

The Economics of Emerging Infections in the Asia Pacific: What Do We Know and What Do We Need to Know?

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The Costs to Trade and Travel of Emerging Infections in the Asia Pacific: What do we know and what do we need to know?

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ABSTRACT

Objectives: 1) To describe the existing information on the “external” (i.e. Trade, travel, inspection etc.) costs of epidemics to economies within trading communities such as APEC. 2) To propose a risk framework based on experience that may enhance understanding of such costs.

Methods: Review of the biomedical and economic literature as well as available business literature and pertinent press accounts. Four case studies from the broad region of the Asia Pacific were assembled and characterized as to the event of emergence, the costs and methods used to quantify these costs.

Results: The Cholera Epidemic in Lima, Peru in 1991, Pneumonic Plague epidemic in Surat, India in 1994, E. Coli epidemic in Sakai, Japan in 1996 and the Avian Flu emergence in Hong Kong, China in 1997 were studied as to “external” costs in trade and tourism. The four were diverse the character of event described and therein allowed some generalizations about risk of disease. Generally such work has not been published in the scientific literature.

Conclusions: Measurable “external” costs have been high in each of the four cases looked at. The range of impact on trade is broad, estimated from millions to billions of dollars per occurrence. Such costs are not routinely counted and therefore have not included in any cost benefit analysis of decisions to invest in prevention or control of disease. It is probably that investment in public health systems will become increasingly important as economies become more closely linked in trade and travel. In fact such investment may have a key role in determining strategic advantage among competitive economies within trading communities.

I. Introduction

Recently the Asia Pacific Economic Cooperation joined a number of other trading cooperations and communities in making the issue of emerging infectious diseases a priority. Although there is a perception that epidemics are costly, description or quantification of these costs has not been systematic. We reviewed published and unpublished information about the costs of epidemic disease activity in the nineteen Asia Pacific Economic cooperation economies and other regional economies to establish the economic costs over the past ten years.* Our findings are 1) measurement of economic impact of infectious diseases has been haphazard, and information is therefore uneven 2) due to the sparcity of information, it proved impossible to quantify a total cost figure for the APEC economies due to epidemic activity impact on trade and travel 3) a case study approach allows the most useful consideration of such activity 4) describing risk factors for economic loss may prove useful 5) more systematic prospective monitoring would be useful to quantify the impact of epidemic activity.

Since World War II, the value of merchandise trade on a global basis has increased by over 1,000 percent.¹ This trend has been especially important for the Asian economies where trade has more than doubled just between the years of 1984 to 1994.¹ Many nations within APEC rely on trade to ensure growth in their economies. Most importantly for disease transmission, trade in agricultural products between 1961 and 1991 has been substantial (figure 1). The growth rate of agriculture trade within Asia has been seven percent annually between 1990 and 1994, and by 1994, nearly 20 percent of all agriculture exports came from Asia.¹ In fact, the economic vitality of trade for these economies is evidenced by the creation of the Asia Pacific Economic Cooperation itself—as a vehicle to liberalize trade in the region.

Along with increased trade (and migration), the pace of emergence and transmission of infectious diseases has apparently increased, particularly within the

* Our study did not include a number of direct or human costs related to the occurrence of major infectious diseases. These costs include treatment costs, lost income as well as other costs related to social changes brought about by the onset of an infectious disease. Rather we focused on loss in revenues and costs of regulation and trade and travel dislocation to economies.

developing nations of APEC (figure 2). The costs of these incidents are unclear, with press accounts relying largely on sources within trade ministries and industry representatives to measure the costs. The economic impact of most epidemic events in the region have not been studied. In reviewing the major epidemics reported for the region either through the PROMED alert system or through the World Health Organization's Weekly Epidemiological Record, we were unable to locate economic studies for the large majority of clusters or outbreaks.

The economic literature is no more complete than the biomedical literature in this regard. Only one emergent infection –HIV/AIDS has been studied to any extent. There have been a number of conflicting studies on the possible impact of the epidemic on economic growth rates of various nations, using two basic techniques. The first technique,^{2,34 5} involves modeling the economy of interest and simulating the effect of AIDS on, for example, growth in per capita gross domestic product. First applied to the economic effects of disease⁶ it takes parameters from actual economies (for example, the percentage of cases that involves the skilled rather than the unskilled work-force), and uses those values in established economic models to project the effects of the epidemic. The effect of AIDS on growth in these models varies from a loss of 2 percentage points per year (Kambou, Devarajan and Over) to three tenths of a percentage point per year (Cuddington and Hancock).

The second technique⁷ uses econometrics to measure the actual effects of the epidemic on economic growth. Bloom and colleagues applied this method in a large study of 51 countries during the period 1980 through 1992. A standard model of growth is used and includes a measure of AIDS prevalence for study countries over the period 1980 through 1992. AIDS prevalence is measured by the EPIMODEL, which is estimated along with the rest of the model. The findings are that although AIDS has a statistically significant effect on growth in the economies before any other determinants of growth are added, after these other determinants are added, the effect becomes statistically insignificant.

Why do the results from the two techniques differ so much? In part because the results using econometrics are statistical in nature and cannot really be compared to the results of simulations, which do not include standard errors. However, both techniques may prove useful in examining the costs of other epidemics reviewed in this paper. In particular, it may be useful to evaluate the economic impact of the 1991 cholera epidemic in Peru using either of these techniques in the future.

It is notable that despite the rapidly increasing incidence and prevalence of HIV/AIDS in the Asia Pacific region, few systematic studies have been carried out. UNDP sponsored a series of research papers early in the Asian epidemic that included a detailed study of the Thai economy, a sectoral study on the Thai transportation sector and a study of the impact on overseas contract workers from Philippines.⁸ Each of these areas is pertinent to the liberalization of trade and travel envisioned by APEC. Using the Interagency Working Group model to model the future epidemic, Michai Viravaidya and colleagues estimated Thailand's potential economic loss at US \$ 7.3 billion by the year 2000⁹, a figure which drew high level political attention to the crisis. In fact, in testimony during a 1992 US Congressional forum, this same group of researchers placed the potential loss as high as \$US 8.7 billion. This estimate was based on an estimated total of more than 3.4 million infections, 650,000 cases of AIDS and 500,000 deaths. However, due in part to the subsequent vigorous national prevention program, as of 1997 WHO estimates that just 780,000 infections have occurred, with 260,000 clinical cases of AIDS and 230,000 deaths. This suggests that the actual experience in Thailand will demonstrate less economic impact, but follow up studies have not been done.

The sectoral study suggested that the transportation sector of Thailand should be affected by the epidemic, given the behaviors and infection rate of truckers.¹⁰ The study of overseas guest workers included very limited data on actual infection, but demonstrated that risks of wage earners abroad could profoundly affect the economy at home¹¹—an example of cause and effect which we found echoed in other economies and with other diseases.

In the United States and Canada studies of economic impact have been carried out. In Canada, Hanveltdt and colleagues documented a loss of wealth production due to HIV/AIDS deaths of \$2.11 billion for the period 1987-1991.¹² Recent work in the United States has measured the loss of QALYs (quality adjusted life years) rather than lost wealth per se, and direct costs have increased with new therapies while QALY's have decreased due to increased years of healthy survival.¹³

WHO estimates an annual infection rate in Asia of 1.7 million and a total of 6 million people infected with HIV as of 1997,¹⁴ and yet few economies have attempted to quantify their losses in direct, indirect trade and travel related costs as the epidemic has matured in the region. Thus, "external" losses are unknown, only domestic impacts have been measured.

Methodology for this Study:

We found four epidemics that affected the economies of the region for which adequate information was available to begin to look at such losses: the 1991 Cholera epidemic in Peru, the 1993 pneumonic plague epidemic in India, the 1996 Japanese E Coli Outbreak in Sakai, and the 1997 Avian flu epidemic in Hong Kong. We then evaluated the costs experienced by the economies in which these events occurred. Information has been compiled into summary case studies below. Based on the case studies, we have proposed an outline of potential economic risk factors, gleaned from the above events. Such a risk framework may prove useful to policy makers when deciding how to prioritize the expenditures necessary to prevent infectious diseases.

Case Study Descriptions of Four Epidemics

Cholera in Peru

In 1991 Peru experienced its first cholera epidemic this century.^{15,16,17,18,19,20,21,22} The epidemic began in Peru's northern ports in late January of that year and by the end of February had been blamed for more than a hundred deaths. By the end of 1991, there were over 300,000 cases of cholera in Peru and nearly 3,000 deaths as a result.²³ The epidemic

continued through 1995 with another 300,000 cases and another 1,500 deaths in Peru.²³ Additionally, the disease spread throughout Latin America causing over 1 million cases and 10,400 deaths between 1991 and 1994.

Peru identified the epidemic and reported it to the World Health Organization in February of 1991 as required by the International Health Regulations. By the end of February, Peru's economy began to experience trade related costs due to the epidemic. In particular, Peru experienced a drop in tourism as well as a loss in trade as a result of canceled orders of fresh fruit and seafood.²⁰ Tourism dropped between 60 and 70 percent in the first quarter of 1991 from a year earlier.¹⁷ Export costs, including canceled orders, delayed sales, deterioration in prices of exports and increased inspection costs have been set at as high as \$700 million dollars in 1991.²²

The Peruvian Cholera epidemic can be characterized as the emergence of a known pathogen in a previously unaffected geographic area. Its emergence in part is attributable to a decade of severe economic decline of Peru between 1981 and 1992. During this period national production fell 23.5% and per capita production dropped 28.9%. Real per capita production in 1992 was no better than it had been in 1960. Inflation had reached a high of 7,650% in 1990 but had been reduced by economic measures at the time of the outbreak. As a result of this decline, real per capita social expenditure in Peru fell from US \$49.50 in 1980 to US \$9.10 in 1991 (in 1985 dollars). In 1990 the Government's social expenditure for education, health and, housing and employment came to only 28% of 1980 levels. This under-expenditure was reflected in a major shortfall in sanitary and water infrastructure for the population. The National Drinking Water and Sewerage Program reported that in 1992 only 76.5% of the urban population was supplied with drinking water services and 60.5% had sewerage services; in rural areas 23.7% had access to drinking water services and 17.4% to sewerage services.^{24,25}

Pneumonic Plague in India

In the middle of September 1994, an outbreak of pneumonic plague occurred in the western Indian city of Surat. By the middle of October, at least 50 deaths were blamed on the disease along with as many as 2,500 other cases.^{26,27,28,29,30,31,32} By all accounts, this

outbreak of a known and highly contagious and mortal pathogen was accompanied by a general panic of the population (despite the fact that plague is endemic in much of the subcontinent). Poor diagnostic capacity of many laboratories compounded confusion about the extent of the infection.³³ The occurrence of the disease led to a well publicized exodus of workers out of Surat,³⁴ a phenomenon not seen in the Peruvian scenario described above.

Subsequently, a number of trade and travel restrictions were placed on India, most of which were lifted by the end of October. The Indian government spent millions of dollars in a campaign to limit the losses due to the trade restrictions.²⁸

The cost of the plague epidemic in India has been put at over \$1.3 Billion.²⁶ These costs are from lost trade revenue as well as lost tourism.²⁸ Additional costs may have occurred because of lost revenues from the forced return of Indian migrant workers from the middle east, as well as some lost or delayed foreign direct investment. Finally, there was loss in diamond trade due to the massive migration of diamond workers out of Surat after the discovery of the disease.²⁸

E Coli 0157:H7 in Japan

On July 13 1996 the Public Health Department of Sakai City received notification from Sakai City Hospital that 10 elementary school children had been admitted complaining of bloody diarrhea and cramps. On July 14, E Coli 1057:H7 was isolated from twenty cases. This agent proved to be the cause of the subsequent massive epidemic. Over the following weeks a total of 14,153 symptomatic cases were reported to the authorities with three fatalities.³⁵

Sakai City is located in Osaka prefecture and is a densely populated (pop. 979421/137 sq. km.) highly urbanized area. Through an extensive epidemiologic and microbiologic investigation, radish sprouts in school children's lunches were identified as the most likely vehicle of the infection. This conclusion was supported by three facts: 1) school children were disproportionately affected by the epidemic and radish sprouts were the only uncooked item served in the school lunches in affected districts 2) school children

absent on the day the radish sprouts were served were not infected and 3) molecular studies suggested that the agent was the same in sprouts and in the cases. Despite very high hygiene level within households, secondary cases did occur.

Costs from the outbreak included: 1) local costs in prevention, care, screening and outbreak investigation. Although these costs have not been quantified, table – gives an idea of the scale of activity which occurred during this outbreak 2) "Cost shifting" in compensation to the victims of the epidemic.

In view of the fact that this case of mass food poisoning was caused by school lunches and that the city accepted the fact that these supposedly safe lunches caused harm to many school children and even resulted in death, those who were directly victimized and those who were the victims of secondary infection were eligible for compensation.³⁵

To date, no quantification of these compensations has been carried out, nor has there been any estimates of indirect costs within the society. 3) Decrease in imports of radish sprouts from the United States. This is also a cost to the United States, and demonstrates the impact of epidemics on trading partners. As shown in figure 3, the total value of radish seeds for sowing shipped to Japan from the United States fell from a high of \$3,933,675 in 1995 to \$2,225,619 in 1996, and to \$1,393,643 in 1997. Thus there was a two year decrease of \$1, 540,032 in the value of this trade. 4) Finally, the radish manufacturer in Japan who imported the seeds from the United States and sprouted them in Japan reportedly sued the Japanese government for 50,000,000 yen (263,000 US) and the 19 manufacturers in the Japanese Radish Sprouts Association sued for 45,000,000 yen (200,000 US) for lost market. These suits have not been settled.

Japan is not the only economy in the region to suffer from E Coli 0157H:7 epidemic disease. The United States has experienced outbreaks due to hamburgers served in fast food establishments³⁶, and unpasteurized apple juice.³⁷ In fact, the U.S has had major beef recalls due to contamination with the agent that involved millions of pounds of product.³⁸ However, we chose to study the Japanese outbreak because of its proximate relationship to trade; a linkage that was less apparent in the U.S. experience.

Hong Kong Avian Flu

In May of 1997, Hong Kong experienced its first human fatality from a flu that was believed to have been contracted from chickens.³⁹ Although this was a single case, it was unprecedented for an avian flu strain to directly infect a human, and this biological fact caused alarm worldwide. Normally influenza viruses pass from fowl through pigs prior to circulating in humans. Concern that this agent (H5N1) represented a major shift in flu, and a highly pathogenic one for humans was compounded by the subsequent occurrence of additional human cases. A total of 18 human cases and six fatalities were recorded in the outbreak.⁴⁰

The government of Hong Kong halted imports of chickens from mainland China in late December of 1997 and proceeded to slaughter the entire population of chickens on the island in early January of 1998. The total number of chickens lost was 1.3 million at an estimated cost of about \$13 million. In addition, Hong Kong residents lost access to a particularly prized variety of chicken for up to two years. Another short term cost to the residents of Honk Kong was the necessity of shifting consumption to expensive frozen chickens from Thailand for the months that fresh chicken was not available. Tourism was also affected by the epidemic.^{41,42,43,44,45,46,47} The lost tourism caused by the event was caused in part by travel warnings posted by Thailand and Taiwan. However, tourism to Hong Kong had already been reduced because of the economic situation in Asia as well as the change in government in Hong Kong.

Similar to the trade in United States Radish sprouts to Japan, the Peoples Republic of China's chicken exports to Hong Kong stopped during the outbreak. This cost to the PRC has not been quantified.

Thus to date the described experience in economic loss from epidemic disease can be summarized as follows:

Date, Epidemic event, Country	Source of Economic Loss described	Dollar amount by source
1991 Cholera, Peru (extension of known pathogen into new area)	Trade restrictions Increased inspection costs (fishing and produce) Lost tourism	Between \$ 700 Million and \$1.5 Billion
1994 Pneumonic Plague, Surat, India (occurrence of outbreak of known highly contagious and mortal pathogen in endemic area)	Trade restrictions Lost Tourism Forced return of migrants to other economies Loss of diamond revenues	Approximately \$1.3 Billion
1996 E. Eoli 0157:H7 In Japan (extension of a known pathogen into a new area)	Local costs of screening, inspection Loss of import market Litigation and Compensation	At least \$1.5 million in lost import market. Other costs unknown.
1997 Avian Influenza with human transmission, Hong Kong (occurrence of human transmission of known avian pathogen in new area)	Trade restrictions (on imports), alternate purchasing of poultry Increased testing, regulation of poultry Loss of locally preferred breeds	Difficult to measure accurately but it includes at least \$13 million in lost produce.

II. Framework for evaluating risk of economic impact:

The infectious disease events discussed above were made worse by failures of local sanitation, timely disease investigation, pest control or food inspection systems. To some extent, therefore, the trade and tourism losses can be attributed to inadequate investment in public health.⁴⁸ It is of note that when we analyzed the total health expenditure of selected APEC economies and compared the growth in this expenditure over time to the growth in trade volume, we found that health expenditure did not appear to keep pace (figure 3). Previous studies of public health projects have proposed establishing the “counterfactual” – i.e., establishing the costs of not doing the project and comparing them to the costs of doing the project.^{49,50} In addition to the costs discussed in those papers regarding the demand for the services provided by the project, the following framework should help determine the possible trade and tourism based costs of failing to provide adequate public health facilities.

1. *Trade and Foodborne agents*: Food based infectious diseases (cholera, cyclospora, hepatitis A, e.coli) often lead to trade restrictions. Thus the dependency of a given economy on food or agricultural exports or imports will determine its risk of losses from foodborne infections.
2. *Trade Restriction , Law and Politics*: What kind of restrictions on exports should the policy maker expect if an epidemic occurs? The International Health Regulations require that the least invasive or disruptive measures to control three notifiable diseases (cholera, plague and yellow fever) are the maximum allowable. However, even for these diseases, experience reinforces the impression that import restrictions are not based on science but rather on the political economy of trade. These restrictions, although in violation of the international rules often last a number of months before the restrictions are lifted. Therefore, an additional risk parameter is the extent to which the agricultural export sector competes with powerful rivals in the countries to which it exports those products. If there are such rivals, they

may use the epidemic as a pretext to lobby for additional protection for their products by restricting imports from the affected economy.

3. *Trade Safety and Public Health:* The state of food and water safety “at home” among trading economies affects the risk of epidemics in their own economies, and the risk of economic impact to their trading partners. As was seen in Peru, the deferral of investment in public health systems was costly to Peru in lost dollars but also costly to economies that imported affected products from Peru. Conversely, if public health infrastructure in a trading partner is perceived to be weak and vulnerable to transmission of imported disease, that economy may be more willing to place restrictions on imports until adequate inspection controls are in place in the economy of origin. Timeliness in notification, investigation and resolution of an epidemic threat is a capacity of public health dependent, in part, on investment. In turn, duration of an epidemic is a key factor in costs. Increasing the efficiency and timeliness of investigation will decrease costs that are due to longer and therefore broader transmission within the population.
4. *Fate of Affected Product:* The costs to the economy of trade restrictions depends on what happens to the product that is not exported as the result of the epidemic. Can the product be sold at home? If so then the price of the goods will fall at home thus increasing consumer welfare even as it lowers industry profits. Additionally, the exporters might be able to sell the product in a third country that does not impose trade restrictions. These sales will be at either a higher cost or a lower price, but the lost profits for the industry will be lower than the canceled sales numbers often reported in the press.
5. *Inspection costs:* Costs of inspection are also likely to increase as a result of the epidemic. These costs will increase export costs over the long term but are likely to have some positive effects as well. Hong Kong reportedly

spent \$1.92 million annually in enhanced inspection and testing to reinstate its live chicken trade with the mainland.⁵¹ To some extent, domestic food safety programs can act as a substitute for export inspection programs and they carry the obvious domestic health benefit as well.

6. *Reliance on migrant labor and/or travel and tourism:* Two possible costs illustrated by the plague event in India are lost tourism and loss of benefits of migrant labor (either lost income from restrictions on the outflow of labor or increased wages as a result of a decrease in the inflow of labor). In Hong Kong an 11% decline in tourist arrivals was noted following the Avian Flu outbreak. As described above, Peru also experienced lost tourism. Therefore, economics that rely on either tourism or migrant labor should factor these possible losses into public health infrastructure spending decision.
7. *Lost Foreign Direct Investment:* Multinational Corporations make investments in developing economies in the expectation of receiving a return. Anything that might disrupt that return imperils FDI. Risk of lost business due to epidemic activity theoretically serves as a deterrent to foreign direct investment but this has not been studied to date.
 1. This might hinder technology transfer particularly in the agricultural sectors.
 2. Multinational corporations might have problems getting employees to travel to some spots if the disease is particularly bad. This effect is hard to quantify but it may be important at the margin.

III. Cost Trade Offs:

Clearly the costs of emerging infections in APEC nations has been significant. However, the costs of preventing such infections is also significant. In particular, many infectious diseases are either transmitted because of poor water safety or because of poor food safety. The costs of adequate food and water safety systems can be high, both in

terms of initial capital costs and in terms of annual maintenance costs. The Pan American Health Organization estimates that Peru had nearly a decade of deferred capital investment in its water and sanitation systems at the time of the 1991 cholera outbreak.

The benefits of such projects include all of the benefits of improved health of the local population. These benefits have been included in project analyses. However, it is not clear that the "external" costs due to lost trade and lost tourism from emerging infections have been taken into account. As the interdependency of economics increases within trading communities counting such costs will become more and more important.

IV. Conclusion

The human costs of epidemics in suffering, illness and death are high. In addition, existing information suggests that epidemic costs are high in economic terms. Costs of recent outbreaks in the Asia Pacific region include direct and indirect costs to the affected economy, losses to trading partner economies and losses due to tourism and travel restrictions. Consideration of risk of loss includes evaluation of the public health infrastructure within economies and their ability to stem the transmission of new infections as well as insight into the political economy of trade within the region. Improving the information base prospectively for the study of the economics of epidemics could be beneficial in guiding policy in epidemic control and for mitigating the economic impact of future epidemics. For instance, local costs can be limited when timely and accurate disease investigation allows the definition of source and prevention of massive infection. The capacity to carry out such epidemiologic work is an important technology that should be accessible to all economies. Understanding the interplay of markets and how epidemics affect them will allow the minimization of real losses. Within the framework of the new APEC initiative on Emerging Infections, such prospective economic studies should become a priority.

The World Health Organization is the primary international agency involved in the health sector of economies around the world. APEC crosses three WHO regional offices: the Western Pacific, the Southeast Asia, and the Americas (PAHO). However, APEC embraces the economies that are linked in trade and travel, and these activities may

increasingly define the risk and economic impacts of epidemics. Thus, improving the information base about such impacts, and promoting synergies among agencies such as WHO, WTO and regional trading groups such as APEC in orchestrating regional response appears to be an important strategy.

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