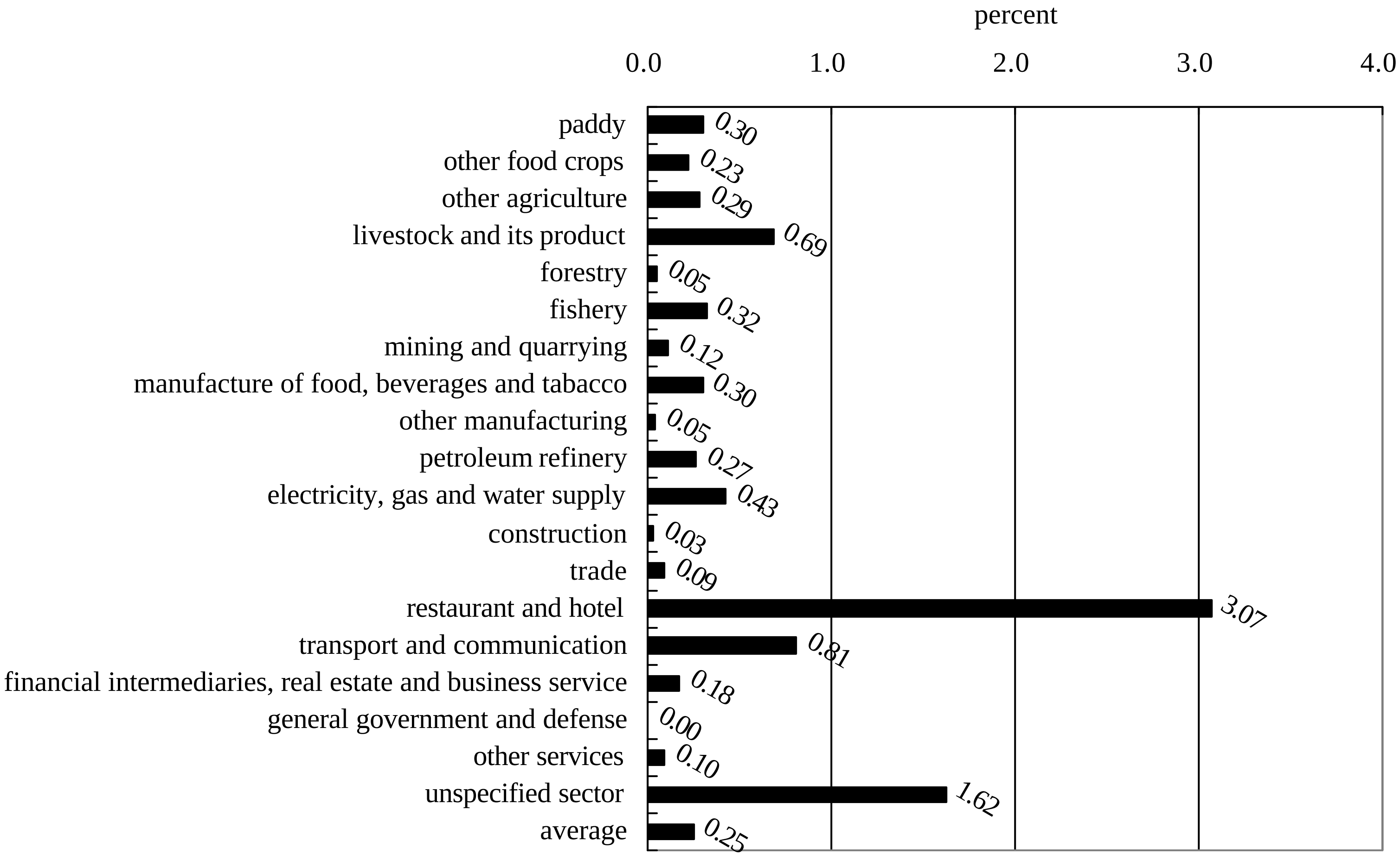
Chart 6: Sector-Specific Results of Estimation by Input-Output Model
(1) 2002 Minimum Damage Case



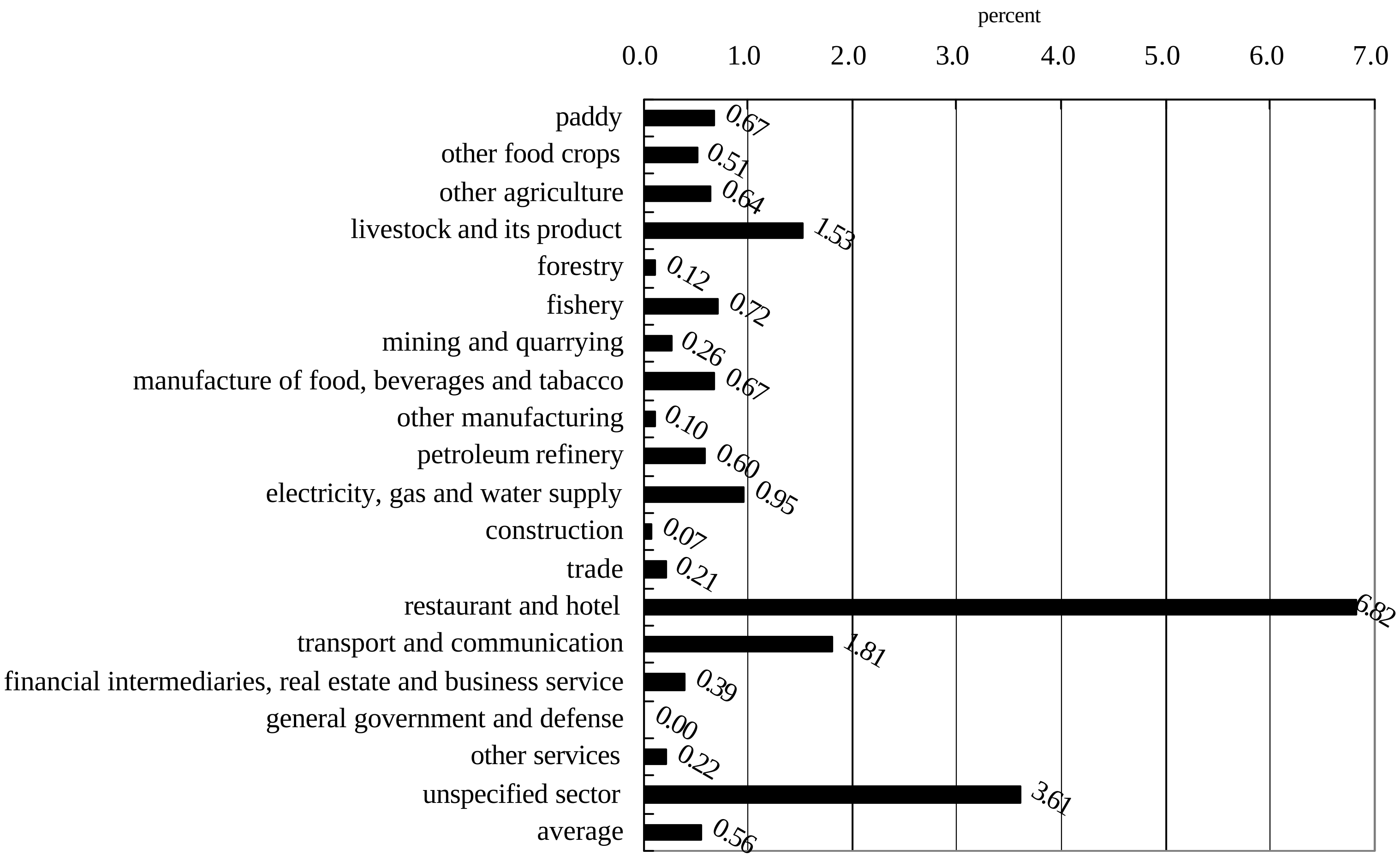
(2) 2002 Maximum Damage Case



(3) 2003 Minimum Damage Case



(4) 2003 Maximum Damage Case



Note: Cases correspond to Table 7.
Unit: Percent deviation.
Source: Author.

According to the results, of course, restaurant and hotel sector is damaged most. Next to this sector, transport and communication sector and livestock and its product sector will be hard hit other than unspecified sector. For overall evaluation, Indonesian GDP will be negatively affected by around 0.2 percent in 2002 and around 0.3-0.6 percent in 2003.

V. Conclusion

The estimated results by ARIMA, state space and input-output models show sizably negative, of course, and urge recovery-helping action for Indonesia and international society, including Japan.

Other than some policy implications, since this is a preliminary estimate, I have to point out following respects to be improved:

(1) Methodology
I here take two types of time series model approaches for forecasting and input-output model for evaluating its influence on Indonesian national economy. It might be, however, required to seek whether or not we can take another appropriate methodology in order to evaluate the negative impact more accurately.
(2) Data Collection
Since this paper presents a preliminary estimation, the data after Bali tragedy is included for the only two months. For more precise evaluation, more recent and broader data must be collected.
(3) Broader Assessment
This paper is concentrated on estimating impact from visitor arrivals at Bali. For economic policy implication, however, broader assessment should be required. Many economists are afraid that Bali tragedy damaged investors' incentive. And also, some insists that relative prices may matter. This paper also excluded its impact on fiscal and financial activities. Since Bali tourism was one of the most stable resources of foreign currencies in Indonesia, more insightful investigation in fiscal and financial aspects is also expected.

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