CIRJE-F-649

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Michael McAleer
Erasmus University Rotterdam and Tinbergen Institute
and CIRJE, Faculty of Economics, University of Tokyo
Bing-Wen Huang
National Chung Hsing University
Hsiao-I Kuo
Chaoyang University of Technology
Chi-Chung Chen
National Chung Hsing University
Chia-Lin Chang
National Chung Hsing University

August 2009

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Michael McAleer

Econometric Institute
Erasmus School of Economics
Erasmus University Rotterdam
and
Tinbergen Institute
The Netherlands
and
Center for International Research on the Japanese Economy (CIRJE)
Faculty of Economics
University of Tokyo

Bing-Wen Huang
Department of Applied Economics
National Chung Hsing University

Hsiao-I Kuo
Department of Senior Citizen Service Management
Chaoyang University of Technology

Chi-Chung Chen
Department of Applied Economics
National Chung Hsing University

Chia-Lin Chang*
Department of Applied Economics
National Chung Hsing University

Revised: August 2009

Corresponding author: Chia-Lin Chang, Department of Applied Economics, National Chung Hsing University, Taichung, Taiwan.
Email: changchialin@nchu.edu.tw, Tel: +886(04)22840350 Ext. 309.

The authors are most grateful for the helpful comments and suggestions of participants at the International Congress on Modelling and Simulation, Christchurch, New Zealand, December 2007.

Abstract

This paper compares the impacts of SARS and human deaths arising from Avian Flu on international tourist arrivals to Asia. The effects of SARS and human deaths from Avian Flu will be compared directly according to human deaths. The nature of the short run and long run relationship is examined empirically by estimating a static line fixed effect model and a difference transformation dynamic model, respectively. Empirical results from the static fixed effect and difference transformation dynamic models are consistent, and indicate that both the short run and long run SARS effect have a more significant impact on international tourist arrivals than does Avian Flu. In addition, the effects of deaths arising from both SARS and Avian Flu suggest that SARS is more important to international tourist arrivals than is Avian Flu. Thus, while Avian Flu is here to stay, its effect is currently not as significant as that of SARS.

Keywords: SARS, Avian Flu, International Tourism, Static Fixed Effects Model, Dynamic Panel Data Model.

1. Introduction

Two diseases with their genesis in Asia, namely the Severe Acute Respiratory Syndrome (hereafter SARS) epidemic, which received worldwide attention in 2003, and the H5N1 Avian Influenza (hereafter Avian Flu) epidemic, which has received worldwide attention since 2004, have significantly damaged the image of international tourism to Asia as a safe tourist destination. According to the World Travel and Tourism Council (2003), the outbreak of the SARS disease led to the collapse of the tourism industry in the most severely affected Asian countries, namely China, Hong Kong, Singapore and Vietnam, SARS is estimated to have cost these four countries over US$20 billion in lost GDP, and a reduction of more than 70% across the rest of Asia, even in countries that were totally disease free (Mckercher and Chou, 2004).

Table 1 presents the number of SARS infections, deaths and the death to infection ratio worldwide in 2003. As shown in Table 1, 8,096 people worldwide were infected by the potentially fatal SARS disease, while 774 deaths were caused by SARS. Of the 8,096 infections, 7,783 (or 96%) have occurred in Asia and only 313 (or 4%) in the rest of the world. Moreover, 729 (or 94%) human deaths have been caused by SARS in Asia, while only 45 (or 6%) human deaths have arisen in the rest of the world. China has accounted for the greatest number of SARS infections and deaths arising from SARS, followed by Hong Kong. However, Malaysia has the highest death ratio at 40%, while Thailand, Hong Kong, Taiwan, Singapore and the Philippines have a death ratio in excess of 10%..

Table 2 presents the Avian Flu spread and infections worldwide from December 2003 to July 2007. As shown in Table 2, Avian Flu epidemics were initially detected in East and South-East Asia, and were subsequently spread worldwide. For Avian Flu confirmed in humans, Vietnam was the first country to report data in both human infections and human deaths to the WHO. As shown in Table 2, the cumulative number of infections of Avian Flu worldwide was 319, with 192 human deaths from Avian Flu. Of the 319 human infections, 279 cases (or 87.46%) have occurred in Asia, while 40 infections (or 12%) occurred in Africa. This is similar to the number of

deaths in humans, with 176 deaths (or 92%) in Asia, and only 16 deaths (or 8%) in Africa.

In Asia, Cambodia and Laos accounted for the highest death rate, and Thailand and Indonesia had death rates in excess of 70%. Nevertheless, the death rates in China, Iraq and Azerbaijan exceeded 60%, while Vietnam and Turkey had death rates of 44% and 33%, respectively. Overall, Asia is the most seriously affected region by Avian Flu, both in humans and poultry. Furthermore, the mortality rate in Asia is very high at 62.72%, which is higher than the average death rate worldwide at 60.25%.

The transmission routes are different between SARS and Avian Flu. SARS is a respiratory illness with pneumonia-like symptoms, so its transmission route is directly through person-to-person contact, while Avian Flu is consistent with animal-to-human, and possible environment-to-human, but is still limited in unsustained human-to-human transmission (Beigel et al., 2005).

In spite of Avian Flu, the disease can be transmitted from animals to humans, not by close person-to-person contact. However, Avian Flu still presents a very high mortality rate among humans, as shown in Table 2, which represents a potential risk arising from the Avian Flu epidemic. Moreover, Page et al. (2006) indicate that Avian Flu at this stage is not transmitted among humans. The critical link between Avian Flu and the tourism industry has a potential global reach in that Avian Flu can be spread through international travel. The concern among health professionals is that Avian Flu may create a new flu virus from animal reservoirs, which will then infect humans who will not have antibodies to resist infection.

Considering these factors, econometric analysis should seek to identify the impact of international tourist arrivals on two recent significant crises in Asia, namely SARS and Avian Flu. Moreover, the effects of SARS and human deaths arising from Avian Flu are directly comparable because both refer to human deaths, although this does not seem to have been examined rigorously from the perspective of international tourism demand.

The remainder of the paper is organized as follows. Section 2 presents the research objectives. Section 3 describes the data set and selection of country sample. Section 4 is concerned with econometric modelling. The empirical results are presented in Section 5, and some concluding remarks are given in Section 6.

2. Objectives

There has been little attention paid in the economic literature to the effect on international tourist arrivals of the SARS crisis. Much of the literature has relied on a description of the severe impact of SARS on international tourist arrivals (see, for example, Chien and Law (2003), Mckercher and Chou (2004), and Wilder-Smith (2006)), and few papers have focused on a particular Asian country, such as Hong Kong or Taiwan (see, for example, Min (2005) and Chen et. al. (2007)). Although these studies have all reported a negative effect of SARS on tourism, they have not been based on a clear econometric methodology.

Compared with SARS, much recent discussion has concentrated on the damage caused by Avian Flu, whereby infected countries have suffered significant reductions in international tourist arrivals and in tourism competitiveness. As suggested by Brahmbhatt (2005), the immediate economic impacts of a pandemic disease might arise, not from actual sickness or death, but from the efforts of the public and private sectors to avoid becoming infected rapidly. Consequently, this might lead to a severe demand shock for service sectors, such as tourism, mass transportation, hotels, restaurants, and retail sales (see also Page et al., 2006).

Avian Flu might also damage destination marketing, as emphasized by Buhalis (2000) and Mohsin (2005). International tourism could be seriously affected, or possibly even restricted, to prevent the spread of Avian Flu and pandemic influenza. Page et al. (2006) observed that Avian Flu could have significant shocks on tourism. For instance, Brahmbhatt (2005) estimated that the 2004 Avian Flu outbreak in Vietnam led to a 1.8% decline in GDP, while a 5% decline in international tourist arrivals could lead to a 0.4% decline in GDP. Furthermore, the World Bank

estimated that the global economic influence of an outbreak of Avian Flu could be US$800 billion, or 2% of world economic output (Brahmbhatt, 2005).

Avian Flu could also lead to a high mortality rate among humans while the disease is transmitted from animals to humans, but not by close person-to-person contact. If Avian Flu were ever to be easily transmitted between humans, travel advisories and tourism authorities would almost certainly be more concerned about pandemic Avian Flu. Furthermore, the concern among health professionals is that Avian Flu will create a new flu virus from animal reservoirs, which will then infect humans who will not have antibodies to resist infection. Brahmbhatt (2005) also indicated there are information gaps in understanding the epidemiological, health and economic issues of Avian Flu, which are of interest to all countries.

A recent study has also compared the impacts of SARS infection and Avian Flu infection on international tourism. Using monthly data for SARS infections from January 2001 to December 2004, and for Avian Flu infections from October 2002 to September 2006, Kou et al. (2008) investigated four SARS-infected Asian countries and two Avian Flu-infected countries, to compare the effects of both SARS and Avian Flu. Their results suggested that the numbers of infected cases have a significant impact on SARS-affected countries, but not on Avian Flu-affected countries. However, their sample period was overly long for SARS, and they examined only two Avian Flu-infected countries, whereas our data set is more expansive in terms of infected countries and human deaths.

With a view to improving the present knowledge of Avian Flu, one of the primary purposes of this paper is to extend the country sample in the empirical analysis and to estimate the impact of human deaths arising from SARS and Avian Flu infections on international tourist arrivals. Such an empirical analysis should provide important insights into how such epidemics can affect international tourism, and to determine how it might be modelled, anticipated and managed.

3. Data

As discussed above, the duration of SARS was only for 2003, while Avian flu has had a much longer duration. Figures 1a and 1b show the accumulated number of infections and deaths of SARS and Avian Flu. As shown in the figures, the SARS event has been controlled since the mid-2003, while Avian flu was still being reported until mid-2007. Meanwhile, comparing the numbers of SARS infections and deaths with those arising from Avian Flu, the figures show the accumulated total infections and deaths from SARS is much greater than from Avian Flu.

For purposes of the empirical analysis, we use two different monthly panel data sets to investigate the effects of SARS and Avian Flu on international tourist arrivals. The first data set is related to SARS infections and deaths, so we have selected 9 Asian countries with at least one case of SARS infection, namely China, Hong Kong, Indonesia, Korea, Malaysia, Singapore, Taiwan, Thailand, Vietnam, Indonesia and Korea. As SARS was discovered in 2003, the sample for estimating the SARS effect is only for 2003. The second data set is related to Avian Flu deaths and infections, so we have used 6 Asian countries with either human infections or human deaths, for the period January 2004 to July 2007, namely China, Cambodia, Indonesia, Thailand, Turkey and Vietnam.

Table 3 gives a breakdown of the data by country. As shown in the column for SARS, Indonesia and Korea have not had any human deaths. Moreover, as shown in the last four rows at the bottom of Table 3, the 9 countries in our sample had a total of 7,748 (727) infections (deaths), which accounts for 99.55% (93.92%) of the infections (deaths) in Asia and 95.70% (94.18%) of the infections (deaths) worldwide. Similarly, the samples include 262 Avian Flu infections in humans, which accounts for 94% (83%) of the infections in Asia (worldwide).

In the empirical section, we use the number of international tourist arrivals as a proxy to estimate the impacts of SARS and Avian Flu on international tourism demand. This proxy has also been suggested by, for example, Garín-Muñoz and Pérez-Amaral (2000) and Garín-Muñoz (2004). Although other proxies have been suggested in the literature, such as the number of foreign visitors, volume of earnings

generated by foreign visitors, and the number of nights spent by visitors from abroad, in this paper the monthly panel data for international tourist arrivals are collected from statistical data sets for each country.

The numbers of SARS infections and deaths are obtained from the World Health Organization (WHO, 2007), and the numbers of Avian Flu (subtype H5N1) for infections and deaths are obtained from the Office International des Epizooties (OIE, 2007) (in May 2003, the Office became the World Organization for Animal Health, but retained its historical acronym OIE).

Finally, time series observed at monthly frequencies often exhibit seasonality. Lim and McAleer (2001) highlighted seasonality as common in tourism time series data. In order to extract the underlying trend component of the time series, the multiplicative moving average method technique was used (see, for example, Lim and McAleer (2001)) to remove seasonal movements in the international tourist arrivals data.

4. Model Specifications

4.1 Linear Static Fixed Effect Model

To estimate the impact of having infections and/ or deaths from SARS (Avian Flu) on international tourist arrivals, we will use two empirical panel data models: (i) a linear static model; and (ii) a linear dynamic model. We start with the fixed effects, which are given in equations (1) and (2):

(1) $$Tourist_{it} = \alpha_i + \beta_1 SARSI_{it} + \varepsilon_{it}$$

We can rewrite equation (1) in the usual regression framework by including a dummy variable for each infected country, i , as follows:

(2) $$Tourist_{it} = \sum_{j=1}^{N} \alpha_j d_{ij} + \beta_1 SARSI_{it} + \varepsilon_{it}$$

where $d_{ij} = 1$ if *i*=*j* and 0 elsewhere. $Tourist_{it}$ refers to tourism demand, *i* refers to SARS infected countries, and $t = 1,...,T$ represents the time period. The parameter β_1 represents the impact of the SARS infection on international tourist arrivals, while $SARSI_{it}$ refers to the number of SARS infections in country *i*; α_i captures unobserved country (region)-specific time-invariant heterogeneity; ε_{it} is the disturbance term, which is assumed to be independent and identically distributed over individuals and time, with mean zero and variance σ_ε^2. We treat α_i as *N* fixed unknown parameters. The model in equations (1) and (2) is referred to as the standard fixed effects models. A negative sign is expected for β_1.

The fixed effects approach is conditional on the values for α_i. However, the degrees of freedom correction involves *N* additional unknown parameters corresponding to the individual intercept terms. Thus, the model is estimated by OLS, with *N* individual dummy variables.

In this paper, we also examine the impact of deaths from SARS and the ratio of SARS deaths to infections. We replace $SARSI_{it}$ by $SARSD_{it}$, where $SARSD_{it}$ refers to the number of SARS deaths in country *i* in equation (1), and replace $SARSI_{it}$ by $SARSR_{it}$, which refers to the death ratio in country *i* in equation (1).

In order to capture the effects of Avian Flu on international tourist arrivals, we rewrite equation (1) for each human infection of Avian Flu in country *i* as:

(3) $Tourist_{it} = \alpha_i + \beta_2 AFI_{it} + \varepsilon_{it}$

As in the SARS model described above, we also examine the impact of the number of human deaths from Avian Flu and the death ratio of Avian Flu. Again, we replace AFI_{it} by AFD_{it} in equation (3), which refers to country *i* for human deaths from Avian Flu, and replace AFI_{it} by AFR_{it} in equation (3) for the ratio of deaths to infections arising from Avian Flu.

4.2 Linear Dynamic Model

We also estimate a dynamic panel data model, specifically a linear dynamic model with exogenous variables and a lagged dependent variable, namely:

(4) $Tourist_{it} = \gamma Tourist_{it-1} + \beta_3 SARSI_{it} + \alpha_i + \varepsilon_{it}$

where $Tourist_{it}$ refers to international tourism demand, *i* refers to SARS infected countries, and $t = 1,...,T$ represents the time period. As described in the static fixed effect model, α_i captures unobserved country (region)-specific time invariant heterogeneity, and ε_{it} is the disturbance term which is assumed to be independently and identically distributed over individuals and time, with mean zero and variance σ_ε^2.

In a dynamic model, a lagged dependent variable, $Tourist_{it-1}$, is included as regressors, but the fixed effect estimator for γ is biased and inconsistent for $N \to \infty$ and fixed *T* (Verbeek, 2008). Moreover, heterogeneity among individuals can also increase the problem of efficiency in estimation (Baltagi, 2001). Garín-Muñoz (2006) noted that, when lagged dependent variables are included as regressors, not only is the OLS estimator biased and inconsistent, but the within groups (WG) and random effects estimators are also biased and inconsistent.

In order to solve the inconsistency problem, we use the first difference transformation to eliminate the individual effect, α_i:

(5) $\Delta Tourist_{it} = \gamma \Delta Tourist_{it-1} + \beta_3 \Delta SARSI_{it} + \Delta\varepsilon_{it}$

where $\Delta Tourist_{it} = Tourist_{it} - Tourist_{it-1}$, an analogous transformation holds for the remaining exogenous variables, and $t = 2,\ldots,T$.

Estimating equation (5) by OLS does not lead to a consistent estimator for γ because $Tourist_{it-1}$ and ε_{it-1} are correlated, even as $T \to \infty$. However, an

instrumental variable approach, whereby $Tourist_{i,t-2}$ or $Toursit_{i,t-2} - Tourist_{i,t-3}$ can be used as instruments, leads to consistency as ε_{it} is not autocorrelated (Anderson and Hsiao, 1981). However, a second instrumental variables estimator requires an additional lag to construct the instrument, such that the effective number of observations used in estimation is reduced.

A generalized method of moments (GMM) approach can be used to unify the estimator and eliminate the disadvantages of reduced sample sizes. As suggested by Arellano and Bond (1991), the list of instruments can be exploited by additional moment conditions and allowing the number to vary with *t*, so that all moment conditions can be estimated by GMM. However, the GMM estimator for γ is asymptotically normal, based on the assumptions of homoskedastic and uncorrelated errors term ε_{it}, namely $E[\Delta\varepsilon_{it}\Delta\varepsilon_{it-2}] = 0$.

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In this paper, the GMM approach is used to compute the GMM-DIFF estimator, where four lags are used as instrumental variables.

In addition to using SARS infections as the exogenous variable, we also examine the impact of deaths from SARS and the ratio of SARS deaths to SARS infections, by replacing $SARSI_{it}$ by $SARSD_{it}$ in equation (5), and i refers to countries which have reported any deaths to the WHO, and by replacing $SARSI_{it}$ by $SARSR_{it}$ in equation (1) for the ratio of SARS deaths to SARS infections.

Similarly, in order to represent the effect of Avian Flu on international tourist arrivals, we rewrite equation (5) for Avian Flu human infections in country i :

(6) $\Delta Tourist_{it} = \gamma\Delta Tourist_{it-1} + \beta_3\Delta AFI_{it} + \Delta\varepsilon_{it}$

Again, we replace AFI_{it} by AFD_{it} in equation (6), and replace AFI_{it} by AFR_{it} in equation (6) for estimating the impact of human deaths from Avian Flu and the ratio of Avian Flu deaths to infections, respectively.

It is worth mentioning that using a dynamic panel model will generate more precise estimates by differencing the data and by removing the problem of non-stationarity (see, for example, Garín-Muñoz, 2006). On the other hand, Song and Witt (2000) noted that the fixed effects model includes dummy variables for purposes of OLS estimation to capture the differences between countries.

In order to support the use of the difference transformation in the dynamic model (equations (5) and (6)), we implement panel unit root tests using the Levin, Lin and Chu. (2002) (LLC) test and the Im, Pesaran and Shin (2003) (IPS) test. The former test assumes a common unit root process, while the latter test assumes separate unit root processes.

The LLC test assumes that each individual unit in the panel shares the same AR(1) coefficient, but allows for individual effects, time effects and possibly a time trend. It may be viewed as a pooled Dickey-Fuller or an Augmented Dickey-Fuller (ADF) test, with the null hypothesis that of nonstationarity, or I(1). After transformation, the t-star test statistic is asymptotically distributed as a standard normal under the null hypothesis of nonstationarity.

The IPS test assumes that all series are non-stationary under the null hypothesis and allows for individual effects, time trends, and common time effects. As for the LLC test, the IPS test is based on the mean of the individual Dickey-Fuller t-statistics of each unit in the panel, and lagged dependent variables may be used to accommodate serial correlation in the errors. After transformation, the Psi[t-bar] statistic is asymptotically distributed as standard normal under the null hypothesis of nonstationarity.

In this paper, these tests use the modified Akaike Information Criterion (MAIC) to select the lag length, and the probabilities for the Fisher tests are computed using an asymptotic chi-square distribution.

The results of the panel unit root tests are obtained using the econometric software package EViews 5.0, and are reported in Table 4. The table shows the results

of the LLC and IPS panel unit root tests. The null hypothesis of a unit root is not rejected for the levels of monthly international tourist arrivals in the models with a constant and with a constant and trend (except for the IPS test with a constant and trend). However, for the series in first differences, the null hypothesis of a unit root is rejected for both specifications using the LLC and IPS tests.

Overall, the null hypothesis of a unit root is not rejected for the levels of monthly international tourist arrivals, but is rejected for the first difference in monthly international tourist arrivals.

As shown in the panel unit root tests, the empirical results strongly support the first difference transformation for investigating the impact of Avian Flu infections, deaths and the death ratio on international tourist arrivals. However, as the sample period is relatively short at only 12 months, we do not implement the panel unit root test for the SARS sample. Table 5 gives the summary statistics for the explanatory variables.

5. Empirical Results

As described in Section 3, SARS and Avian Flu are independent events as the effects of the former had actually ended before the latter had even started. In order to reflect this fact appropriately, we will estimate the SARS model for the period January 2003 to December 2003, and estimate the Avian Flu model for the period January 2004 to July 2007. We have also estimated the SARS and Avian Flu static linear fixed effect and difference transformed dynamic models using the whole sample period from January 2003 - July 2007. However, as SARS had ended by the end of December 2003 and Avian Flu was not discovered until January 2004, it makes little sense to combine the sample from January 2003 to July 2007.

The static linear fixed effects model and difference transformation dynamic model described in Section 4 were estimated for SARS infections, SARS deaths and the death ratio for SARS, as well as for human infections, human deaths and the death ratio of Avian Flu.

We first present the estimates of the static linear fixed effects model discussed in sub-section 4.1, and then present the estimates of the difference transformation dynamic model discussed in sub-section 4.2. The results of the static fixed effect model are presented in Tables 6a to 6c. Table 6a gives the results of SARS and Avian Flu for human infections, Table 6b gives the results for human deaths, and Table 6c gives the results of the death ratio. The results of the dynamic difference model are presented in Tables 7a to 7c. As for the static model, Tables 7a-7c give the results of SARS and Avian Flu for infections, human deaths and the death ratio, respectively.

5.1 Static Linear Fixed Effect Model

As explained in Section 4, we report the estimates of the static linear fixed effects model. Table 6a shows the results of a static (long run) impact of SARS and Avian Flu on international tourist arrivals. All the static models include a set of country dummy variables, which are not reported in the tables for reasons of space (the detailed results are available from the authors on request).

Overall, the estimates show that international tourist arrivals are negatively affected by SARS and Avian Flu. Table 6a shows that, for infections, international tourist arrivals are significantly reduced by about 723 arrivals for an outbreak of SARS , while international tourist arrivals are reduced by about 295 arrivals (although not significantly so) for an outbreak in humans of Avian Flu.

Table 6b gives the results for the number of deaths. Table 6b shows that international tourist arrivals are significantly reduced by about 9,382 arrivals for each death caused by SARS, while international tourist arrivals are significantly reduced by about 1,530 arrivals for each human death from Avian Flu. It is revealing that SARS infections or deaths have a far greater effect on international tourism than do infections or human deaths from Avian Flu.

Table 6c presents the results of the deaths to infections ratio model. The empirical results suggest that international tourist arrivals are significantly reduced by about 107,682 arrivals for each 1% increase in the ratio for SARS, while international tourist arrivals are not significantly reduced by increasing the human deaths to infection ratio for Avian Flu.

In comparing the estimates for SARS and Avian Flu, it may be concluded that SARS has a greater impact on international tourist arrivals than does Avian Flu. In addition, deaths arising from both SARS and Avian Flu suggest a much stronger impact on international tourist arrivals as compared with infections.

5.2 Difference Transformation Dynamic Model

As described in Section 4, the consistency of the GMM estimator hinges heavily upon the assumption $E[\Delta\varepsilon_{it}\Delta\varepsilon_{it-2}]=0$. In order to guarantee an estimator to be consistent, Arellano and Bond (1991) propose the "m_2" test statistic under the null hypothesis that there is no second-order serial correlation, or follows a random walk for the disturbances of the first difference equation (see Arellano and Bond, 1991, p. 282). However, as the "m_2" statistic tests for a lack of second-order serial correlation in the first difference residuals, the test will not reject the null hypothesis if the errors in the levels version of the model are not serially correlated, or if the errors in levels follow a random walk process.

Additionally, Arellano and Bond (1991) also suggest Sargan's (1958) test of the validity of instrumental variables, which is a test of overidentifying restrictions. The underling null hypothesis of the Sargan test is that the instrumental variables are uncorrelated with a set of residuals, and hence are acceptable instruments. In other words, if the null hypothesis is not rejected, the instruments are valid. Sargan's test of overidentifying restrictions is described in detail in Arellano and Bond (1991, p. 283).

The m2 test statistics generally do not reject the null hypothesis in most cases, which indicates consistent GMM estimators are obtained (in only one case does m2 reject the null). Sargan's test overall does not reject the null

hypothesis for SARS and Avian Flu. These results suggest that the instrumental variables are uncorrelated with the residuals, so that the instrumental variables are valid.

Tables 7a to 7c gives the estimates for the dynamic (short run) impacts of SARS and Avian Flu on international tourist arrivals for infections, human deaths and death ratios, respectively. The estimates show a negative effect of SARS and Avian Flu on international tourist arrivals. Table 7a indicates that international tourist arrivals are significantly reduced by about 580 arrivals for an additional outbreak of SARS infection, while Table 7b shows that international tourist arrivals are significantly reduced by about 8,942 arrivals for an additional case of a death from SARS. Table 7c shows that international tourist arrivals are significantly reduced by about 106 arrivals for an increase in the ratio of deaths to infections for SARS.

However, the estimates of Avian Flu overall are insignificant in the dynamic (short run) model on international tourist arrivals for each of infections, deaths and the death ratios.

In comparison with the static (long run) fixed effects model, the results suggest that SARS has a significant negative impact on short run international tourist arrivals. Overall, the empirical estimates suggest that human deaths arising from SARS greatly reduces international tourist arrivals, and the impact is much more serious than for Avian Flu.

6. Conclusion

The primary purpose of the paper was to compare the effects of SARS and human deaths arising from Avian Flu on international tourist arrivals in Asia. The effects of SARS and human deaths from Avian Flu are directly comparable because both refer to human deaths. In order to reflect appropriately the impacts of the two independent events, we estimated the SARS model for the period January 2003 to December 2003, and the Avian Flu model for the period January 2004 to July 2007.

The nature of the short run and long run relationships was examined empirically by estimating a static linear fixed effect model and difference transformation dynamic model, respectively. The data set for SARS was a panel of 9 SARS infected countries and 7 SARS countries with deaths over the period January 2003 to December 2003, while the data set for Avian Flu was a panel of 6 Avian Flu countries with human deaths and infections over the period January 2004 to July 2007.

A very important finding was that, in both the short run and long run, SARS had a more significant impact on international tourist arrivals than Avian Flu. In addition, the cases of deaths for both SARS and Avian Flu suggested that SARS is more important to international tourist arrivals than is Avian Flu. Thus, while SARS seems to have been eradicated whereas Avian Flu is almost certainly permanent, the effect of Avian Flu is not as significant empirically as that of SARS.

It is worth noting that a biased estimate of Avian Flu could possibly arise from mismeasured data (or errors in measurement), and hence lead to biased inferences. However, some infected countries may not report truthfully the precise number of outbreaks of Avian Flu in humans to the WHO (either through delays in reporting, or simply with holding the correct figures) because of the likely adverse effects of such reporting on the image of a safe tourist destination. On the other hand, most SARS infected countries should be monitored more carefully by the WHO, as the transmission routes through direct person-to-person contact is of serious concern.

Based on the empirical results presented in the paper, the destructive effects of SARS and Avian Flu on international tourist arrivals are absolutely clear. In short, SARS had a significant negative effect, so it had to be controlled immediately. However, as the potential risks and damage arising from Avian Flu, and the subsequent pandemic influenza, is possibly much greater than for any previous diseases, the need for precautions in the event of an outbreak of Avian Flu and pandemic influenza warrants further attention and action in modelling and managing tourism demand and risk.

Figure 1a. Accumulated Human Cases of SARS and Avian Flu Infections

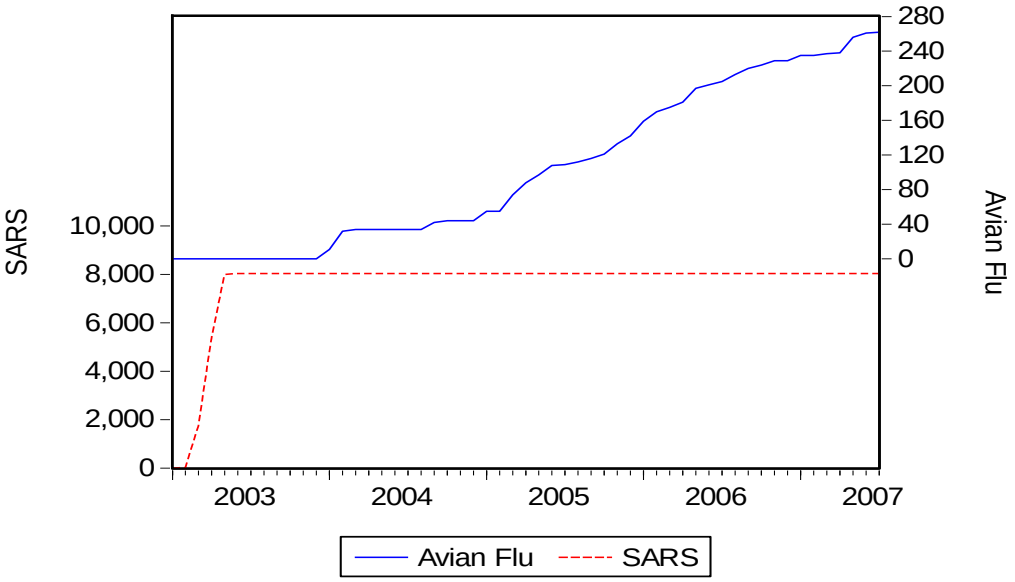

Figure 1b. Accumulated Human Cases of SARS and Avian Flu Deaths

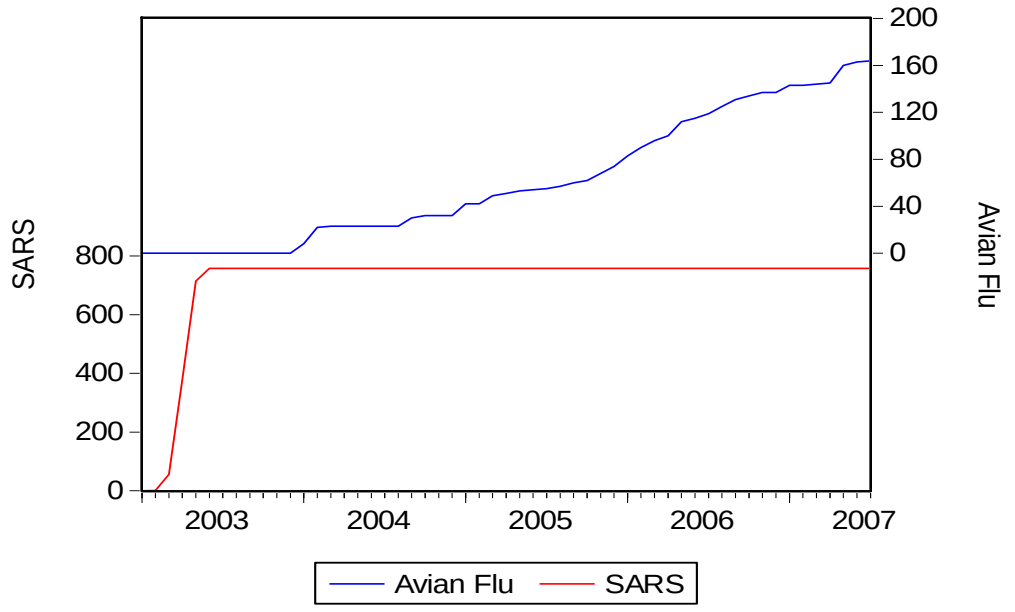

Table 1. SARS Spread and Infections Worldwide in 2003

Continent	Country	Confirmed human cases		
		cases	deaths	death rate (%)
Asia	China	5327	349	6.55
	Hong Kong	1755	299	17.04
	Taiwan	346	37	10.69
	Singapore	238	33	13.87
	Vietnam	63	5	7.94
	Philippines	14	2	14.29
	Thailand	9	2	22.22
	Mongolia	9	0	0.00
	Australia	6	0	0.00
	Malaysia	5	2	40.00
	Korea	3	0	0.00
	India	3	0	0.00
	Indonesia	2	0	0.00
	Macao	1	0	0.00
	New Zealand	1	0	0.00
	Kuwait	1	0	0.00
North America	Canada	251	43	17.13
	USA	27	0	0.00
Europe	Germany	9	0	0.00
	France	7	1	14.29
	Sweden	5	0	0.00
	United Kingdom	4	0	0.00
	Italy	4	0	0.00
	Republic of Ireland	1	0	0.00
	Romania	1	0	0.00
	Russian Federation	1	0	0.00
	Spain	1	0	0.00
	Switzerland	1	0	0.00
Africa	South Africa	1	1	100.00
Asia		7783	729	9.37
North America		278	43	15.47
Europe		34	1	2.94
Africa		1	1	100.00
World		8096	774	9.56

Source: World Health Organization (2006)

Table 2. Humans Cases of Avian Flu Worldwide, December 2003 - July 2007

Continent	Country	First report in poultry	Outbreaks of poultry	Confirmed human cases		
				infections	deaths	death rate (%)
Asia	Vietnam	Jan. 8, 2004	2402	95	42	44.21
	Thailand	Jan. 23, 2004	1137	25	17	68.00
	Indonesia	Feb. 2, 2004	261	102	81	79.41
	Turkey	Oct. 10, 2005	212	12	4	33.33
	China	Jan. 37, 2004	88	25	16	64.00
	Myanmar	Mar. 12, 2006	90	0	0	0.00
	Pakistan	Mar. 2, 2006	40	0	0	0.00
	Korea	Dec. 12, 2003	26	0	0	0.00
	Bangladesh	Mar. 30, 2007	23	0	0	0.00
	Afghanistan	Mar. 20, 2006	22	0	0	0.00
	Cambodia	Jan. 24, 2004	20	7	7	100.00
	Kuwait	Feb. 26, 2007	20	0	0	0.00
	Malaysia	Aug. 19, 2004	16	0	0	0.00
	Laos	Jan. 27, 2004	9	2	2	100.00
	Japan	Jan. 13, 2004	9	0	0	0.00
	Israel	Mar. 17, 2006	9	0	0	0.00
	Occupied Palestinian Territory	Apr. 5, 2006	8	0	0	0.00
	India	Feb. 18, 2006	8	0	0	0.00
	Iraq	Feb. 2, 2006	3	3	2	66.67
	Azerbaijan	Feb. 24, 2006	2	8	5	62.50
	Kazakhstan	Aug. 2, 2005	1	0	0	0.00
	Jordan	Mar. 24, 2006	1	0	0	0.00
Europe	Romania	Oct. 7, 2005	162	0	0	0.00
	Russia	Jul. 23, 2005	140	0	0	0.00
	Ukraine	Dec. 5, 2005	40	0	0	0.00
	Hungary	Feb. 28, 2006	9	0	0	0.00
	Sweden	Mar. 16, 2006	5	0	0	0.00
	Albania	Mar. 7, 2006	3	0	0	0.00
	France	Feb. 25, 2006	1	0	0	0.00
	Germany	Apr. 6, 2006	2	0	0	0.00
	Serbia & Montenegro	Mar. 2, 2006	1	0	0	0.00
	United Kingdom	Apr. 6, 2006	1	0	0	0.00
	Denmark	Mar. 15, 2006	1	0	0	0.00
Africa	Egypt	Feb. 19, 2006	346	38	15	39.47
	Nigeria	Feb. 8, 2006	60	1	1	100.00
	Sudan	Apr. 18, 2006	18	0	0	0.00
	Burkina Faso	Mar. 3, 2006	4	0	0	0.00
	Côte d'Ivoire	Apr. 25, 2006	4	0	0	0.00
	Ghana	May 3, 2007	6	0	0	0.00
	Niger	Feb. 28, 2006	2	0	0	0.00
	Cameroon	Mar. 12, 2006	1	0	0	0.00
	Djibouti	May 27, 2006	1	0	0	0.00
	Togo	Jun. 22, 2006	3	1	0	0.00
Asia			4407	279	176	63.08
Europe			365	0	0	0.00
Africa			445	40	16	40.00
World			5217	319	192	60.19

Source:

1. World Health Organization (2007).
2. Office International des Epizooties, now the World Organization for Animal Health (2007).
3. The rowshighlighted in grey denotecountries that have confirmedhuman cases.

Table 3. Human Cases of SARS and Avian Flu by Country

	SARS			**Avian Flu**		
Country	Infection	Deaths	Death rate (%)	Infection	Deaths	Death rate (%)
Cambodia	-	-	-	7	7	100.00
China	5327	349	6.55	22	13	59.09
Hong Kong	1755	299	17.04	-	-	-
Indonesia	2	0	0	101	81	80.20
Korea	3	0	0	-	-	-
Malaysia	5	2	40.00	-	-	-
Singapore	238	33	13.87	-	-	-
Taiwan	346	37	10.69	-	-	-
Thailand	9	2	22.22	25	17	68.00
Turkey	-	-	-	12	4	33.33
Vietnam	63	5	7.94	95	42	44.21
Our Sample	7748	727	-	262	164	-
Asia	7783	729	-	279	176	-
World	8096	774	-	319	192	-
Time Period	Jan. 2003-Dec.2003			Jan. 2004-July 2007		

Table 4 Panel Unit Root Tests

Variables	**LLC Test**		**IPS Test**	
	No time effects	Time fixed effects	No time effects	Time fixed effects
Tourist	-0.709	-1.117	0.063	-1.688**
Δ*Tourist*	-16.703***	-15.297***	-16.730***	-15.982***

Note: ** and *** denote significance at the 5% and 1% levels, respectively.

Table 5 Summary Statistics

Infection	Variable	Mean	Std. Dev.	Min	Max
SARS	*SARSI* (Infections)	74.39	346.24	0	2654
	SARSD (Deaths)	7.02	27.32	0	173
	SARSR (Ratio)	0.14	0.73	0	7
	Tourist	1,356,298	2,269,647	47,596	8,602,658
Avian Flu	*AFI* (Infection)	1.02	2.77	0	18
	AFD (Deaths)	0.64	1.79	0	15
	AFR (Ratio)	0.17	0.35	0	1.5
	Tourist	2,215,942	3,539,899	65,109	11,543,112

Note: For the sample period and number of countries in the sample, see Table 3 above.

Table 6a. Static Fixed Effect Estimates - Infections

Variables	SARS	Avian Flu
Constant	1410093.11*** (2521.45)	2216241.44*** (1398.63)
$SARI_{it}$	-723.16*** (12.57)	-
AFI_{it}	-	-294.91 (549.87)
Adjusted R^2	0.998	0.993
No. observations	108	258

Standard errors are in parentheses; *** denotes significance at the 1% level. All models include a set of country fixed effects.
The sample period for SARS is Jan. 2003 to Dec. 2003, and for Avian Flu it is Jan. 2004 to July 2007.

Table 6b. Static Fixed Effect Estimates - Deaths

Variables	SARS	Avian Flu
Constant	1718282.31*** (7631.12)	2216914.34*** (1430.29)
$SARSD_{it}$	-9382.045*** (606.01.)	-
AFD_{it}	-	-1529.719* (913.12)
Adjusted R^2	0.995	0.993
No. observations	84	258

Standard errors are in parentheses; * and *** denote significance at the 10% and 1% levels, respectively.
All models include a set of country fixed effects.
The sample period for SARS is Jan. 2003 to Dec. 2003, and for Avian Flu it is Jan. 2004 to July 2007.

Table 6c. Static Fixed Effect Estimates- Ratio

Variables	SARS	Avian Flu
Constant	1371375.175*** (32719.11)	2213211.307*** (22971.62)
$SARSR_{it}$	-107681.664** (45347.17)	-
AFR_{it}	-	16230.63 (62565.35)
Adjusted R^2	0.978	0.991
No. observations	108	258

Standard errors are in parentheses; ** and *** denote significance at the 5% and 1% levels, respectively.
All models include a set of country fixed effects.
The sample period for SARS is Jan. 2003 to Dec. 2003, and for Avian Flu it is Jan. 2004 to July 2007.

Table 7a. First Difference Dynamic Estimates - Infections

Variables	**SARS**	**Avian Flu**
$\Delta Tourist_{it-1}$	0.544*** (290.15)	0.855*** (0.0003)
$\Delta SARSI_{it}$	-580.164*** (-965.31)	-
ΔAFI_{it}	-	-2573.873 (2124.30)
m_2	-0.041	0.057
Sargan test (d.f.)	5.9049(7) P-value=0.551	4.379(4) P-value=0.357
No. observations	90	246

Standard errors are in parentheses; *** denotes significance at the 1% level.
Method of estimation: GMM-DIFF by Arellano and Bond (1991) 2-step estimation.
Estimates are obtained using instruments to $Tourist_{it-2}$ to $Tourist_{it-4}$

Table 7b First Difference Dynamic Estimates - Deaths

Variables	**SARS**	**Avian Flu**
$\Delta Tourist_{it-1}$	0.426*** (0.0039)	0.854*** (0.0003)
$\Delta SARSD_{it}$	-8941.77*** (29.15)	-
ΔAFD_{it}	-	-1202.137 (3354.29)
m_2	-0.341***	0.055
Sargan test (d.f.)	3.907(5) P-value=0.563	4.750(4) P-value=0.314
No. observations	70	246

Standard errors are in parentheses; *** denotes significance at the 1% level.
Method of estimation: GMM-DIFF by Arellano and Bond (1991) 2-step estimation.
Estimates are obtained using instruments to $Tourist_{it-2}$ to $Tourist_{it-4}$

Table 7c First Difference Dynamic Estimates - Ratio

Variables	**SARS**	**Avian Flu**
$\Delta Tourist_{it-1}$	0.717*** (0.0014)	0.864*** (0.0005)
$\Delta SARSR_{it}$	-106.25*** (11.09)	-
ΔAFR_{it}	-	1055.471 (876.93)
m_2	-0.678	0.044
Sargan test (d.f.)	8.100(7) P-value=0.324	3.300(4) P-value=0.509
No. observations	90	246

Standard errors are in parentheses; *** denotes significance at the 1% level.
Method of estimation: GMM-DIFF by Arellano and Bond (1991) 2-step estimation.
Estimates are obtained using instruments to $Tourist_{it-2}$ to $Tourist_{it-4}$

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