

**The Economic Implications of Epidemics Old
and New**

By Clive Bell and Maureen Lewis

Abstract

The outbreak of Severe Acute Respiratory Syndrome (SARS) in the winter of 2002–03 raised the specter of a new, unknown and uncontrollable infectious disease that spreads quickly and is often fatal. Certain branches of economic activity, notably tourism, felt its impact almost at once, and investor expectations of a safe and controlled investment climate were brought into question. Part of the shock of SARS was the abrupt reversal of a mounting legacy of disease control that had altered societies' expectations from coping with waves of epidemics of smallpox, cholera, and measles, among other diseases, to complacency with the virtual elimination of disease epidemics. This paper analyzes the economic implications of the Great Plague in the fourteenth century, the 1918–19 influenza epidemic, HIV/AIDS and SARS to demonstrate the short- and long-term effects of different kinds of epidemics.

The Economic Implications of Epidemics Old and New*

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1. Introduction

The outbreak of Severe Acute Respiratory Syndrome (SARS) in the winter of 2002-03 raised the specter of a new, unknown and uncontrollable infectious disease that spreads quickly and is often fatal. Certain branches of economic activity, notably tourism, felt its impact almost at once and directly. Yet such an event can have potentially much larger and widespread economic effects simply by changing expectations. The unknown nature of the disease and duration of its outbreak introduced a strong element of uncertainty into the calculations of investors and policymakers alike. In particular, there was the concern that the epidemic would slow economic growth in China and impede the flow of cheap imports into OECD markets. In the event, it was swiftly brought under control by means of old-fashioned public health measures (isolation, quarantine and prohibition of travel); and the culprit, a corona virus, was identified by the most advanced methods within half a year.

SARS provides reminder of the importance of epidemics in recorded social and economic history. The well-documented past of Europe and China reveals waves of epidemics even in early times, and human remains from ancient Egypt suggest the presence of the same diseases. McNeill (1977), indeed, goes so far as to advance the thesis that epidemics often contributed to the rise and fall of empires, as well as determining the course of campaigns of conquest. The great event of this kind, from a demographic, social and economic standpoint, was the outbreak of the Black Death in medieval Europe in 1347, which carried off about a third of the population within four years. Cohn (2002) observes that this catastrophe was soon followed, not only by the general optimism and individualism of the Renaissance, but also by the growing conviction, in medical and literate circles at least, that its causes lay not in God's wrath or the position of the stars, but rather in this natural world.

This conviction opened the way to scientific progress in understanding the nature and transmission of disease, which served as the basis for the development of effective methods of prevention and treatment. The great improvements in economic welfare that have occurred over the past two centuries and more have been associated with, and have owed much to, the decline of communicable diseases. This latter development stemmed, in turn, from the implementation of strikingly successful measures to combat these diseases. By the second half of the 20th Century, the combination of knowledge, experience and medical technology had

produced a sharp drop in the incidence of epidemics, and with it the confident expectation that infectious diseases could, and would, be largely conquered within a lifetime.

This confidence had been shaken long before SARS burst onto the scene; for in the late 1970s, numerous cases of a new and almost invariably fatal disease had begun to appear in East Africa. They signaled the outbreak of the great modern epidemic known as HIV/AIDS. Here, unlike SARS, no such clear-cut success can be claimed. The very slow progression of the disease, its pathogen's frequent mutations, and its principal mode of transmission, which involves a fundamental behavioral drive, do much to undermine the effectiveness of the usual public health measures. Its established concentration among high-risk groups poses a constant threat to those of the uninfected who are ill-informed and unwary. The development of drugs to treat and manage the course of the disease represents real medical progress, but an effective vaccine appears to be a long way off and an outright cure unlikely anytime soon. AIDS and SARS are new, contrasting epidemics that not only confirm the value of experience gained in the past, but also confront societies with different problems.

In this paper, we confine ourselves largely to the economic effects of epidemics – itself a vast topic. In order to provide the necessary background, section 2 briefly sketches infectious diseases, their epidemiology and some selected examples of their contributions to history. Section 3 lays the groundwork with a discussion of the costs of morbidity and mortality, paying particular attention to communicability. Four epidemics – the Black Death, the so-called 'Spanish' influenza of 1918-19, HIV/AIDS and SARS – are then taken up in detail and compared in Section 4. There follows, in Section 5, an examination of the instruments of public policy and how best to employ them. The paper concludes by drawing together the main findings.

2. Epidemics and History

An intuitive, rather loose, definition of an epidemic is a sudden, sharp increase in the incidence of a communicable disease, which afflicts a large number of people in a relatively short period of time. While this conveys the general idea, we shall need something more precise for the discussion in the sections that follow.¹ A communicable disease must, in the nature of things,

¹ The definition of an epidemic is a surprisingly controversial matter. Originally reserved for communicable disease outbreaks, epidemiologists now routinely apply the term to other health risk factors, like obesity, and have

have a reservoir on which it can draw, or it will have become extinct. The reservoir usually takes the form of infected individuals, human or even animal; but it can also be a phial in a laboratory, which is now the last refuge of the smallpox virus. At any given time, the disease may be dormant, in the sense that there are no current clinical cases and those who happen to carry it are both immune and currently non-infectious. At the other extreme, the prevalence of the disease in a particular population may be significant, while fluctuating a bit about a roughly constant level. In close keeping with normal usage, we shall define the latter situation as one in which the disease is *endemic*. Both cases are effectively steady states – though not necessarily stable ones. It is then natural to say that an epidemic begins as a sudden, sharp increase in the incidence of a disease, starting from some steady state. The course of the epidemic is the trajectory of the prevalence rate from the initial to the final steady state, which need not be the same. For the disease may establish itself endemically in what was previously ‘virgin territory’, as in the case of malaria and other diseases in the Americas following European conquest and the transportation of slaves from Africa. Spanish influenza, in contrast, burst upon the scene, ran its global course within a couple of years, and has not reappeared in the specific form since.

Epidemics only occur when there is a sufficiently large pool of uninfected people to contract and transmit the disease, that is to say, there must be a large enough reservoir of potential victims (or “susceptibles”) for the disease to spread. For example, epidemiological models suggest that a minimum population of 250,000 is required to support a measles epidemic (Hunter, 2003). As it spreads, the disease uses up the available pool of “susceptibles” in two ways: by killing them, or, if they survive, by conferring immunity on them. At some point, it may burn itself out; but it can survive at low levels and reemerge later as a new epidemic, either in its original form or as a more deadly mutation. For an outbreak to develop into a global epidemic, the number of carriers must be large. Urban crowding assists in efficient transmission, and geographic mobility enlarges the stock of “susceptibles”, as was the case with influenza in 1918-19 and SARS in 2003.

The pathogens themselves include viruses, bacteria and parasites. Most of them emerge from cross-species transmission: smallpox and TB from cattle, malaria, HIV and

introduced multiple qualifiers, so muddying the definition. There are also no set rules as to when an outbreak becomes an epidemic. There is agreement on the term pandemic, however: it is an epidemic that has crossed national borders.

yellow fever from primates, and measles from dogs or deer. Transmission to humans will occur if a human virus mutates when exposed to animal viruses of the same family (Hull, 1963; Diamond, 1997). SARS, which is caused by a corona virus, is believed to be transmitted via wild animals (e.g., masked palm civets and raccoon dogs). Other species of animals are also carriers, though they may be immune to the disease. The modes of transmission of the diseases themselves are diverse: airborne (influenza, diphtheria, whooping cough, SARS), contact with blood and other bodily fluids (HIV/AIDS, typhoid), the ingestion of pathogens (cholera), and insect bites (bubonic plague, malaria, yellow fever). While some infectious diseases, such as the common cold, normally do little more than make their sufferers a bit miserable for a few days, others often cause serious morbidity (illness) and mortality.

Cholera, smallpox, measles, malaria and TB have been part of mankind's history. Malaria afflicted both primates and the first humans, and among its known victims are numbered Roman emperors, St. Augustine and Oliver Cromwell. Smallpox lesions and evidence of tuberculosis have been found on Egyptian mummies, although the populations of those kingdoms of the Nile are thought to have been too small to sustain major epidemics. Elsewhere in the ancient world, there is evidence of epidemics among the Hittites (1346 B.C.) and Athenians (490 B.C.), whose populations were larger. India, China, Korea and Japan suffered epidemics of smallpox in the first six centuries A.D. (Hunter, 2003).

Wars, migration, trade, famine and social chaos drive epidemics, bringing diseases to virgin populations. In war, it was often the soldiers themselves who were most at risk. Half a million soldiers died in an outbreak of smallpox in the Franco-Prussian War of 1870-71 (Morgan, 2002). In the British invasion of Cartagena during the War of Austrian Succession (1740-48), over 90 percent of the soldiers were felled by yellow fever, a disease unknown in Europe and to which Britons had no immunity (*ibid.*). In the Crimea War (1845-56), ten times as many British soldiers died from dysentery than from enemy bullets, and in the Boer War (1899-1902), the ratio was still five to one. A harbinger of future successful efforts to control disease among soldiers emerged during the Russo-Japanese War (1904-06). The Japanese used sanitation measures and vaccination to prevent epidemics among their soldiers, and lost to disease only a quarter of the number killed in battle (McNeill, 1977).

The conquest of the Americas by Europeans can be traced to the propagation of infectious disease as much as to superior weaponry and military organization. The Spanish

and British explorers and adventurers, naturally immune themselves, carried with them a range of diseases, notably smallpox and measles, to which the native peoples lacked any immunity. In North America, communities were small and isolated, making it hard for communicable diseases to be sustained. In Mexico and Peru, however, populations were concentrated in large cities that were beginning to reach the required carrying capacity, though despite their densities, communicable diseases had remained virtually absent. They were therefore highly vulnerable to the new infectious diseases brought by the Europeans (Diamond, 1997; McNeill, 1977; Fenn, 2002). Between 1519 and 1620, it is estimated that Mexico's population declined from 28 to 1.6 million due to waves of measles, smallpox, typhus and influenza. In subsequent centuries, new diseases arrived. African slaves introduced yellow fever to the New World, and in a disastrous series of outbreaks in the mid-18th Century New Orleans and Memphis lost half their populations to the disease. As these diseases wiped out the Amer-Indian population, the areas were subsequently settled by African populations, whose immune systems were adapted to both yellow fever and malaria (Hunter, 2003; McNeill, 1977).

Illiffe (1995) contends that waves of epidemics wiped out much of North Africa's population so regularly that the conditions of economic progress could never be established in that region. During the 4th Century, twenty waves of bubonic plague in Egypt reduced the size of the population by 50-75 percent. Similar epidemics decimated other settlements in North Africa, undermining its dominance of trade and economic activity across the Mediterranean. The rise of prosperity in Egypt and Algeria in the 19th Century can be traced to the disappearance of the plague (the reasons for which are not known), vaccinations against smallpox and the resulting rise in population.

3. The Costs of Morbidity and Mortality

All forms of ill-health bring costs of one sort or another in their train, the nature and burden of which depend heavily on two factors: first, whether the ailment in question proves to be fatal to those who suffer from it, and secondly, whether it is infectious. Although it is infectious diseases that concern us here, we begin by laying out the costs that arise from a single episode of individual illness or injury of any kind, restricting attention to that individual. Only then do we extend the account to deal with what happens when the individual can communicate the disease to others.

In sorting out the various effects, it will be helpful to consider two extreme examples. A young, unmarried woman twists her ankle so badly that she is confined to bed for a week, but she then makes a full and rapid recovery from her injury. The resulting costs are of broadly three types. Her absence from her job entails a fall in the value of output. Treating the injury makes a direct claim on resources, in the form of a visit to the emergency room for x-rays and a bottle of ibuprofen to relieve the swelling and pain. Thirdly, there are what can be thought of as the intangibles, in this case, the misery caused by the pain and the loss of a weekend of leisure among friends. Who actually bears these costs – it bears emphasizing that they must be borne by some party or other – depends on her insurance coverage from public and private sources. In most affluent economies, she will be granted sick leave with pay and her employer will lose the value of her output for the week. The whole, or at least the greater part, of the costs of treatment will usually be covered by insurance, either private or public; but the intangible costs of illness and disability she must bear herself.

Now consider, in contrast, a married male in his mid-thirties with two small children, who suffers a heart attack so massive that he is unable to resume working at all before he succumbs to a second and fatal one. All of his future output, dating from the time of the first attack to expected retirement, with a suitable adjustment for ‘normal’ morbidity and mortality during that span of life, is thereby lost. The long treatment in the intensive care unit after the first attack, the extensive efforts at rehabilitation that followed and the final, vain effort to resuscitate him after the second attack are correspondingly expensive. The only ‘saving’ under this heading is the expected costs that would arise from the treatment and care of his ailments in old age, which he fails to reach, and the pay out of social security earned at retirement. The costs of the intangibles are no less sobering. The physical pain is accompanied by his inner struggle to come to terms with the prospect of an early death and what that will mean for his spouse and children. For them, there is not only the grief at his death, but also the enduring loss of his love, companionship and particular contribution to family life and child-rearing. Insurance arrangements might suffice to cover the first two, but cannot, in the nature of things, fully deal with the last.

These examples illustrate the importance of the family as an institution for, among other things, the pooling of resources. Even in a welfare state, membership in the family carries with it advantages and burdens that the larger society cannot fully smooth out. If the lost

earnings and the cost of medical treatment are not fully covered by insurance arrangements, then one individual's illness will directly and adversely affect the well-being of other members, particularly the children, whose formal education may well suffer. Yet even if the available insurance arrangements can eliminate these particular direct effects at the level of the family and the family itself is willing to pay the requisite insurance premium, the intangible costs will still remain. In the second example, it is perhaps the children who stand to lose most. This applies, *mutatis mutandis*, with undiminished force if the mother were to die early. These inter-generational effects imply that premature mortality among parents does potential long-term damage that goes well beyond the calculations involving their own lost earnings and the costs of treating their final illness, regardless of whether that illness is an infectious one.

With an eye on the sections to follow, it will be useful to formulate the elements of the above discussion in a somewhat more general way. As a reference case, one can think of an 'ideal' trajectory, along which the individual enjoys robust good health throughout an untroubled childhood, a long and productive working life, and a full old age, and then dies suddenly and peacefully in an armchair. Each episode of illness disturbs this trajectory in some measure, perhaps catastrophically. The episode may have no lasting effects; or it may so damage the individual's constitution as to increase the chances of various illnesses in the future, possibly with a fatal outcome; or it may itself be fatal. Depending on its nature, it brings with it one or more of the immediate effects set out above, to which must be added the *expected* value of the future costs that will arise if the present episode increases the chances of illness in the future, as happens, for example, when a childhood illness arrests the development of an organ.

What additional considerations come into play if the disease is infectious? The immediate consequence is the risk that the sick individual will infect others, who will go on to propagate it in their turn. There is therefore a further chain of *expected* costs, whose magnitude depends not only on the damage the disease does to each individual, but also on the probability that it will be transmitted. So long as that probability is at all positive, the illness is not a purely private matter for the infected individual and those of the immediate family who share in a common economic fortune, as set out in the second example above. Rather, the infection has a certain *public* character, in that the infected person can, wittingly or otherwise, transmit the disease to others without their consent or even without their knowledge. Any case of a

communicable disease therefore generates, at least potentially, negative externalities. If transmission does occur, the parties contracting the infection will often become aware of the fact only after the event, and no doubt would have rejected the transaction had they been aware that it was ‘on offer’ at the time. The very fact that the threat of transmission exists will itself cause costs to arise, to the extent that measures are taken to ward it off.

Thus far, we have implicitly treated the aggregate costs of morbidity and mortality as the sum of the costs arising from individual cases, the timing and number of which depend on the prevalence of (infectious) diseases and the age structure of the population. This procedure is not fundamentally invalid if everything is correctly measured, but it does raise the question of how prices – and especially factor prices – depend on the levels of morbidity and mortality. In order to pursue this question, we suppose that there is some prevailing, ‘normal’ pattern of morbidity and mortality in the population, which provides the necessary benchmark. A single, additional case of a disease causes a very small disturbance to this pattern, and hence will have a negligible effect upon current and future prices – unless it arouses the suspicion that many more cases will follow, a possibility we shall take up in a moment. An actual epidemic, in contrast, produces a measurable change in overall morbidity and mortality, however temporary. The associated effects on the structure of relative prices depend not only on its duration, but also on which age groups suffer most.

An epidemic among children has no immediate effect on economic output, fully measured, though resources will surely be diverted from other uses to treat and care for them. Gross domestic product could therefore fall in the short run, as parents stay away from work to devote more time and energy to their stricken children. There can be long-term effects on the aggregate supply of labor and skills if the epidemic is a long one and fertility does not rise to ‘replace’ those children who die, or if some of those who survive are left mentally or physically weakened by the encounter.

An epidemic among young adults has wider and more profound consequences. As the illness takes hold, there is an immediate reduction in the supply of labor, but without any attendant effects on the stock of physical capital in all its forms; so that the wage rate will tend to rise unless there is a sufficiently large pool of unemployed workers. Disability or death will make reductions in the supply of labor permanent. An increase in mortality in this group is also very likely to lead to lower fertility, and hence to a smaller labor force in future. The other

channel through which such an epidemic can affect the long-run supply or quality of the labor force is through its effect on the formation of children's human capital. The end result is a reduction, not in the size of the future workforce, but rather in its quality. Determining what happens to the accumulation of physical capital is a complicated matter. Higher mortality among young adults and the lower fertility that attends it will reduce the rate of growth of the labor force. At the same time, a marked and prolonged increase in morbidity will very likely divert savings away from investment in all types of capital into treatment of the sick; and the loss of lifetime family income will normally reduce savings. Hence, whether an epidemic of this kind brings about an increase or a fall in the level of physical capital per worker remains an open question.

An epidemic among the elderly has a direct effect on labor supply only to the extent that the elderly work or devote some of their time to caring for their grandchildren and their adult children's households, whereby the diversion of resources into treatment of those who fall sick also occurs. The magnitude of the long-term effects of morbidity and mortality among the old on labor supply and its quality will depend on the strength of two factors, which pull in opposite directions. There is the extent to which these contributions to younger households further fertility and the formation of human capital. At the same time, there are the claims of the old on resources, which compete with investment in human and physical capital alike.

To complete this brief account of the general workings of epidemics on the economy, two are particularly worthy of attention. If the scale and gravity of an outbreak are large and enduring, the whole structure of insurance arrangements could be burdened to the point of collapse. This applies not only to the capacity of the health system itself to deal with a flood of the sick and dying, but also to the very institutions that provide public services and other forms of health insurance. Affluent societies, with adequate public revenues, are better placed to deal with such a shock than poor ones, which rely heavily on the extended family and local communities for support in times of difficulty. The collapse of these institutions could well result in very large economic and social costs indeed.

An outbreak of an infectious disease does not have to occur on a grand scale, however, in order to produce large economic effects. For economic activity depends heavily on expectations and psychological sentiment, the formation of which can, in turn, be very susceptible to reports of a disease outbreak. It may take a while, depending on the nature of

the disease and the location of the outbreak, before the true scale of the threat becomes clear; so that expectations in the interim can err in both ways. Should the appearance of a new disease or a new variant of an old one prove to have grave and enduring consequences for morbidity and mortality in a population, the associated risks will eventually be embodied in the population's expectations and hence in its members' decisions concerning the allocation of resources. Erroneous or not, expectations play a central role.

4. The Economic Impacts of Four Epidemics

The economic impacts of epidemics are broad ranging; some of them are quantifiable, but many are not. The relationship between the costs inflicted on individual households and those on the society in aggregate can vary considerably across epidemics, as can that between the direct and indirect costs, and that between the long and short term effects (Lewis, 2001). The historical context also matters. Demographic factors played a decisive role in determining the general level of economic activity during medieval times, whereas modern epidemics occur in a world with instant information, and so can affect business confidence even when the attendant death toll is small and far away. Other key influences are the nature of the disease, the duration of the epidemic, and the socioeconomic groups affected. For reference, Table 1 summarizes key characteristics of five major infectious diseases that have left their mark on societies: HIV/AIDS, influenza, bubonic plague, malaria and SARS.² This section pieces together the experiences of four of them to arrive at general conclusions.

4.1 The Black Death

The plague that swept through Europe between 1347 and 1351 changed the social and economic face of the medieval system and proved to be a major event in European history. In carrying off a quarter to a third of the population, it also constituted a (grim) natural laboratory experiment, the lessons from which are still being drawn.

Economic and demographic developments in the previous two centuries had left the entire system vulnerable to an external shock. A warming of the climate that had begun early

² Diseases of historical importance that have been eradicated (smallpox) or can be controlled through immunization (yellow fever, hepatitis B, typhoid), better hygiene (typhoid, TB) and simple treatments (cholera) are not included, but possess some of the same characteristics as those in the table. In many cases these diseases, as is true of the disease in the table, reoccur, usually due to lapses in surveillance, lax interventions once identified, or simply mutations or adaptations of the infectious disease agent.

in the 12th Century – there is evidence of viticulture in Yorkshire, for example – led to improvements in yields and a substantial increase in the population. There were only very modest improvements in underlying technology, and marginal lands were increasingly brought under the plow. Another qualitatively important change in this period was the growing numbers of town-dwellers, who depended on transported grain and so were at greater risk of suffering malnutrition and disease when food was in short supply. Towards the end of the 13th Century, the cooling phase of the climatic cycle set in, and the first two decades of the 14th Century were marked by cold, wet weather and poor harvests. Food scarcity and starvation followed the famine of 1315-1317, leaving the population susceptible to disease. The grain monoculture and the failure to invest in community granaries for the storage of surpluses for lean years exacerbated these problems. A decline in marriage rates and high morbidity led to declining birth rates and rising infant mortality (Genicot, 1966). Even before the Plague arrived, Europe's total population had retreated by about ten percent from its peak at the close of the 13th Century. The population was not only pressing in on the means of subsistence, but it was also seriously weakened by malnutrition and other diseases. With no immunity, it offered fertile territory to the Plague pathogen.

Other factors were to propel the epidemic's advance after its outbreak. By some accounts, black rats, upon which the infected fleas fastened and feasted, had proliferated in the preceding years. They were also – and remain – inveterate stowaways. This habit was to be particularly significant; for economic expansion in the previous two centuries had naturally given a strong impulse to international trade. There was a dense network of trade routes in the Mediterranean, and the passage through the Straits of Gibraltar allowed ships to carry cargoes – and rats – from the Mediterranean to ports in the British Isles and Northern Europe, whence the plague was to spread rapidly inland. Perhaps more significant still was a development on the biological front: the pathogen also mutated. From bubonic plague, which is transmitted by flea bites, arose pneumonic plague, a form transmitted by sneezing and coughing, a far more efficient and deadly means of transmission among humans.

By the time the first wave had run its course, Europe had lost about a quarter to a third of its population, the proportion generally rising as one goes north. Even within regions, however, the severity of the blow was uneven: in Italy, mortality ranged from 50-70 percent mortality in some places (Siena lost three-quarters of its population) to 15-20 percent in others.

There is some fragmentary evidence that those who were poorly fed were more likely to be affected; but Cohn's (2002) careful research suggests that all age- and income groups were equally affected. In subsequent waves, which were to recur periodically for the remainder of the century across Europe³ and North Africa, the plague became increasingly a disease of children (Cohn, 2002)⁴, with modest demographic effects.

The ensuing upheaval also dealt the feudal system a blow from which it never recovered. Whole villages were depopulated, marginal land returned to scrub and pasture, the value of land plummeted, the marginal cost of agricultural production declined, and food supplies became more plentiful. The apparatus that had tied the serf to his lord's manor was gravely weakened, and many feudal holdings were broken up due largely to the shift to more modern contractual arrangements. Surviving tenants had the choice between taking on additional leases and moving away. Those without the means to cultivate could migrate to jobs in other villages and in the towns, where labor shortages expanded employment opportunities (Genicot, 1966; McNeill, 1977; Hirschleifer, 1987).

In a recent paper, Clark (2003) analyses the plague's effects on the course of factor prices (of land, labor and capital), and productivity. His findings suggest that while real wages indeed rose after 1350, the return on capital declined (although this was a continuation of a long-term trend that began before the onset of the plague). Land rents fell somewhat and then fluctuated around this lower level. Clark goes on to show that the direct, longer term impact of the Black Death on the level of productivity in Europe was negligible. It was not until the 1600s that the signs of 'modern' growth appeared, due in large part to technological advances and the concomitant rises in agricultural productivity. These were unrelated to the plague. Hirschleifer (1987) attributes economic stagnation to recurrences of the plague over the

³ During the second half of the 14th Century, London had 20 separate outbreaks of the plague (Genicot, 1966; Cohn, 2002).

⁴ Cohn (2002) in his recent, meticulously researched book on the Black Death raises questions regarding the nature of subsequent bouts of the plague, and in particular whether they were indeed Bubonic or Pneumonic Plague. He notes that in these later episodes, numerous physicians claimed success in treating the disease, something that was not true of the first wave. Finally, he poses the conundrum of why the plague mutated in some places to a pneumonic form, but not in others. He contends that the subsequent waves involved an entirely different infection that was improperly diagnosed, but was assumed to be a resurgence of the plague that hit Europe in 1347.

subsequent century, and secondarily to continued wars on the continent, notably the “Hundred Years War” between England and France.⁵

4.2 The Influenza Epidemic of 1918-19

The exact origins of this virulent strain of influenza are not clear. What is known is that it swept across the globe in three waves – the second of which, in the fall of 1918, was the most deadly – in the space of a year or so, making hundreds of millions sick and sending 40 million or more to their graves (Potter, 2001). This severe shock turned out to be very short-lived, however; two years after the first recorded outbreak, the virus had disappeared.

The pattern, incidence and mortality of the epidemic in the U.S. have been the subject of some study. Initially characterized by U.S. public health officials as “only influenza”, the military congregated army recruits in Army camps prior to shipping them off to Europe. The disease killed many soldiers before they ever reached Europe, and it spread rapidly upon their arrival (Barry, 2003). By the time the epidemic had run its course, one quarter of the U.S. population had contracted the disease and 675,000 (0.66 percent of the total population) had died. Influenza usually carries off children and the aged, and many of them did indeed die. A salient feature of the 1918-19 strain, however, is that it caused an especially sharp rise in mortality among adults in their prime years (ages 15-44), so that the age-specific mortality profile temporarily assumed a ‘W’-shape.⁶ The inner ‘spike’ was especially sharp among adult men, a fact that has been attributed to higher rates of latent tuberculosis among males. The aggregate result was an abrupt decline in life expectancy at birth of about 12 years for both sexes, followed by a rapid recovery, especially among males (Noymer and Garenne, 2000).

Despite the absolute scale of the mortality, this epidemic has not received much attention from economists. Recently, Brainerd and Siegler (2003) attempt to assess its effects on the U.S. economy using one measure of performance, namely, the growth of real per capita income. They employ so-called growth regressions, exploiting the fact that data are available on death rates due to influenza and pneumonia (a very common complication) in thirty states

⁵ Bloom and Majal (1997) analyze wage fluctuations and their impact on economic growth in England and France, and find no significant effects of the Great Plague on output. However, their analysis was constrained by small sample size and the results are inconclusive.

⁶ This feature was also found in all other populations for which there are reliable records (see Brainerd and Siegler, 2003, p. 6).

for the period 1918-19. These data are combined with a variety of economic variables, chief among them the initial level of real per capita income. As the authors note, the data are not ideal for this purpose. The levels of real per capita income in this disaggregated form are available for the two time-points 1919-21 and 1930. Since the outbreak occurred in 1918, what is really needed are data for the immediately preceding years. A confounding factor is the short recession in 1919 and the swift recovery that followed. The Great Depression, which started to take hold in 1930, rules out any examination of a longer span. Hence, Brainerd and Siegler confine their analysis to the medium run, with a decade as the unit of time.

Controlling not only for the level of a state's real per capita income in 1919-21, but also for a variety of other factors – its climate, population density, schooling, proportion of the foreign-born population, membership in the Confederacy and initial share of income derived from agriculture –, the authors arrive at a robust and statistically significant finding: the higher the death rate due to influenza and pneumonia in 1918-19, the greater the proportional increase in real per capita income between 1919-21 and 1930. One explanation is that the heavy, but short-lived concentration of deaths among the most productive age groups in 1918-19 caused an immediate reduction in real per capita income, a shock from which the level of the latter progressively recovered over the years that followed, and so resumed its earlier long-term path. The larger the shock, the stronger was the transient element representing the recovery. In the absence of data for the years leading up to the outbreak, however, it is hard to see how any explanation of the authors' main finding can be properly tested. What can be said is that, unlike the case of a full-blown AIDS epidemic, the shock was not only temporary, but also relatively small; so that there was little danger of the outbreak tipping the economic system into a different regime, a possibility that we take up in section 4.3 in connection with AIDS.

There are also two noteworthy studies of the effects of the epidemic on India, at that time an almost wholly agrarian economy. In the course of his classic treatise on backward agriculture, Schultz (1964) was concerned to demonstrate that, even in that setting, labor is almost always scarce, in the sense of having a positive marginal product. The epidemic offered a useful natural experiment to test this hypothesis, and the decennial census of 1921 was conveniently timed to permit a key part of the measurement. Schultz estimated that the agricultural labor force and output fell by 8 percent and 3.3 percent, respectively. In a more recent study, Bloom and Mahal (1997) examine the relationship between changes in the

acreage sown and the reduction in population across 13 provinces, and find none. It might be argued that sown area is a closer measure of labor inputs than output, the latter being more heavily influenced by the weather and growing conditions. "Sown area" in India, however, was (and still is) much more dependent on draft animals than field laborers, many of whom could turn their hand to the plow if needed. The basis of Schultz's (1964) findings is more persuasive, and we conclude that influenza did indeed have a negative effect on economic output in India.

4.3 HIV/AIDS

The HIV virus is thought to have mutated from non-human primates in Africa, perhaps around the middle of the last century. The virus strain made its way into human populations in parts of central Africa by the early 1970s. By the early 1980s, the disease was beginning to claim large numbers of prime-aged victims with such clear, common symptoms as to arouse the suspicion that a new and mysterious infectious disease had broken out. The first stream of cases in affluent societies began to appear among homosexual men, intravenous drug users and hemophiliacs in the 1980s. It was only after the virus had been identified in 1984 that its modes of transmission and the progression of the resulting disease known as AIDS to certain death became fully understood. Two decades later, the pandemic has assumed alarming proportions. According to UNAIDS (2003), 38 million people are infected, 3 million are dying annually, and 4.8 million new infections (630,000 of them children) occur each year. The cumulative death toll has reached at least 25 million worldwide, and AIDS has killed more people than any other communicable disease over the last two decades.

The course of the illness in an infected adult is insidious, long and ultimately fatal, with a median time between infection and death, if untreated, of about a decade. The onset of symptoms signals a phase of increasingly severe morbidity, which can be treated through a constant, rigorous and carefully monitored regime of anti-retroviral therapy (ART) and treatment of opportunistic infections. As a sexually transmitted disease, HIV/AIDS has struck mainly young adults, whose premature deaths are leaving behind an ever-growing number of orphans. Some of their children are destined to suffer what is arguably a still crueler fate. A newborn has about a 30 percent chance of contracting the disease at birth if the mother is sero-positive and Nevirapine is not administered pre-natally. The threat of transmission continues

with breast-feeding. With an immature immune system, infected infants typically die within a couple of years in the absence of extensive and costly ARV treatment.

The microeconomic effects of the epidemic are both evident and, to a substantial extent, measurable. Individual households are severely affected when they must cope with the consequences of sick, debilitated and dying family members. The rising burden of health-care costs and the declining productivity of adults, who are the breadwinners and family managers, combine to bring the household into acute financial difficulties (Bloom and Majal, 1997; Lewis, 2001). The death of one or more adults results in a drastic loss of lifetime family income and perhaps the dissolution of the household itself. To the extent that other families help out financially or take in the children, the burden is spread, but not diminished.

As argued in Section 3, there are also the more subtle, but potentially very important, long-term effects on the formation of human capital, as the children lose the love, guidance and support of one or both parents. These elements of child-rearing complement and often promote formal education, and those children who lack them are arguably ill-equipped for independence or the working world. Some recent empirical work supports the view that these adverse effects are indeed substantial. A study of Indonesian children shows that orphans are less healthy, less likely to go to school, and overall less prepared for life (Gertler, Levine and Martinez, 2003). In a comparison of 19 African countries, Case, Paxson and Ableidinger (2003) find that orphans live in poorer households and are significantly less likely than non-orphans to be enrolled in school. The sheer scale of orphan-hood caused by AIDS is becoming rather daunting. As of early 2003, 12 million children in Sub-Saharan Africa, a sizable part of the cohort on which Africa's future depends, had lost at least one parent to AIDS (UNAIDS, 2003). According to another estimate, 12-20 percent of children under the age of 15 in Lesotho and Swaziland will be orphaned by 2010 (Haacker, 2002).

Morbidity and mortality among young adults and those in their prime years also affect firms. Business costs rise due to the high personnel turnover caused by AIDS, though Haacker (2002) concludes that the effects on productivity and output in southern Africa are not empirically clear. He does argue that the health sector will be put under severe strain, as the cost of treating AIDS patients and their associated opportunistic infections rises dramatically and members of already strapped medical staffs themselves succumb to AIDS. Expenditures

on such treatments are expected to double in the next few years, with all that entails for the government's budget.

At the level of the entire economy, various efforts to pin down the epidemic's direct, aggregate effects on economic activity have revealed at most only a modest impact, especially in the short to medium term. Indeed, most attempts at macroeconomic modeling in the 1990s yielded virtually no economic effects at all (Bloom and Majal, 1997; Lewis, 2001). In view of the fact that the scale of morbidity and mortality has remained relatively modest in many countries until very recently, that is not wholly surprising; but there are now clear hints of damage in the making. Arndt and Lewis (2000), for example, estimate that between 1997 and 2010, the AIDS epidemic in South Africa will reduce that country's GDP by 17 percent and its per capita income by about 8 percent (or about 0.6 percent annually). There would be little effect on the scarcity of low-skilled workers, however, because initial unemployment levels among that group were already high at the start. MacFarlan and Sgherri (2002) model the likely macroeconomic impacts of AIDS in Botswana and conclude that the growth rate of GDP in the non-mining sector will slow by a third or more between 2000 and 2010 due to expected reductions in labor productivity and capital accumulation, these stemming in part from a decline in the experience and skills of formal sector workers. A heavy fiscal impact from higher health spending is also projected.

Over the long run, the effect of AIDS on per capita income will make itself felt both through its destruction of existing human capital, a good part of which takes the form of experienced workers, and its weakening of the mechanisms through which new human capital is accumulated. Many countries have already lost a significant number of their highly educated citizens, and the prospects remain grim. The longer term effects of a prolonged and severe epidemic are likely to be both very damaging and broad, as investment in the human capital of orphaned and needy children falters. These ramifications will take decades to make themselves felt in full, not only because of the slow progression of AIDS (see Table 1), but also because 15-20 years must pass for the knock-on effects to be evident in the children of its victims. When they reach full force, they could be devastating if the current course of the epidemic in Southern Africa continues unabated (Bell, Devarajan and Gersbach, 2004).

4.4 SARS

Measured by the yardstick of global mortality and morbidity, SARS must be judged unimportant. Yet its economic consequences, though short-lived, were not trivial. They stemmed from both the stern public health measures undertaken to contain the epidemic – somewhat paradoxically – and the volatile changes in expectations before it became clear that the outbreak was under control and the need for containment was temporary. Media coverage also fueled concerns, making the outbreak an international event that effectively scared individuals, governments and businessmen alike.

In February 2003, the Chinese Ministry of Health reported 305 cases of “atypical pneumonia” to the World Health Organization (WHO), but indicated that the outbreak was under control. By the following month, cases exhibiting the same symptoms were reported in Hong Kong, Vietnam and other East Asian countries, and epidemiological surveillance experts from WHO and its member countries were attempting to contain the spread of what was clearly a communicable disease, which WHO had by then christened Severe Acute Respiratory Syndrome (SARS).

From November 2002, when the first cases occurred in Guangdong Province, until July 5, 2003, when WHO announced that “the last chain of transmission was broken”, a total of 8422 probable cases, 916 of them fatal, were reported from 29 countries. While China reported the largest percentage and number of cases (5327), the incidence rates among the population were highest in Hong Kong and Taiwan due to their much smaller populations and extensive contacts with China. The crude case fatality rates (CFR) ranged from zero to 50 percent, depending on the location, age and health of those infected, with most countries’ CFRs in the 10-17 percent range. The elderly were particularly susceptible. In Canada the crude CFR was 16.7 percent, but 83 percent for those over the age of 60. The contrast was scarcely less dramatic in Hong Kong: the CFR for those under age 25 was zero, but 52 percent for those over age 65. Although the numbers of cases were relatively small, particularly in some countries, there is the generally consistent finding that age and poor health were among the most important factors in raising the risk of mortality (WHO, 2003). The other at-risk group was health workers, who made up 18.2 percent of the reported cases in China and almost half of those in Canada. SARS was very much an occupational hazard.

The disease was first transmitted via food handlers (who obtain and butcher animals, sell their meat, or prepare and serve food), and subsequent transmission occurred primarily among individuals in close contact with infected patients in hospitals, hotels and households. The pattern of infection reflects the mode of transmission, namely, through infectious, respiratory droplets that enter mucous membranes (eyes, nose and mouth), so that others within a radius of a few meters of an infected individual are at risk. The infectiousness of the disease is illustrated by the fact that a single case in Guangzhou city resulted in transmission in two hospitals and 82 new cases (*ibid.*).

The rapid epidemiological response led not only to a very successful campaign to contain the outbreak, but also to a strikingly early discovery of the pathogen. Within a matter of a few months, Canadian researchers had identified it as a corona virus, linked the agent to animal populations, and decoded its genome structure. Until the appearance of this variety, corona viruses had been associated with mild illnesses that posed a minimal threat to humans. The transmission from animal to man likely followed the familiar path of an animal virus mixing with a mutated human virus, a common occurrence in influenza and other airborne diseases (WHO, 2003). If the disease is indeed zoonotic (transferred from animal to man), the virus will remain in animal reservoirs, where it may mutate and strike again.

Travel bans were put in place for the major affected areas in April – China generally, led by Hong Kong and Guangdong Province, and other cities in Asia and North America followed, often on the heels of WHO's designation as an epidemic city. Almost half the planned flights to Southeast Asia were cancelled during the month of April. Total arrivals declined by about two-thirds over the course of the crisis (Siu and Wong, 2003), with corresponding effects on related parts of the economy, mainly hotels, restaurants and even shipping. Business deals and arrangements were also postponed. Many of these transactions involve inherently perishable goods, such as a hotel room or a passenger seat, the use of which cannot always be made up through mere postponement. In Hong Kong, both restaurants and retail trade are particularly heavily dependent on tourism, which declined by 10-50 percent over the period, with ripple affects throughout the economy, including a 50 percent drop in retail sales. Across the entire region, tourism declined by 20-70 percent.⁷ At the height of the

⁷ Even in unaffected Southeast Asian countries (e.g., Thailand, Malaysia and Indonesia), tourism declined 15-35 percent (World Bank, 2003).

epidemic, visitors and tourism declined 80 percent in Taiwan and almost as much in Singapore (Siu and Wong, 2003; Hanna and Huang, 2003; World Bank, 2003; Oxford Economic Forecasting).

The effects were also felt in other branches worldwide. For example, Advanced Micro Devices Inc., a leader in technology, suffered a drop in revenues, posted losses over two quarters and faced a precarious cash flow situation, all due to SARS (Ojo, 2003). Nor should the supply side of the story be forgotten. In Taiwan, nearly a million people were quarantined in mid-May, and the inhabitants of many large cities in East Asia responded to the threat of infection by staying at home voluntarily. Removing the related effects of the Iraq war, SARS cost the region nearly \$15 billion, or 0.5 percent of GDP.

A less readily measurable, but arguably more serious, impact was caused by faltering business confidence. Investors dislike uncertainty, and the uncontrolled outbreak of an unknown disease makes the investment environment an uncertain one, in the sense that the associated risks are not clear. In the early phase, the perceived inability of the Chinese government to identify and contain a highly infectious disease surely generated uncertainty in this sense, and the widely reported deaths of nine foreign businessmen who had visited China provided subjective reinforcement. The premium on financial instruments for China-related investments provides a quantitative measure of the shift in confidence. The Eurobond spreads in China declined precipitously, from 140 in early April to around 40 in August, suggesting wavering business confidence (Brahmbhatt, 2003; Hanna and Huang, 2003).

International investors had good reasons to become particularly wary, for the initial bungling and attempts to cover up occurred on top of the Chinese government's other failures in the realm of corporate governance and regulatory transparency. These are just the actions that undermine investor confidence, and so deter foreign direct investment – an important matter in China, where roughly 55 percent of industrial production involves foreign investment. The unfolding of events raises longer term questions about the reliability and predictability of conditions in China, and by extension other Southeast Asian economic partners. Perceptions matter in business, and once established, may be hard to change.

4.5 Summary

Two of these four epidemics, namely, Spanish influenza in 1918 and SARS in 2003, broke out suddenly, spread rapidly and then petered out in less than a couple of years. They had very limited macroeconomic effects in relative terms, as the impact on aggregate mortality was relatively small. Even though the former killed 40 million people worldwide, and so caused great individual suffering, with some households and communities incurring dramatic economic losses, it was still a small event when viewed globally.

The first wave of the Black Death in the 14th Century was also short-lived, but it carried off about a third of Western Europe's population, and its recurrence over the subsequent century slowed economic growth and took a significant toll in mortality. A final judgment on whether HIV/AIDS will rival the Black Death in this respect cannot yet be made. Viewed globally, the scale of associated mortality is small, though it has already produced a dramatic increase in deaths in Eastern and Southern Africa. The long-term character of the disease, the pattern and pace of the AIDS pandemic, its concentration among normally productive young adults and its undermining of long-term human capital formation all distinguish it from the other epidemics discussed here. If the African experience is repeated on other continents – most threatened are Asia and Eurasia – the economic damage will assume grave proportions

Sustained epidemics, or diseases that become endemic with high levels of prevalence, appear to constrain growth. Medieval Europe, for example, functioned in an endemic disease environment where outbreaks of disease came and went with some regularity, killing large swaths of the population. By the turn of the 14th Century, stagnation had set in. On the other hand, it can also be argued that the Black Death transformed medieval Europe in a positive way over the long term by undermining the economic, political and social status quo, thereby opening up new opportunities and establishing some of the preconditions for growth.

5. Public Policy: Prevention and Response

Advances in knowledge about, and measures to contain, infectious diseases placed public health at the center of public policy-making. Public health so defined encompasses the epidemiological, demographic, administrative, and other instruments of intervention needed to keep disease at bay. In this connection, it is clear from the discussion in section 2 that efforts to combat endemic communicable diseases heavily overlap those needed to combat epidemics.

For some measures that influence the prevalence rate in a steady state also influence both the probability that an epidemic breaks out and, should it do so, its subsequent course.

An analogy may be helpful. Building codes can influence both the probability that a fire breaks out and, if one does so, the speed with which it spreads and the chances that those inside at the time will escape unharmed. The communications network in the building will also raise the alarm in the local fire stations, and the fire crews will set out to rescue those still inside and bring the blaze under control. Now suppose smoking in buildings is banned and stringent standards for electrical circuitry are introduced. Both measures are purely preventive, in the sense that they affect only the probability that a fire will break out. Superior sprinkler systems and fire-retardant materials, while they do not prevent an outbreak, are still preventive measures in that they reduce the expected magnitude of the losses in the event of an outbreak; and the superior sprinkler system also provides an active response, in that it may douse the fire or at least keep it under control until the fire brigade arrives. Providing firemen with better training and equipment can be thought of as an improvement in the means of ‘pure’ response. All these belong in the arsenal of measures to deal with the hazard of fire, even though some of them are put into effect only when a fire breaks out.

Returning to communicable diseases, the large and mobile populations of the modern world are inherently at risk. The provision of clean water and sanitation, the vigorous implementation of vaccination programs, the control of disease vectors, and the promotion of health education are all essential both in preventing outbreaks and in containing them should they occur. Two key components of public health systems complement these measures: first, an epidemiological surveillance apparatus to spot outbreaks and track the patterns of their spread; and second, the capability to respond immediately to an outbreak, both in identifying and managing its course. Effective implementation of these measures requires continuous and comprehensive monitoring, preparation for action and the resources to act when needed – including the imposition of isolation and quarantine. Not only are they vital to the well-being of populations and to securing high levels of economic activity, but they are also relatively inexpensive: in the U.S., for example, just 1 percent of all public spending on health is allocated to public health.

5.1 Public Health

It is instructive to begin with some historical examples of government action. When the Black Death was at its peak, many communities simply dissolved into chaos, but others took concerted measures. Some Italian cities established public health commissions, which were charged with a variety of functions: to quarantine (*quarante die*, or forty days) individuals thought to be infected, to cordon off infected areas, to inspect incoming traders, travelers and food, to collect data, and to handle the needs of affected families. In some communities, they had powers to seize property, fumigate houses, set curfews and the times for public meetings, to name a few highly intrusive measures (Cohn, 2002; Hunter, 2003). In the second half of the 18th Century, sanitation engineers recognized the link between infectious disease and contaminated water. The Thames embankment, for example, not only eliminated the threat of malaria, but also made it possible for diseases such as cholera and typhus to be brought under control. All these actions belong in the armory of measures available to modern governments.

These newly controlled diseases also led to a series of international sanitary conferences starting in the mid-1800s, and resulted in a set of international health regulations that by 1951 were embodied in the charter for the creation of WHO. SARS has given new impetus to planned revisions in these regulations for the new century, and some of the key lessons learned from that epidemic – use of syndromes not specific diseases to trigger action, accepting reports from official as well as private sources, and specific authority for WHO to act when governments fail to do so – provide a platform for significant updates.

The 1918 influenza epidemic brought more public health improvements, notably new or revamped public health laws in many countries. It also served to strengthen the health aspects of the League of Nations debates.

Advances in medicine have led to still more effective interventions to stem the spread of infectious diseases, principally through the ability to identify the agent, to develop vaccines and to treat those who fall sick. At the same time, well-chosen combinations of old and new measures are often essential. Information, outreach, tracking of partners and treatment are all vital in controlling sexually transmitted diseases. The spike in TB in New York prisons, for example, alerted public health officials to the likely presence of HIV/AIDS among prisoners, and hence the need to check the spread of both TB and HIV/AIDS among the incarcerated and so hinder their eventual transmission into the general population.

The virtues of a well-functioning system of public health are nicely illustrated by what happened in the SARS epidemic. When a new, communicable pathology arises, isolating and quarantining patients is required while efforts are made to track those who have been in contact with the infected, and to trace the nature and source of the disease. In China none of this was done. Raised in a political and bureaucratic culture that discourages the reporting of problems, public health officials only very reluctantly raised the alarm, and the physician who did so was jailed. The failure of information to flow between provincial and national levels, the absence of epidemiological surveillance, and the slow response of the authorities to an apparently new pathogen allowed SARS to spread, first in China, and then beyond its borders. The Global Meeting on the Epidemiology of SARS, which was convened by WHO, endorsed standard public health practices quite unambiguously: “early case identification and isolation, vigorous contact tracing, voluntary home quarantine of close contacts for the duration of the incubation period, and public information and education to encourage prompt reporting of symptoms” (WHO, 2003). In doing so, it also delivered a rebuke, however indirectly, to the Chinese government.

The timely involvement of WHO, the US Centers for Disease Control and Prevention (CDC) and other entities with experience and expertise led to measures that averted a broader and more serious crisis. These measures also had the immediate economic effects discussed in section 4.4 – the burden of which was relatively modest and fell mainly on China itself.

But perverse effects have followed in the wake of SARS as well. The media coverage portraying China as unable to control a raging communicable disease, combined with wavering business confidence in the wake of SARS, has led to China’s almost exclusive focus of its public health resources on epidemic response activities. Consolidation of staffing in units devoted solely to epidemic management has been achieved at the expense of both basic public health maintenance functions and chronic disease management (Yach, 2004). Nonetheless, the success in epidemic control, once the world was alerted, offers a success story. Current actions simply bode poorly for future threats, and suggests that the public health lessons have been only partly internalized.

In contrast to the success in dealing with SARS, progress in stemming the HIV/AIDS epidemic has been uneven. This troubling fact owes much to the latter’s distinct nature, and it reveals a pressing need to bring the tools of public health to bear on the problem in a more

effective way than hitherto. Operating on behavioral factors is of paramount importance in preventing new infections. For unlike cases of SARS or influenza, whereby infected individuals can be kept from coming in close contact with the healthy population through temporary isolation and quarantine, individuals infected with the HIV-virus are infectious for life. Effective quarantine therefore amounts to lifelong house arrest. This may be a feasible policy at the early stages of the epidemic, but it raises thorny ethical issues. At later stages, the numbers of individuals will be so large as to make it impractical. With this measure ruled out, others assume greater importance.

One major lesson of the last 15 years has been the need to address directly and publicly the disease's existence, its modes of transmission, and the means to reduce the probability of infection; for the population's ignorance of such things is the greatest barrier to its containment. Some governments have been reluctant to launch full-scale public awareness campaigns, or even to target high risk groups, due to what are often dubbed cultural sensitivities associated with sexual matters. Proposals to distribute condoms and make clean needles available to intravenous drug users (IVDU) have often met with similar stonewalling. Brazil and Thailand are notable exceptions. Preventive measures in the form of intensive campaigns, the aggressive promotion and distribution of condoms, clean needle exchange programs, and the targeting of high risk groups with information, counseling and testing have enabled both countries to limit the spread of the disease and to focus resources on treating those already infected. A number of other countries are catching up with these public health leaders.

The experience in Africa has been mixed, with Uganda in particular an outlier, having established an early, effective intervention program. Figure 1 provides a vivid contrast of Uganda's relative success with disease control, and the fruits of inaction in Botswana, the former benefiting from effective and creative policies, the latter suffering from official denial of the problem – at least until very recently. Although the disease took hold earlier in Uganda, prompt intervention translated into a slowing of prevalence after peaking at just above 30 percent of pregnant women, the best indicator for tracking HIV/AIDS in the adult population. By comparison, following dramatic increases in HIV/AIDS infection for almost a decade, prevalence growth appears to be tapering off in Botswana, although it has already reached close to 45 percent of adults, the highest recorded level anywhere in the world.

Disease surveillance figures prominently in public health efforts to identify and control infectious diseases – indeed, successful and efficient prevention is scarcely possible without it. In the case of HIV/AIDS and other sexually transmitted diseases, surveillance requires blood tests, which are often carried out during pre-natal care. The debate over the ethical issues – the acceptability of universal blood tests for particular groups (in this case, for pregnant women), whether the mother should be informed of the results, and how follow-up should be managed – have raged for years. From a public health perspective, there is the presumption that public welfare takes precedence over individual rights. In developed countries, for example, the law requires that all children be vaccinated against communicable diseases to protect both the individual child and the public, especially other children. Administering blood tests for HIV/AIDS, and conveying the results and their implications to patients, should follow similar rules. In order to produce the public good in question, it is essential that the government have this knowledge and that those who test positive be informed – though it is also vital that individual privacy be strictly protected.

Counseling and testing pregnant women reinforces the messages of the general campaign in a personal way. Many of those found to be infected will be in the early stages, all those infected – and only those – will receive the medications that prevent transmission from mother to child, and these women will be in a position both to manage their illness and to prevent its further spread. Although these steps cannot unaided achieve all the lofty goals for public surveillance and individual behavior change, they are necessary components of an effective and comprehensive program.

Prevention is not only generally cheap; it is also the only effective means of stemming the AIDS epidemic in the long term. For although anti-retroviral therapies extend life for some undetermined period, they neither cure the disease nor do they render infected individuals non-infectious. The populous countries of China, India and Russia need to take these lessons to heart. All face the threat of an epidemic on the scale currently prevailing in Africa if they fail to confront this possibility; but the political will to grasp the nettle seems to be lacking, and prevention efforts are still minimal. The result could well be a truly appalling toll of deaths, and misery and impoverishment for the survivors.

5.2 Immunization

Another important tool for disease control is immunization, which prevents the transmission of a particular disease by rendering those immunized resistant to infection. To give an important historical example, those who survived smallpox developed life-long immunity, and others were indirectly immunized by contracting cowpox through tending milk cows.⁸ But for centuries the vast majority of the population remained susceptible to infection. The fact that immunity can be conferred through exposure to small doses of the smallpox virus from an infected individual was known in China in the 11th Century, even though the mechanism was not understood. This knowledge spread westwards to Europe, and subsequently to Africa and the Americas. Napoleon had his troops inoculate themselves against smallpox, as did Washington in his campaigns against the British (McNeill, 1977). By the mid-1800s, Egypt was relying on barbers to vaccinate 80,000 children against smallpox each year (Ilfie, 1995).

As the pathogens causing infectious diseases were steadily identified, systematic research into the development of vaccines became standard practice. Vaccines against the important diseases of smallpox, typhus, cholera, mumps, whooping cough, diphtheria, polio and, more recently, hepatitis have been developed. Although they vary in their degree of effectiveness and in the incidence and severity of their side-effects, none confers much more than a few years of substantial immunity. Even so, sustained immunization programs have served to reduce the incidence of communicable disease. Progress towards effective vaccines against malaria, tuberculosis and HIV-AIDS, the first of which poses no general threat to the populations of affluent countries, has been slow, although all three are targets for vaccine research. The prospects for a general AIDS-vaccine are also clouded by the tendency of the virus to mutate freely, but scientific efforts are being vigorously applied to the problem.

5.3 Welfare and Relief

The activities of the public health commissions established in Italian cities during the Black Death had to be financed by additional taxes. More importantly, the commissions' strong powers challenged the church and business circles alike, often curtailing the functions of both in the interests of preserving the health of the community. The commissions' actions restricted the movement of goods and people, thereby increasing the costs of trade and commerce. These

⁸ For much of their history, Europeans were in close contact with livestock animals, from which a number of infectious diseases originated (Diamond, 1997).

often draconian measures also highlighted the city's plight, and so further reduced its commercial transactions and trade with the outside world. The authorities in Milan and Florence backed the public health commissions in the interests of securing their cities' long-term economic health, and refused to capitulate to demands for looser policies that would have brought short-term relief to business (Hunter, 2003; Cohn, 2002).

The public relief measures took the form of the provision of food and goods, the burden of which was extensive where large portions of the population were poor. By any reasonable interpretation of the term, about three-quarters of medieval Europe's population were poor, and the taxes in question fell heavily on merchants and traders. New knowledge brought new options. Some governments embraced vaccination programs early in the 19th Century,⁹ and mass immunization campaigns were undertaken late in that century partly because they were a far less costly alternative to providing welfare after an outbreak.

The response to SARS is also instructive. At the height of the epidemic, Asian countries made various efforts to mitigate its impact on businesses and households. Hong Kong launched a package of relief measures with an estimated cost of \$1.5 billion, mostly one-time in nature, to tide companies over. The elements of the package included refunding of employment taxes, concessions on utility bills for both households and businesses, a three-month discount for tenants in public housing, short-term bank loans for hard hit sectors, and training and work-fare for the unemployed (Siu and Wong, 2003). Singapore offered \$132 million in relief to businesses that were especially affected, although this represents only about 10 percent of lost revenues. Taipei authorized \$1.4 billion to cover medical costs and business losses. China introduced price controls for SARS drugs, offered free medical care to farmers and poor urban residents who became infected, extended subsidies and temporary exemptions on personal income tax to medical staff treating SARS patients, and introduced subsidized credit for tourism and air transport companies. Even Malaysia and Thailand, which were not directly affected by the SARS outbreak, offered concessions to hard hit industries and pumped up government spending (Lee and McKibbin, 2003; World Bank, 2003).

⁹ By 1821, inoculation for smallpox had become mandatory in Bavaria, Denmark, Norway, Bohemia, Russia and Sweden; but many governments faced organized opposition from those who either "didn't believe" in the practice or found it a violation of their civil rights (Morgan, 2002). Today, most governments legally require immunizations, and prevent children from entering community programs, including schools, without them.

The Asian economic crisis of 1995 had exposed the regional governments' inability to deal with the effects of exogenous events. The SARS epidemic, while short-lived, prompted public sector efforts to cushion its economic impacts. Like the Black Death during the 14th Century in Europe, SARS raised the profile and functions of government in managing society through a major shock.

6. Conclusions and Policy Implications

By the mid-20th Century most of the pathogens that had plagued Europe from early recorded times began to be brought under control more widely. Vaccinations dealt with smallpox, measles and yellow fever, and general public health measures significantly reduced the incidence of dysentery, cholera and typhoid. Moreover, a whole range of drug therapies led to fewer deaths and shorter bouts of illness. The populations of what are now the OECD countries had become largely free of the more serious infectious diseases, the increasing control of which had contributed greatly to economic growth and welfare during the previous century – and at modest cost.

It is perhaps understandable that a sense of security, if not complacency, should have set in, and that with the apparent defeat of these old foes, the attention of affluent populations and their governments should have shifted to non-infectious chronic diseases, especially those of ageing, whose prevention is so much more difficult and whose treatment is relatively more expensive. The HIV/AIDS pandemic and the outbreaks of the Ebola virus and SARS have brought home the fact that new pathogens will continue to emerge, whether through the mutation of existing viruses or new transmissions from animals to man, even as final efforts are made to eradicate old ones. They reinforce the lesson of history that allocating resources to public health amply and consistently yields a very good bargain.

This conclusion holds especially in poor countries, where the burden of communicable diseases is high. Although the magnitude and nature of their economic effects vary, the returns to combating many of these diseases, even calculated on a narrow economic basis, are also high. For example, the control of onchocerciasis in West Africa led to the opening up of fertile agricultural areas to farmers who had previously been forced to subsist on marginal lands. The spread of HIV/AIDS in Africa and elsewhere will, unless checked, have severe economic consequences; but they will make themselves fully felt only over the longer term, as the heavy

losses of prime age adults weaken the mechanisms through which human capital is formed and accumulated.

In principle, the world is far better equipped to deal with infectious diseases than it was in the past, but the practical problems are still formidable. The main source of trouble in any common property system is ensuring collective action among the individual agents. When they are nation states, the touchy issue of sovereignty arises. A so-called “rogue country” with a weak commitment to, or capacity for, rigorous public health management can allow the spread of a virulent pathogen that threatens not only its own population, but also those outside its borders who come into contact with it. Since such countries are not uncommonly at odds in political and security matters with their neighbors or other groups of countries, the task of agreeing on the right course of action and how to share the costs, and then of actually implementing it, will demand skilful diplomacy or even sanctions.

A more serious threat is likely to come from the more numerous “failed states”, which can exert little control over their borders or internal affairs, much less reach their populations with public health measures.¹⁰ Widespread guerrilla conflicts, war or weak administration in post-conflict situations hinder efforts to prevent the emergence and spread of communicable diseases. Indeed, Angola’s HIV/AIDS epidemic broke out after the return of soldiers from the conflict in the Democratic Republic of the Congo, where civil war had raged for decades. Movements of civilians, willing or forced, exacerbate the situation.

The decay of public health systems in what can be called “faltering” states is also very troubling. The chaos and poverty following the breakup of the Soviet Union led to intermittent and uneven immunization coverage, as well as deteriorating water and sanitation services, and so permitted the resurgence of infectious diseases. Periodic outbreaks of measles and other diseases over the 1990s were clear evidence that the public health system had deteriorated (Jones and Revenga, 2000). As a result, immigrants from the former Soviet Union often arrive in Western Europe without current, standard vaccinations. Nigeria, whose reputation in most matters of governance and administration is unenviable, has also come under scrutiny once more, this time in connection with polio. With a child immunization rate of just 17 per cent in 1999, the government has refused to distribute vaccines and oversee vaccination programs in

¹⁰ A recent report by Eizenstat, Porter and Weinstein (2004) defines “failed states” and the associated threats to the US and the world at large that arise from ignoring and marginalizing rogue countries. These countries offer fertile ground for instability of all kinds, including the spread of communicable diseases.

compliance with the WHO's standards. Flare ups of polio cases across the country reveal the government's unwillingness or inability to deal the final blow to a disease that global, coordinated efforts have brought to the brink of eradication. In many of these cases, the immunization technology exists, and often successful immunization coverage has been achieved in the past; but failed or faltering states cannot or will not perform basic public health functions, so placing the rest of the world at risk.

The lessons from SARS are also instructive. The international system displayed its strengths and effectiveness in dealing with epidemics, particularly in its instant response and ability to mobilize and coordinate essential expertise. The flaw lay in the assumption that China, like other countries, not only monitors its epidemiological situation closely, but also would report any untoward developments quickly. The WHO took immediate action when it was informed, belatedly, by the Chinese government of a new and unidentifiable pathogen of an unknown source; and so warned by the WHO, it was the governments of other countries in Asia and North America that promptly implemented the necessary public health interventions to bring the epidemic under control. Once the severity of SARS and its highly communicable nature had become clear, the Chinese government cooperated with the international community. Without the sequence of immediate international response, sharing of information and cooperation, the epidemic would have spiraled out of control and become a worldwide pandemic. It should be added that had the pathogen been more aggressive or complex, the delay in initial reporting might have made such a disastrous outcome unavoidable.

China's reluctance fully to adopt modern methods for identifying, tracking and controlling epidemiological aberrations – notably by actually discouraging reporting and failing to quarantine the infected – was the main weakness in the whole system. While the international community compensated for these failures, it was alerted too late to avert the resulting morbidity and mortality outside China. The delays in identifying the emerging epidemic caused the direct and indirect economic losses sustained by China and other affected countries.

Under current arrangements, the WHO and other international bodies are limited in what they can do. They can provide guidance and information based on the experiences and challenges facing its member countries, and they can promote best practice in member countries and collaboration among them. While these bodies have no direct authority over

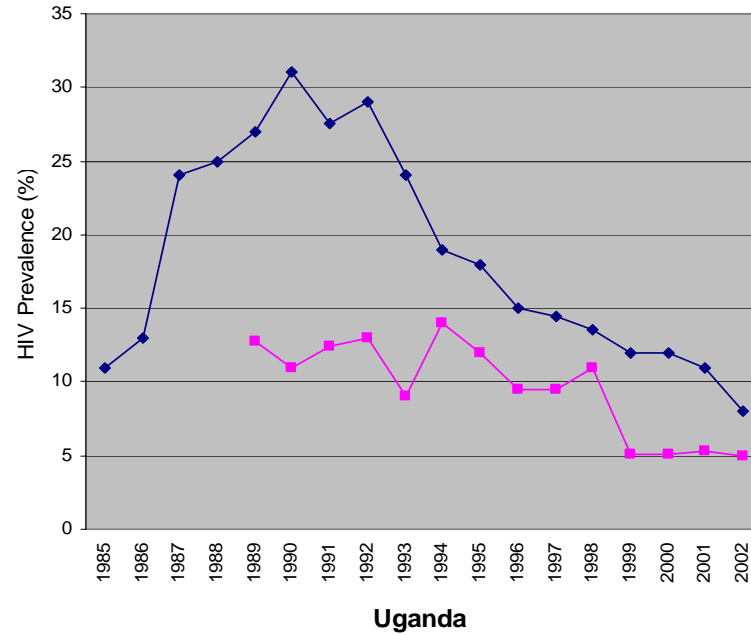
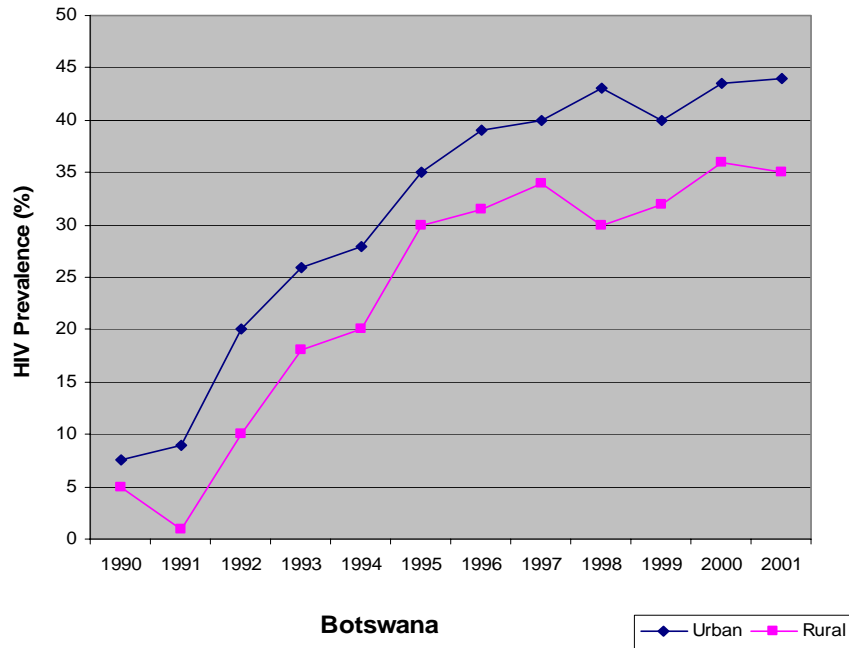
country-level surveillance and disease management, they are expected to compensate for lapses in country commitment and action that threaten international health. What failed in the SARS epidemic, however, was precisely local authority and national action.

The conclusions from this discussion are clear. The arm of the WHO that deals with communicable diseases should be maintained and supported, both in its capacity and in its functions. An operations and evaluation department should monitor the performance of member states and formally report their failures to adhere to established standards. Egregious and persistent cases should be referred to a central gremium, and thence, in the absence of the required corrective action, to the U.N. Security Council. The World Bank, the IMF and other multilateral donors should make satisfactory performance in the sphere of public health – as measured by a basket of suitable indicators – an explicit element in the conditionality of their overall willingness to lend. To the extent that performance so measured depends heavily on good administration and governance, there would be a correspondingly strong incentive to improve them. Rich countries, in their bilateral relations as donors, should do the same.

Public health is too important to the world's growth and wellbeing to not be a central concern of developed and developing countries, and the organizations that represent their collective interests. And because countries are increasingly interdependent, and infectious diseases affect not only the health of individuals but also of economic activity, disease control has become a truly global issue.

Charts and Graphs added Below

Figure 1: Trends in HIV prevalence among antenatal clinic attendees in Botswana and Uganda



Source: Botswana and Uganda, Epidemiological Fact Sheets on HIV/AIDS and Sexually Transmitted Infections. 2004 Update. UNAIDS/WHO.

Summary Characteristics of Selected Infectious Diseases Linked to Epidemics 5/27

Diseases	Period of Epidemic	Source of Infection	Form of Transmission	Disease Nature and Speed of Transmission	Prevention of Transmission
SARS	2002/03 epidemic	Corona-virus	Through respiratory contact with infected animals or humans	Symptoms: occur within 4-5 days Death: depends on individual, but can occur within 48 hours, especially of elderly. Case fatality rate: 10-15%	Isolation and quarantine of infected humans and animals. Hygiene.
HIV/AIDS	Virus identified: 1980s Ongoing epidemic	Virus	Through sexual contact, contact with blood, sharing of hypodermic needles of infected individuals	Symptoms: 8-10 years delay; transmit infection when asymptomatic Death: avg. 7 years from diagnosis without treatment; undetermined with anti-retroviral treatment	Prevent contact with bodily fluids of infected humans. Use of condoms, clean needles, treatment of STDs
Influenza	1918-1919	Virus	Aerosole: airborne particles, through close humans contact	Symptoms within 48 hours of contact Death: within a few days	Isolation, quarantine, hygiene, vaccination
Bubonic Plague	14 th Century Europe	Bacteria	Through flea bites from infected carriers (usually rodents); can be airborne, transmitted by human droplets.	Symptoms: manifested in bubos, death occurs in 3-4 days. Rapid transmission in densely populated areas. Average mortality: 60-70%	Isolation; rat control

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