Smoke or Substance? The Economic Cost of Infectious Disease

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Abstract

Aims

Media reports and some economic models have suggested that the economic repercussions of a worldwide infectious disease outbreak, such as pandemic influenza, would be large scale, long term and catastrophic. To evaluate the accuracy of these suggestions concerning the impact of a future outbreak, an historical analysis of the global macro-economic cost of the 20th Century influenza pandemics and SARS outbreak is undertaken.

Methods

Data were taken from the US National Bureau of Economic Research Macro History Database and from a variety of national statistics databases. These data were then used to estimate the macro-economic consequences of the morbidity and mortality associated with three influenza pandemics and the SARS outbreak.

Results

The main effects of the influenza pandemics were on broad macro-economic indicators concerning GDP and production, whilst the effect of SARS was more sectoral, with losses concentrated on tourism and transport. In all cases impacts occurred at the time of the outbreak but tended to be short lived. In most cases the economy rapidly bounced back to pre-pandemic levels to the extent that the monthly/quarterly impacts are indiscernible at annual levels, and even sometimes occur in a period of annual growth.

Conclusions

Based on this historical analysis, the economic impact of a pandemic is unlikely to realise some of the model estimates and media hype. The contained, short-term, impact of pandemic flu may be associated with the seasonality of the disease. The relatively mild impact of SARS may be attributable to the extensive efforts to contain and control it at the time of the outbreak. Both cases support the view that future assessments of the levels of preparedness for infectious disease control need to consider the counter-factual to the evidence presented here. These results suggest that a global macro-economic and epidemiological model is needed that is focussed

on the area of global infectious disease outbreak and is able to take account of the factors presented.

Introduction

There seems to be growing acceptance that at some point in the near future there will be an outbreak of an infectious disease that will be of global concern (Barclay Wendy S and Zambon M 2004). The concern is not only limited to the health impact that this would have – the possibility of widespread mortality and morbidity – but also the economic impact. That any sort of pandemic would have some economic effect is not disputed, but the size of the economic impact has been the subject of some debate (Fan 2003; Knapp, Rossi et al. 2004; Lee and McKibben 2004). Much of this has been conjecture, and some has been based on modelling or an appeal to the size of the outbreaks in years past scaled up to account for the increase in travel and trade in recent years.

However, there has been little work on assessing the actual impact of previous pandemics on national economies. Such information is required not only to validate models against, but also to determine the level of actual impact that may be expected, to provide information on the distribution of this burden (by economic sector and/or country) and to provide baseline information to weigh counter-factual states of the world against – to evaluate the possible impact of control and containment measures. Outbreaks of particular relevance here include influenza and Severe Acute Respiratory Syndrome (SARS). The former because these are often the cases pointed to in support of the 'doomsday' perspective on global infectious disease outbreaks, and the latter because it is the most recent global infectious disease outbreak, as well as one illustrating the possible danger from previously unrecognised and unknown disease (contrasting with flu which has well known characteristics of spread, pathology etc) (Wenzel, Bearman et al. 2005).

There have been three influenza pandemics during the past 100 years – in 1918, 1957 and 1968. Morbidity rates (the proportion of the population experiencing symptoms) ranged between 20 and 35 per cent, and many more were likely to have been infected but remain asymptomatic. While high infection rates were common to these three pandemics, resulting mortality differed greatly. The 1918 pandemic featured much higher mortality than the 1957 and 1968 pandemics, which had very similar disease properties to each other and are therefore considered together in our analysis.

Although the first cases of the 1957 pandemic were recorded in June, the main pandemic wave began at the beginning of September and morbidity was heaviest in October (Potter 2001). There was a second wave which began in December before the first wave had dissipated, but this second wave exhibited much lower morbidity and dissipated in February 1958. The main impact was in a single wave and the main impact of that wave occurred in a single month, similar to the 1918 pandemic.

The main pandemic wave of the 1968 pandemic occurred in December, but this pandemic was less severe than in 1957.

SARS emerged in late 2002. Having started in the Guandong province of China, the disease was transmitted with great rapidity to Australia, Brazil, Canada, China, Hong

Kong, South Africa, Spain and the USA. This lead to serious public health concerns. The SARS outbreak peaked during the second quarter of 2003 and was declared over by July 2003. Although approximately 10,000 individuals were infected, of which 10% died, the overall impact on health was not as devastating as some had feared.

Clearly there is a direct economic cost involved when a large proportion of the working population infected with influenza or SARS seek medical attention, require hospitalisation and are unable to work. However, these direct costs are not necessarily large (Smith, Drager et al. 2006). However, there is also the likelihood of wider, more indirect, economic impacts that are not directly related to the disease itself, but to changes in peoples' behaviour in response to the disease. Thus, for example, there may be reduced consumer spending, fewer hours worked, or removal of children from education which occur to those who are not actually infected with the disease. It is these indirect costs that have been the subject of recent conjecture (Fan 2003; Knapp, Rossi et al. 2004; Lee and McKibben 2004; James S and Sargent T 2006; Keogh-Brown M R and Smith 2006; Keogh-Brown M R, Wren-Lewis S et al. 2006). Often it is the assumptions made about these indirect costs that drive the results of economic models used to predict the impact of global outbreaks. However, it is not clear whether these assumptions, and the consequent model results, are providing smoke or substance when it comes to assessing the economic cost of infectious disease.

This paper attempts to shed light on this issue through evaluating actual economic data rather than through economic models. Rather than adding another model estimate to the existing pool we examine the relatively sparse data from recent outbreaks and attempt to estimate the economic effects. Therefore, rather than using epidemiological parameters as inputs to an economic model, we go straight to the economic parameters and attempt to piece together a picture from economic effect data rather than epidemiological cause data. In the next section we describe the properties of the disease outbreaks, the countries, indicators and sectors studied and the estimation methods used to assess the economic impact. In the results section we provide an overview of the main economic effects (or absence thereof) of the flu pandemics and SARS outbreaks. We then draw conclusions and discuss the findings, their implications and the needs that they highlight.

Methods

In order to keep this presentation of our data to a manageable size it is not possible to present detailed results of all of the findings of our analysis. More details of the analyses presented here are provided in (James S and Sargent T 2006; Keogh-Brown M R and Smith 2006) but in this paper we present the edited highlights of this research in order to provide an overview of the key messages from the results.

Our analysis takes two main approaches. First, estimates of the economic impact of past influenza pandemics focuses specifically on Canada and the USA as national case-studies. The second approach concerns the SARS outbreak of 2003. This is a broader analysis of countries which experienced cases of SARS. In both cases national statistics databases are used that are freely available. In this section the specific data used for the analysis of both these approaches is outlined in turn.

Firstly the epidemiological aspects of the influenza pandemics and SARS outbreak are compared. Table 1 below illustrates the comparatively low attack rate and much lower population mortality rate of SARS compared with the influenza pandemic. However, the case fatality ratio of SARS was ten times that of influenza, which illustrates how serious the SARS outbreak would have been if the clinical attack rate had been higher. The table also shows the case fatality rates for each outbreak by age. This data shows that SARS exhibited higher case fatality rates for all except the youngest victims and was particularly fatal to those over the age of 65.

Table 1: Flu/ SARS outbreak epidemiology

	1918 Flu	**1957/69 Flu**	**SARS**
Clinical attack rate	35%	35%	Approx 0.014%[1]
Population mortality rate	0.58%	0.08%	0.00012%
Case Fatality Rate	1.6%		Approx 15%[2]
Case Fatality Rate by Age			
Age	**1918 Flu CFR**	**1957/69 Flu CFR**	**SARS CFR[3]**
0-24	1.78	2.17	0%
25-44	2.86	4.2	6%
45-64	1.80	1.9	15%
65+	4.55	3.1	52%

For more information on the diseases see (James S and Sargent T 2006; Keogh-Brown M R and Smith 2006).

Data

We now outline our methods of data collection and analysis.

Countries

Influenza

For influenza analysis, Canada and USA are the countries chosen for our analysis. The main reason for this choice being the availability of data from these countries at the time of the flu pandemic. Data from the time of the 1918 pandemic is particularly scarce, so it is not possible to be selective with regard to the countries analysed. However, since the US was the most industrially and technologically advanced country at the time of the pandemic, it is US data that will be most applicable when drawing conclusions with regard to the anticipated effects in our current modern society.

SARS

[1] 0.051% Canada (Toronto), 0.0191% China (Beijing), 0.022% China (Guandong), 0.025% China (Hong Kong), 0.023.% China (Taiwan), 0.059% Singapore

[2] 16.7% of probable cases in Canada, 1.4% in Beijing, 15% in Hong Kong, 13% in Taiwan, 14% in Singapore

[3] Hong Kong estimates

Data is more freely available for the period of SARS than for the previous influenza pandemics. In order to obtain this data, national statistics databases for countries reporting at least five cases of SARS were used in order to obtain data on sectors that were deemed most likely to exhibit an economic effect.

Countries for SARS analysis were chosen on the basis of having had some presence of SARS. It is accepted that countries who id not actually have any cases may also have been affected, but the impact would be correspondingly diminished. With the caveat that these countries may also have had some impact attributable to SARS, the analysis reported here is based on countries which had at least five cases of SARS as recorded by the WHO[4]. Thus, the analysis presented here concerns:

- China
- Hong Kong
- Canada
- Singapore
- Malaysia
- Vietnam
- Thailand
- United States
- Taiwan
- Australia
- Germany
- Japan
- Mongolia
- Philippines
- France
- Sweden

Sectors/ Indicators

Influenza

The sectors and indicators studies for the influenza pandemics include

- GDP
- Industrial production
- Public transport
- Travel
- Tourism
- Retail sales
- Exports
- Bank Clearings
- Bankruptcy data

There are some differences between the sectors obtained for influenza and for SARS due to the difference in time between the outbreaks and the resultant change in the type and frequency of data that is recorded.

[4] WHO data up to 31st December 2003 http://www.who.int/csr/sars/country/table2004_04_21/en/index.html

SARS

It is known that during the SARS outbreak, there was a noticeable downturn in travel, and tourism income for many infected countries. It was also anticipated that fear of disease would impact those industries which gather people in public places such as restaurants, cinemas and retail establishments (Smith 2006). Therefore the indicators and sectors that are most likely to be impacted by both the changes in the public's perception of risk toward that country, the impact of infection with SARS and the impact of interventional policies implemented to contain SARS are those considered in this analysis. For instance the avoidance of public places by natives together with the avoidance of a certain country by tourists will mainly impact the retail, tourism and entertainment related sectors. Clearly there are likely to be effects on countries where no case was eventually identified, and on other sectors (e.g. production of face-masks). However, these are likely to be more marginal in nature and even harder to attribute to SARS than other concurrent effects, such as the Iraq conflict of 2003. Further, since observational data are used, it is not possible to divorce the impact of SARS and the impact of policies to contain SARS.

Because of the increased availability of national statistics data in recent years, we were able to obtain much more data on the SARS outbreak than for the earlier influenza pandemics.

The chosen indicators were:

- GDP (the country's Gross Domestic Product)
- Growth (GDP growth from the previous year)
- Exports and Trade (the country's total export revenue or total trade with other countries))
- Budget (government budget, expenditure and revenue)

The chosen sectors were:

- Health (total health expenditure for the country)
- Tourism (total revenue from the tourism sector)
- Hotels (total revenue from hotels and or boarding houses)
- Airlines (total revenue for airline sector)
- Retail (total revenue from retail sales)
- Restaurants (total revenue from food and restaurants)
- Entertainment (total revenue from leisure and entertainment activities)
- IT (total revenue in the computer or information technology sector)

GDP and growth are of obvious importance in capturing the economic impact on a country. However, the papers (Fan 2003; Knapp, Rossi et al. 2004; Lee and McKibben 2004) consider exports, trade and investment as likely to exhibit economic effects. They also consider government budget, health, tourism, retail and restaurants. In addition to considering tourism as a whole, we decided to separate the tourism impact into hotels, airlines, and restaurants as the SARS impact may affect some of these sectors more than others. The entertainment industry was included as it is likely to exhibit an effect if people avoid public places in an attempt to escape SARS and the IT sector was included as it will reflect an increase in the number of people working from home via the internet to avoid exposure to SARS

whilst at work or travelling to work. The health sector was included as it will reflect an increase in medical expenditure due to SARS.

Sources of Information/ Data

Influenza

For 1918 in particular, given the length of history involved, several problems were encountered that required a different approach than the 1957/68 pandemics. The United States Bureau of Economic Analysis (BEA) did not begin publicising GDP for the US prior to 1929, however, the necessary high frequency data from the United States National Bureau of Economic Research (NBER) Macro History Database for US economic data is available, and this was therefore used to analyze the economic impact of the 1918 pandemic.

Data for the production of a wide variety of commodities, goods trade data, data on the consumption of travel services, retail sales, equity prices and currency demand is available on a monthly basis. This is important since the 1918 pandemic was highly concentrated in the single month of October, so analysis of its economic effect requires the use of monthly data. There is also the possibility of rebounds occurring in subsequent months for which monthly data is also required.

In order to estimate the aggregate impact of the pandemic monthly data on industrial production and translate this into GNP impacts annual growth of the Romer real GNP series was regressed on annual growth of the NBER index of industrial production and trade.

1957/68 Pandemics

Although it is not possible to directly measure the number of working days lost in the 1918 pandemic through illness related absenteeism, the Labour Force Survey of Canada's Dominion Bureau of Statistics recorded monthly illness absenteeism rates throughout the 1950s and this data is used in addition to the data sources mentioned for the 1918 pandemic for our estimation. For all three pandemics, data from national statistics offices was also obtained.

SARS

National statistics databases for countries of interest were visited in order to locate data on the above sectors and indicators. Where search facilities were offered, the keyword representing the sector was used to locate the data. The statistical data sections were also searched by hand for the appropriate data. A list of the national statistics databases used is provided in the appendix.

Estimation Method

Influenza

Many of the influenza data series' presented are for one year's data. The method used to estimate anomalies attributable to the influenza pandemic is to focus on the data that correspond to the time period of the influenza pandemic to see whether there are any gains/ losses at this time period compared with the data points prior to the pandemic. When assessing these gains/ losses the volatility of the series and standard deviation are taken into account to determine whether the potential influenza effects can be explained as typical variation of the series or whether they indicate a flu effect.

SARS

In order to calculate the size of any losses or gains in the data we examined the time period most likely to exhibit effects of SARS: the second quarter of 2003, whilst allowing for a possible smaller effect in the third quarter and, for some Asian countries, the possibility of economic effect in the first quarter. Where seasonal trends were evident, these were taken into account and, where possible, each data item was compared with the corresponding data item of the previous and/or succeeding year. In cases where data was scarce and such comparison of data was not possible, a comparison of points within the same year was necessary.

Therefore, for quarterly/monthly figures, the equivalent quarters/months in 2002 and 2004 (where available) were used to calculate an average or expected 2003 value in the absence of SARS. Where quarterly/monthly data was not available for the surrounding years, the previous and succeeding quarters/months of the same year were used (i.e. quarters one and three used to estimate the second quarter). In a similar way, when only yearly figures were available, annual data from the surrounding years was used to estimate data from 2003 data in the absence of SARS, using the previous and successive year's average where possible, but also taking into account any trend in neighbouring data. Occasionally plots of data were found without an accompanying set of the data points themselves and in such cases losses have been estimated by visual examination and comparing previous and successive data points in a similar manner to that described above.

More detailed information on the data obtained and methods used to analyse it are available in (James S and Sargent T 2006) and (Keogh-Brown M R and Smith 2006) for flu and SARS respectively.

Once non-SARS estimates had been formed, the actual data for the period of loss/ gain was subtracted from the estimated (non-SARS) value for the period of loss/ gain to form estimates of the economic impact of SARS.

Results

The 1918 Flu Pandemic

The main 1918 pandemic wave was limited to the September-November period with half the morbidity occurring in October.

Figure 1 illustrates the monthly levels of the NBER industrial production index. Taking the average loss from September to November compared with August, an average fall of industrial production of 7% for that wave may be estimated. This is equivalent to a –1.7 percent annual impact and a –0.45% GDP impact using the estimated GNP-industrial production elasticity. This estimate may exaggerate the flu related effects since the First World War ended in November and it is therefore reasonable to assume that part of the November impact is attributable to the cancellation of defence orders. However, the decline during this time period is notably less than the declines during normal business cycle contractions such as those in early 1915 and early 1921.

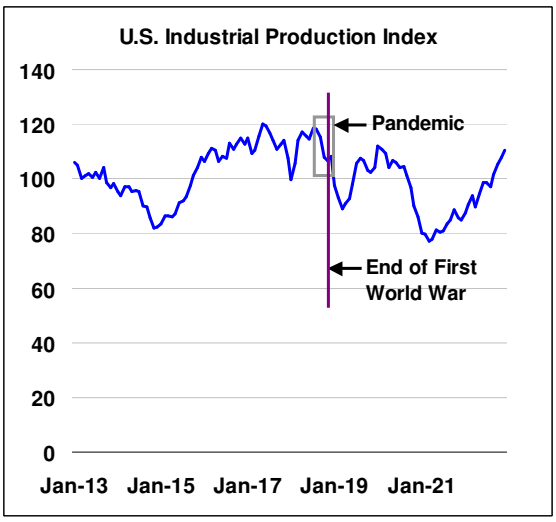

Figure 1 US Industrial production

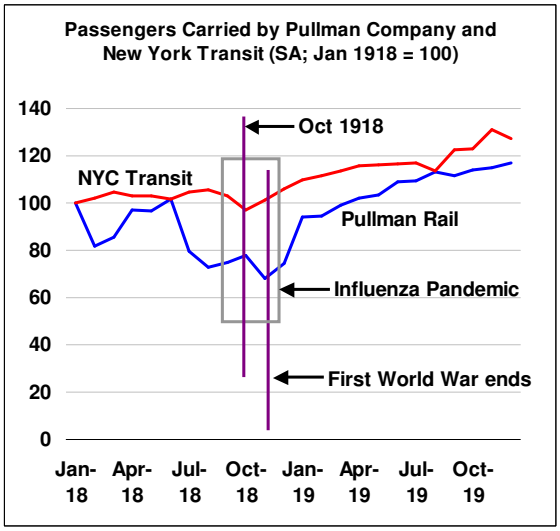

Figure 2 Passengers Carried 1998

One of the sectors expected to exhibit losses during an infectious disease outbreak is public transport and travel. Detailed data on this for 1918 are available from the Pullman Company who recorded passenger miles carried in the days when the City of New York recorded all passenger trips on its subways and street railways. This is presented in Figure 2.

Whilst it is known that passenger travel, particularly tourism, was affected in the SARS outbreak (see below), Pullman rail passenger traffic during the peak of the 1918 flu pandemic shows no apparent impact. Traffic remained at consistent levels in September 1918 and actually increased in October when the pandemic was at its peak. New York transit use showed a rise in September, followed by a fall in October, before bouncing back to normal levels in November. This data therefore suggests a small annual impact, of -0.6%.

There was also a decline in retail sales at the time of the pandemic, though it should be pointed out that the October decline is smaller than the standard deviation of monthly changes in the series. The implied annual impact is –1.4%. It would seem that the impact of the 1918 pandemic in these supposedly sensitive sectors is smaller than might be expected.

Exports are thought to be a volatile area of the economy at a time of pandemic outbreak since it is reasonable to conclude that uninfected countries will be unwilling to encourage trade with countries when that trade might be the cause of infecting their country. However, US real exports for 1918 show little disruption in trade flows at the time of the pandemic: there is a steady decline at the time of the pandemic, but this decline is small compared with other parts of the series. More detail is available in (James S and Sargent T 2006).

Absenteeism is often expected to affect the economy: the loss in productivity caused by absent workers together with the additional firms costs in overtime to cover for absent workers is expected to have an impact (Brown S and Sessions J G 1996).

However, since daily bank clearings rose during the pandemic, there is no evidence to suggest that absenteeism had a significant impact on the financial sector. Bankruptcy data concur with this finding and show no evidence of an economic effect on the manufacturing sector.

1957 and 1968 Flu Pandemics

Canadian excess illness absenteeism rose in September to 0.7%, continued to rise in October up to 3.1% and declined to 1.1% in November, 0.4% in December and January and 0.2% in February. These time periods correspond to the two waves described above and the peak of daily excess absenteeism is estimated to be 3.8% around the 15th October.

Once again, monthly data is necessary in order to identify signs of an economic impact of the pandemic. Monthly Canadian industrial production is shown in Figure 3 (left) together with the inverted monthly change in the excess illness absenteeism rate. Just as the pandemic wave began in September 1957 industrial production fell 1.9%, it continued to fall by 1.1% in October when, as mentioned above, excess absenteeism rose significantly. In November, excess absenteeism fell and industrial production rose by 0.2%.

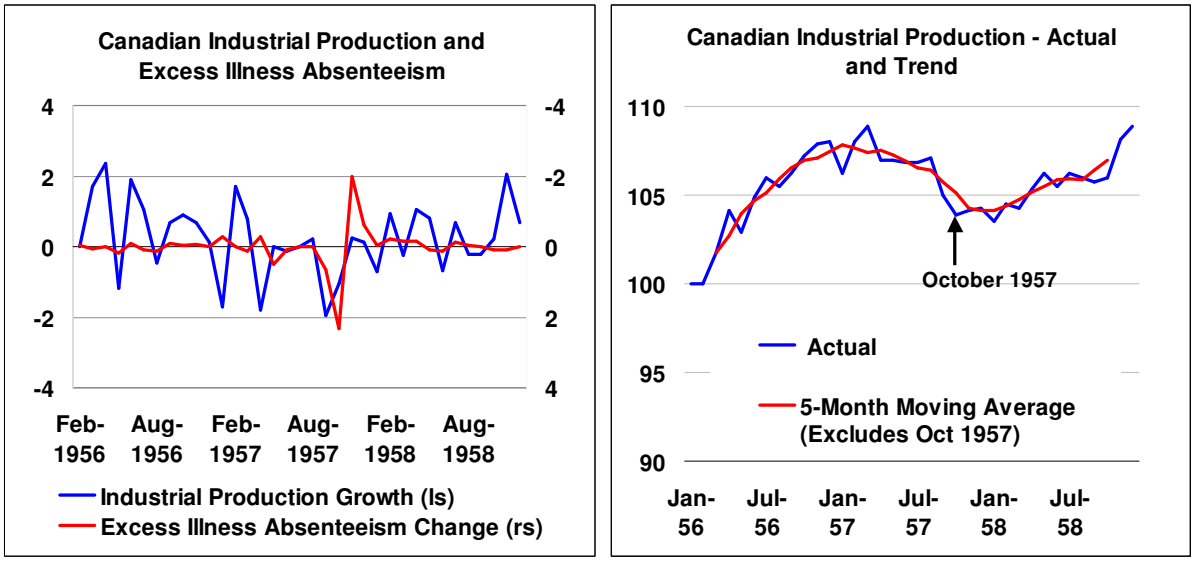

Figure 3 Canadian monthly industrial production

Figure 3 (right) shows a filtered industrial production series consisting of a 5 month centred moving average that excludes October 1957 from the averaging, so as to avoid contamination of the trend with the peak pandemic effect. From this data, industrial production is estimated to have fallen to 0.7% below the trend in September 1957 and a further 1.2% below in October, returning to the trend in November. Assuming that these are the pandemic impacts on industrial production, these estimates correspond to an annual loss of 0.15%. With the elasticity of real Canadian GDP growth to industrial production growth at 0.58 during the 1950s, the annual GDP impact was –0.08%.

Whereas there was an effect on retail sales in the 1918 pandemic, there seems to be no 1957 pandemic impacts in Canadian monthly retail sales. The U.S. personal savings rate over the period 1956-69 shows no spike to indicate an impact in the

pandemic quarter, but rather the savings rate falls in the fourth quarter of 1957 and is flat in the fourth quarter of 1968.

Viewing the 1957 and 1968 data overall suggests the possibility of very small direct economic impacts, but no evidence of the indirect impacts that might be expected during a pandemic period.

SARS Outbreak 2003

SARS was first noticed in China towards the end of 2002 and by February 2003, it had spread to Hong Kong and Vietnam, and by spring 2003 it had spread to several other countries. WHO estimates suggest that 8096 people were infected, of whom 774 died, implying a case mortality rate of 9.6%. Whilst this does not compare with influenza cases in an average pandemic year, which exceed 10 million cases annually and 40,000 deaths, the SARS outbreak was expected to have significant indirect effects on the economy. Canada was the worst affected non-Asian country with 251 cases and 43 deaths, most of which were in Toronto.

Hong Kong was at the epicentre of SARS and exhibited a decline in GDP for the first and second quarters of 2003 (Figure 4) We estimate the loss for the first and second quarters to be US$3.7bn. These losses can be traced to a fall in service exports and particularly to tourism and related sectors such as hotels (US$0.2bn) and restaurants (US$0.26bn). Annual tourist visits account for 20.3% of Hong Kong's population which compares with, for example, 4% for Japan. As a result Hong Kong's GDP is vulnerable to decreases in the number of tourists. In subsequent quarters Hong Kong's service exports rebounded and goods exports were unaffected as was air cargo. The plot below shows a rapid return to pre-SARS levels following the outbreak and this "bounceback" is common to many of the affected series at the time of SARS. A fall in Hong Kong's retail sales is also suggested (Figure 5). in 2002 and 2004, the seasonal trend is for February and march to rise after the January trough, but in 2003, there is a clear decline in March's retail sales. This loss is estimated at US$334m. In addition to this, Hong Kong's foreign direct investment declined rapidly in 2003 by an average of US$23.1bn based on the surrounding years. Although monthly or quarterly data were unavailable for this sector, it is not possible to establish whether this loss is mainly attributable to SARS, but it would be reasonable to assume that SARS was the main impact on the Hong Kong economy in 2003.

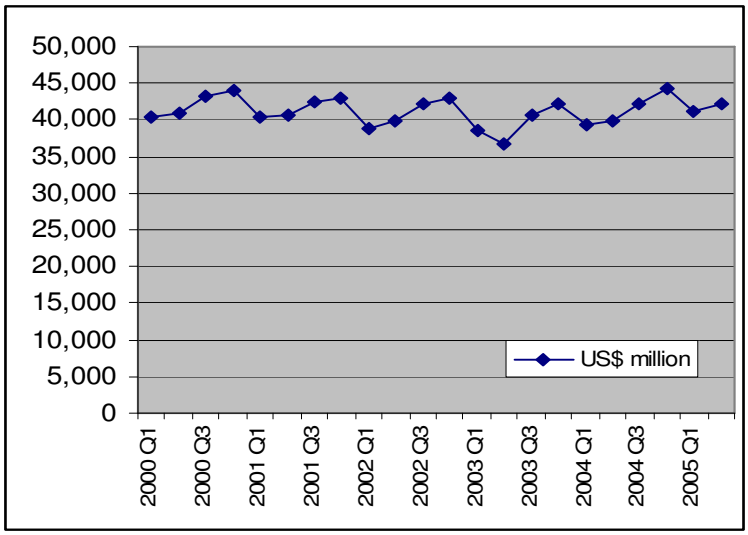

Figure 4 Hong Kong GDP (HK$ million)

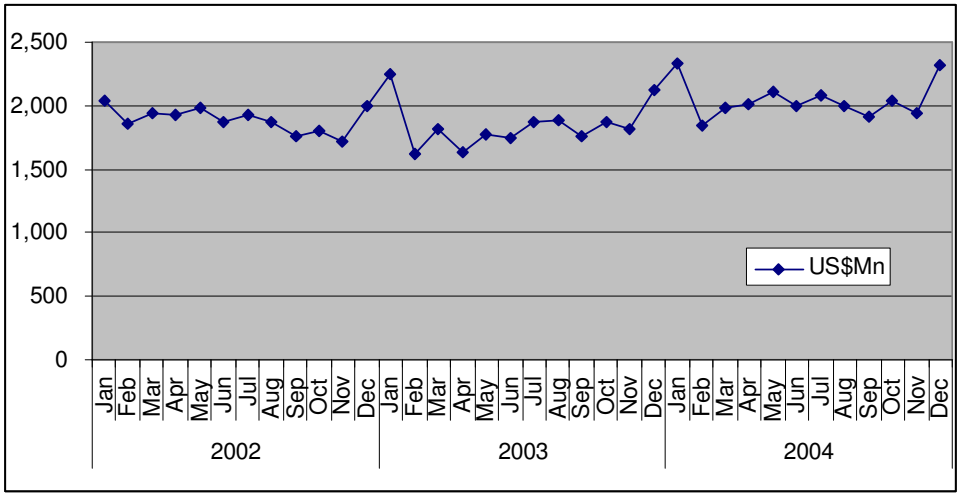

Figure 5 Hong Kong Retail Sales

Singapore was in the throws of a SARS outbreak in March and April of 2003. Figure 6 shows that visitor arrivals fell rapidly during the outbreak and remained at low levels in May before bouncing back in June. Hotel occupancy fell from 71% in March to 34% in April. Figure 7 shows the losses in Singapore dollars to hotel revenue and shows that bouceback to pre-SARS levels was not made until the middle of the third quarter of 2003, though some recovery had begun by June. By assuming that the second quarter data should be approximately similar to the first, third and fourth quarter, the estimated loss to Singapore's hotel revenues is approximately US$0.12 billion**.** Singapore's quarterly GDP pattern is similar to that of Hong Kong and Singapore's retail sales were unaffected as was shipping tonnage. Surprisingly, freight carried by Singapore airlines rose during the height of SARS, but passenger arrivals fell by 17.4%.

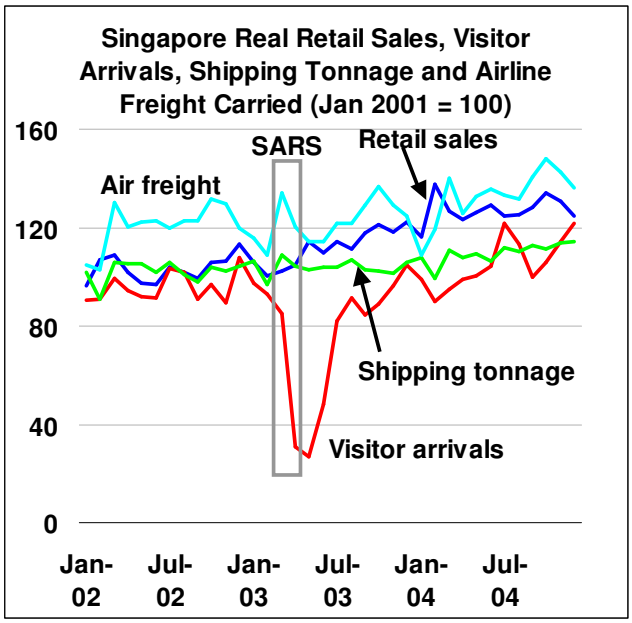

Figure 6 Singapore retail sales, visitor arrivals, shipping tonnage and airline freight carried

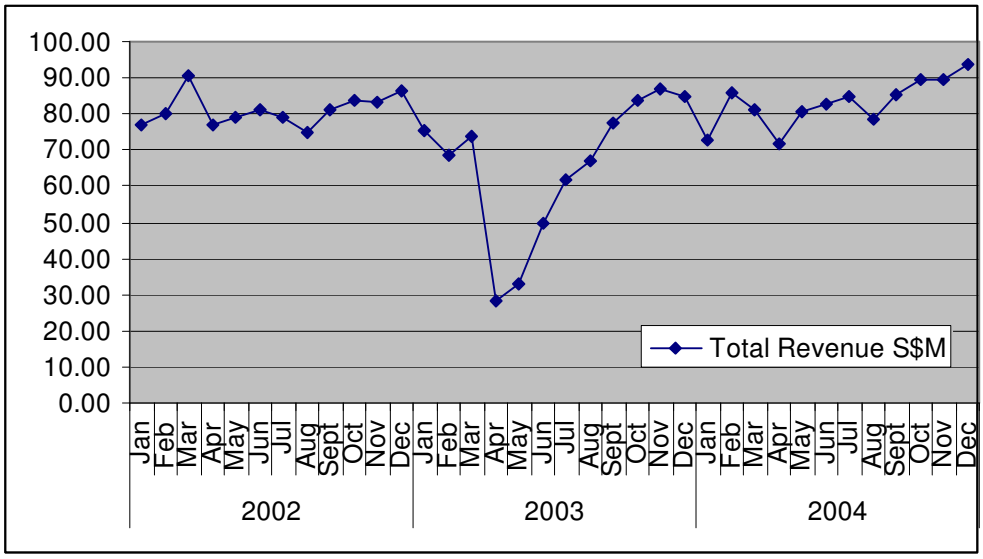

Figure 7 Singapore gazetted hotels revenue

Tabulated in Table 2 are annual growth patterns of Hong King, China and Vietnam. The economies of Hong Kong, China and Vietnam experienced faster growth in 2003 than in 2002, though annual growth slowed in Singapore. In contrast to this, when viewed at quarterly levels a different perspective is given.

Table 2 GDP Growth – Asian Countries Affected by SARS

	Hong Kong	China	Singapore	Vietnam
2000	10.2	8.0	9.6	6.8
2001	0.5	7.5	-2.0	6.9
2002	1.9	8.3	3.2	7.1
2003	3.2	9.5	1.4	7.3
2004	8.1	9.5	8.4	7.7

Table 3 reveals that the growth figure for 2003 overall displays positive growth for 2003, but the second quarter of 2003 value shows an average loss compared with the other quarters of 5%. Clearly a temporary effect from SARS was experienced, but the annual impact of this loss is negligible.

Table 3 Hong Kong Growth

		GDP Growth (%)
2002	Q1	-0.6
	Q2	0.8
	Q3	3.4
	Q4	5.1
	Overall	2.3
2003	Q1	4.5
	Q2	-0.5
	Q3	4.0
	Q4	5.0
	Overall	3.3

Similarly for China, as shown in Table 4, we see that although the annual figures show a notable rise in growth in 2003, the quarterly figures suggest that the second quarter exhibited an impact from SARS of approximately 3%.

Table 4: China's GDP growth 2003[5]

Quarter	GDP growth (%)
First quarter	9.9
Second quarter	6.7
Third quarter	9.6
Fourth quarter	9.9
Source: NBS	

Whilst there are no quarterly data for Vietnam, the two previous examples suggest an interesting reality for certain sectors and indicators: that notable impacts are made on the economy at the time of the pandemic or outbreak, but that when viewed on an annual basis, these impacts are indiscernible.

Malaysia also exhibited a loss to the tourism sector of approximately US$1.7bn, which might reasonably be attributed to SARS. There was no evidence of any other impact to Malaysian economic indicators or sectors.

Canada, like China and Hong Kong suffered a GDP decline in the second quarter of 2003. However, further analysis does not support the claim that SARS had a significant negative impact on the Canadian economy.

[5] Absolute value is computed at current price, growth rate is computed at constant price. Growth Rate over the Same Period Last Year (%)

During the SARS quarter, Canadian real net exports of travel services declined and remained at low levels to date (Figure 8). Rather than attribute this long decline to SARS, it is more likely that it represents the significant appreciation of the Canadian dollar against the U.S. dollar in the second quarter of 2003 which is shown in (James S and Sargent T 2006) to account for all losses, leaving no impact to attribute to SARS.

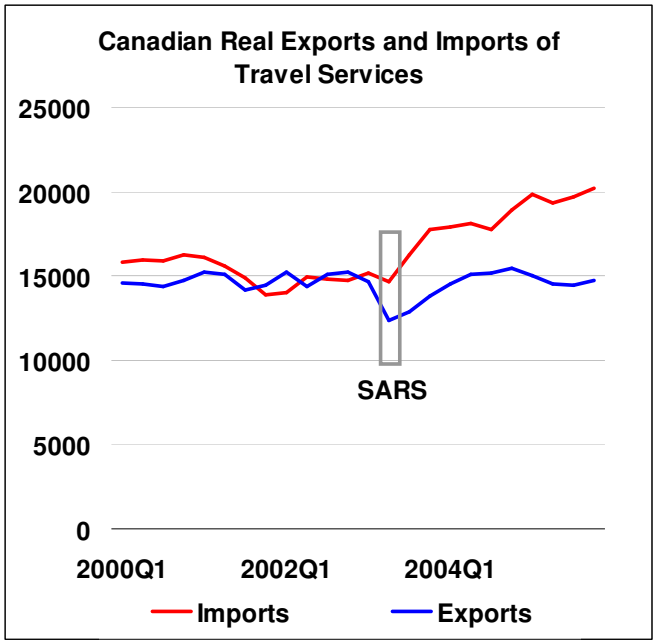

Figure 8 Canadian Travel Services

In contrast to this Figure 9 shows a clear loss at the time of SARS in accommodation and food services. This loss amounts to approximately US$4 billion and the loss between March and May equals 0.03% of 2003 GDP, since the food sector was unaffected, much of this loss may be attributed to the accommodation sector. Figure 10 confirms the accommodation loss, and though the amount cannot be calculated in dollars, a 14 percent loss for air transportation can be seen at the same time and for the same duration as the accommodation loss.

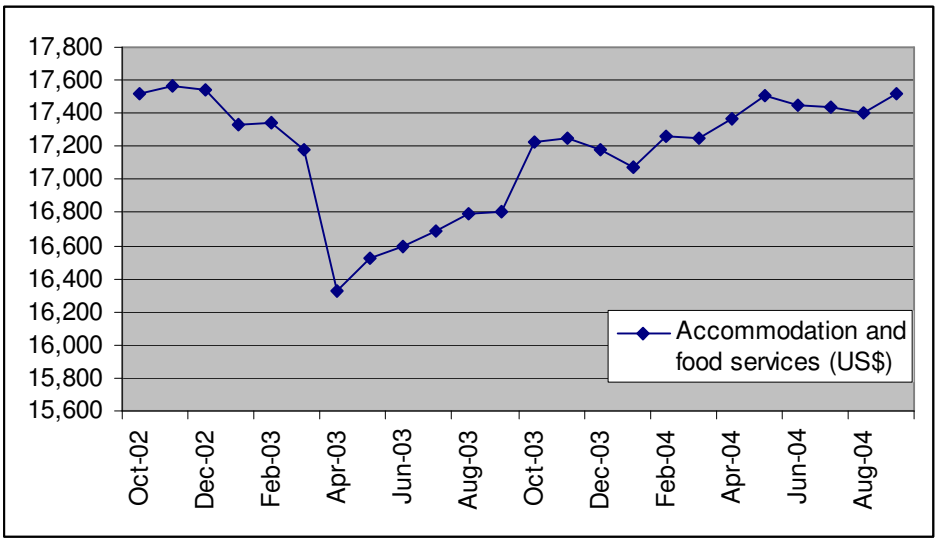

Figure 9: Canada Accommodation and food services sector (millions chained (1997) dollars)

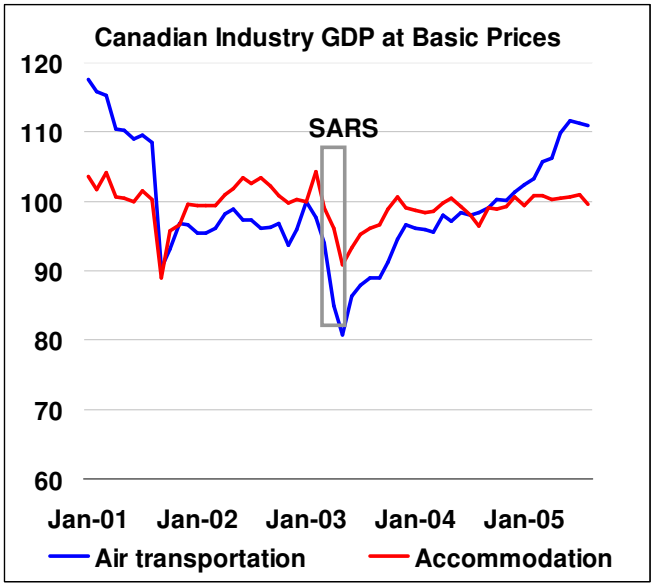

Figure 10 Canadian Accommodation and Air Transport

Once again, in contrast to the influenza effects, these losses are attributable to indirect economic effects cause by a change in peoples behaviour to delay or cancel their holidays.

Discussion

This analysis presented in this paper suggest that economic losses incurred during influenza pandemics seem to be the result of the unavoidable direct economic impact of the disease itself, whereas those resulting from SARS, perhaps because it affected much fewer individuals, are from the indirect effects caused by avoidance of the disease area by tourists. However, in each case the magnitude of these losses was relatively trivial.

The direct effects of the influenza pandemic in 1918 involved some losses to production and a small disruption to exports, and even these impacts seem relatively unimportant compared with some of the volatility in some of the surrounding years. It might be reasonable to suggest that, having faced the fears associated with war on a daily basis might produce a different effect from that which might be expected in today's comparatively peaceful and affluent society. In addition to this, those living in 1918 were part of a far less globalised society and the differences in modern day shopping, travel and living may produce different effects in 2006 from those seen in 1918, but many of the fears and confusion that might result in the early 21st century were experienced in 1918 and it would seem that the economic impact of them was small.

The effects of the 1957 and 1968 pandemics seem to be even smaller than those for the 1918 pandemic. Once again, the effects that are observed are directly related to the disease itself, and the lower mortality of these pandemics may explain the smaller economic effects. However, despite the absence of a recent world war and the increased globalisation compared with 1918, the more modern society of 1957 and 1968 exhibited no additional susceptibility to the economic impacts of infectious disease. There was also a confounding factor in the late summer of 1957 when Canada and the United States suffered a capital investment recession that ended in the spring of 1958.

Interestingly the largest economic impacts seem to be attributable to the least serious of the pandemics: SARS. Many of the suggestions by economic modellers regarding large economic effects of pandemics could, however, have quite possibly been incurred of course were it not for the intervention of globalised networks to reduce the impact. However, the estimates and analysis detailed above suggest that, although there was an economic cost of SARS, it was indeed smaller than predicted by the media and by several models. However, the SARS outbreak coincided with start of the second Gulf War and heightened fears of terrorist attacks (James S and Sargent T 2006) show that U.S. international travel declined in the spring of 2003 to reflect a generalized fear of terrorism, not SARS. For this reason it is difficult to discern the SARS effect of travel to Canada from the heightened fear of terrorism.

The costs attributable to the SARS outbreak, in contrast to the influenza costs, seem to be indirectly related to the disease. Since relatively few people were infected with SARS, the economic impact of absenteeism and morbidity is negligible. Likewise many of the expected costs to sectors such as retail sales and entertainment were not realised, except in the case of Hong Kong where March exhibited a retail sales loss. The costs that are apparent are those related to the tourism sector. Reduced visitor arrivals and losses in the accommodation and food industries had a notable impact on some economies, but many of these losses were short-lived and some were recovered before the end of 2003.

It is possible that these costs were exacerbated by the fact that SARS was not a global pandemic affecting all countries. For this reason, by changing behaviours, cancelling holidays and travel arrangements etc, it was possible for those in unaffected countries to avoid the riskiest areas. Such behaviour was not possible in the global influenza pandemics in 1918, 1957 and 1968. In addition to this the increasing ability of the media to spread news rapidly across the world and, in the case of SARS, to exaggerate the potential harm of the disease, may have had an influence that would not have been observed in less modern times.

It is not possible to predict exactly what the economic impact of an unknown future pandemic will be and there are aspects to modern globalised society that may serve to increase the economic impact. Media hype (or helpful public information) may serve to increase (or reduce) the impact. Modern technology, for example, an increased demand for online direct grocery shopping might serve to boost the economy during a pandemic for those who want to avoid public places. However, the evidence presented in this paper suggests that the economic impact of the type of pandemic seen in the 20th century is much less than the predicted impacts of future pandemics. Clearly there will be impacts of death and morbidity, though some of this effect may be mitigated by cover for absent colleagues. As with SARS, there may be significant tourism related impacts, but in general, there is little evidence to support the economic meltdown suggested from some quarters. Certainly, in the absence of control measures the economic impact of a disease outbreak could be much greater. Therefore rapid globalised intervention, as exhibited in the SARS outbreak is important and will serve to minimise the epidemiological as well as economic effect of the disease, but it seems unlikely that an infectious disease pandemic, if similar to previous pandemics, would be an economic catastrophe.

These results do not decry the use of economic models to estimate the cost of infectious disease outbreaks, but rather highlight the need of a global macro-economic and epidemiological model that is specifically focused on the area of global infectious disease outbreak and able to take account of the factors highlighted above and the synergy between epidemiology and economically-related behavioral factors.

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Appendix

National Statistics databases used:

China: http://www.stats.gov.cn/english/index.htm

Hong Kong: http://www.censtatd.gov.hk/home/index.jsp

Canada: http://www.statcan.ca/menu-en.htm

Singapore: http://www.singstat.gov.sg/

Malaysia: http://www.statistics.gov.my/

Vietnam: http://www.gso.gov.vn/default_en.aspx?tabid=491

Thailand: http://web.nso.go.th/eng/index.htm

United States: http://www.fedstats.gov/ , http://www.bea.gov/ , http://www.bts.gov/ , http://www.cdc.gov/nchs/

Australia: http://www.abs.gov.au/

Germany: http://www.destatis.de/e_home.htm

Japan: http://www.stat.go.jp/english/index.htm

Mongolia: http://www.nso.mn/eng/index.php?PHPSESSID=d708a6e6e1c76b899177cdb94d353c8f

Philippines: http://www.nscb.gov.ph/

France: http://www.insee.fr/en/home/home_page.asp

Sweden: http://www.scb.se/default____2154.asp