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## A Global View For Investors

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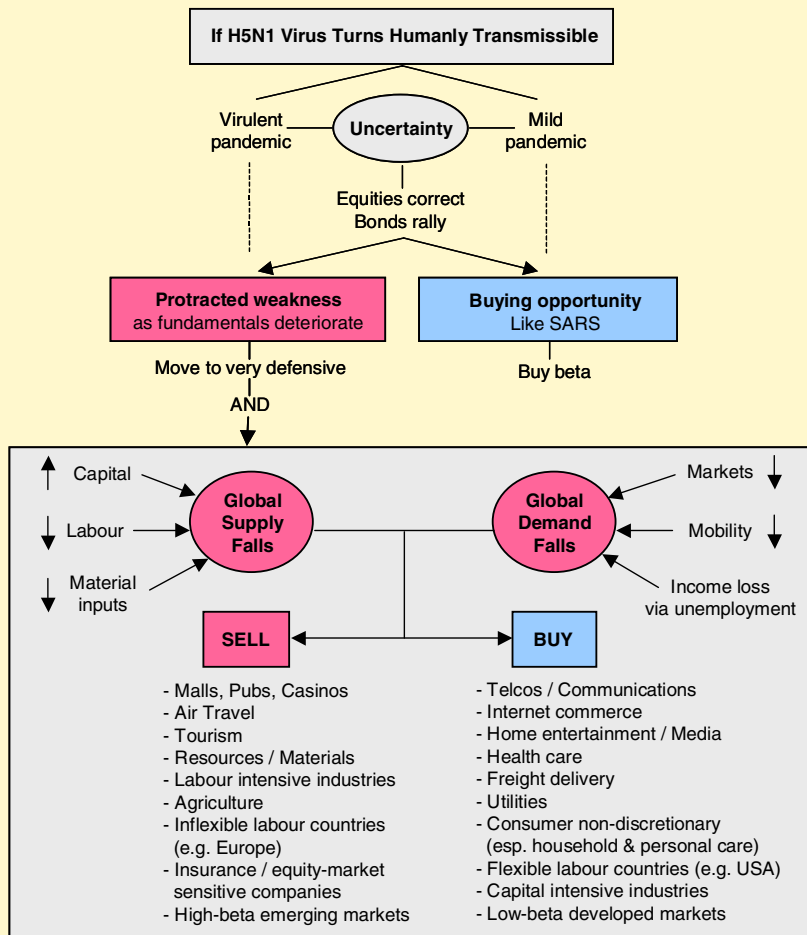
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# Avian Flu

## Science, Scenarios and Stock Ideas



Source: Citigroup Investment Research

**Citigroup Investment Research economists, strategists and equity analysts sketch several possible scenarios, highlighting asset class vulnerabilities, leverage and stock opportunities across sectors and regions.**

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## Avian Flu Update #3

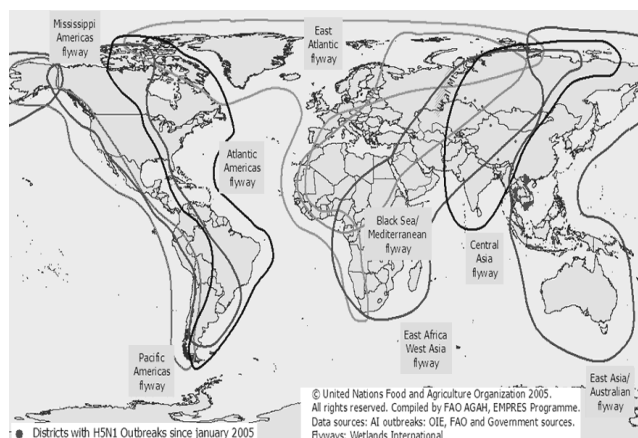
This is our fourth investigation of H5N1 avian flu, following reports in February 2004, February 2005 and November 2005. Two years after the first widespread bird deaths in Asia, the world’s understanding of the H5N1 virus is more nuanced, and preparedness has increased — however the risks have risen, too.

### Health warning: fast-changing information

New information about avian flu is emerging continuously. Investors can find the latest news on the following websites: [http://www.who.int/csr/disease/avian\\_influenza/en/](http://www.who.int/csr/disease/avian_influenza/en/) (World Health Organisation), <http://www.promedmail.org/pls/askus/f?p=2400:1000> (International Society for Infectious Diseases), <http://www.cdc.gov/flu/avian/index.htm> (US Center for Disease Control and Prevention) and <http://www.pandemicflu.gov> (US Government). A recent WHO study “*Avian influenza: assessing the pandemic threat*” may be useful for readers seeking further information:

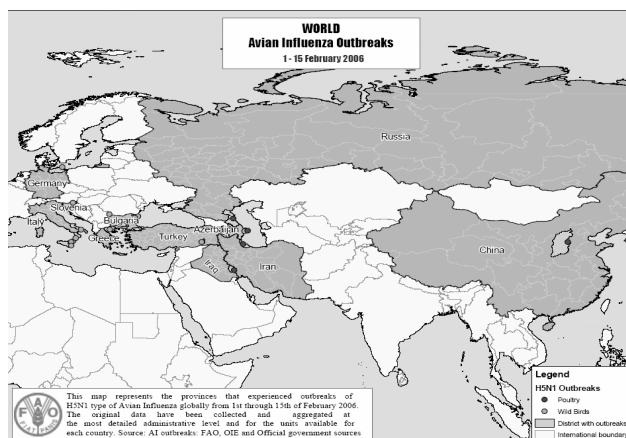
[http://www.who.int/csr/resources/publications/influenza/WHO\\_CDS\\_CSR\\_GIP\\_05\\_8-EN.pdf](http://www.who.int/csr/resources/publications/influenza/WHO_CDS_CSR_GIP_05_8-EN.pdf).

### Migratory Pathways



Source: Food and Agriculture Organisation of the United Nations (FAO).

### Recent Incidence of H5N1



Source: Food and Agriculture Organisation of the United Nations (FAO).

*Epidemic – a fast spreading, localised disease.*

*Pandemic – a worldwide, or widely spread epidemic.*

***Highly pathogenic H5N1 avian influenza has become endemic — a permanent part of the environment — across large parts of Asia. From there, migratory birds are spreading it around the world. Thus far, no sustained chains of human-to-human transmission have been reported, but governments are updating epidemic preparedness plans. While difficult to quantify the precise likelihood of a human H5N1 pandemic, our analysis suggests avian flu is a rising risk to the global economic outlook. In this report, we lay out some facts and sketch potential scenarios for economies, markets and asset classes.***

#### **Economic Impact: Two main scenarios**

From an economic perspective, we assess two scenarios: Best case: H5N1 does not become humanly transmissible; and Worst case: H5N1 becomes humanly transmissible – a global problem, not just an Asian one. In addition, we also present our “Asian Flu Pandemic Sensitivity Index for Asian Countries”.

#### **Currency Impact: current account countries at risk**

A mild pandemic – risking short-lived speculative spikes in “safe haven” currencies; a virulent pandemic – declining growth places current account deficit-currencies at risk, notably the USD.

#### **Equity Strategy: Sector selection & stock leverage**

We revisit the market impact of SARS, highlighting the binary nature of a pandemic-led sell-down: our best case represents an excellent beta-buying opportunity; our worst case, implying slower global growth, rising risk aversion, declining interest rates, labor/capital substitution, and significant wealth effects. Buy-rated stocks with positive avian flu leverage, include **Ansell, Community Health, CSL, Gilead Sciences, GlaxoSmithKline, Google, Henkel, National Grid, Reckitt Benckiser, Roche, Tenet Healthcare, and Yahoo.**

#### **Virus is endemic**

A new highly pathogenic avian influenza virus, the H5N1 strain, was first observed in Hong Kong in 1997. It reappeared on a massive scale in late 2003 and has since then established itself permanently in the ecosystem of several Asian countries (eg. Indonesia, China, Vietnam, Thailand), and has now spread to Europe.

#### **Migratory birds spreading it around world**

Scientists believe the main hosts for the H5N1 virus are domestic ducks and migratory waterfowl that shed the virus without falling ill. Their seasonal migration patterns are spreading H5N1 avian influenza to ever more countries.

#### **Epidemiologically: several outcomes possible**

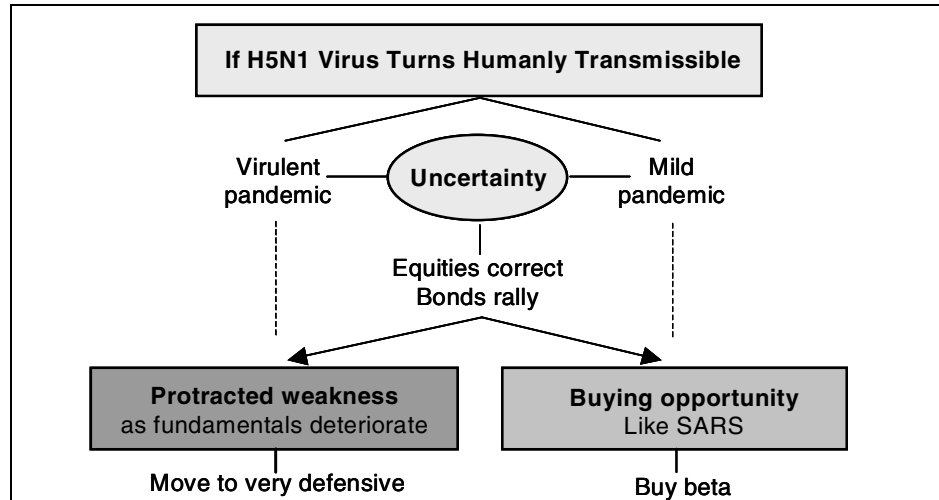
Experts believe that the likelihood of H5N1 avian influenza virus evolving into a humanly transmissible form is 100% — eventually. What remains open to question is when and how virulent the “human H5N1” virus will be. Our analysis suggests several outcomes are possible, including:

1. Gradual evolution of humanly transmissible strain by 2008;
2. Rapid evolution of transmissible strain in 2006;
3. Reassortment event in 2006; and
4. It’s all a bad dream: H5N1 never becomes humanly transmissible.

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# Market Strategy Overview

Figure 1. H5N1 Avian Influenza — Strategic Scenarios of POSSIBLE Human Pandemic



Source: Citigroup Investment Research.

## Disruption expected for economies and markets

The threat of a *potential* H5N1 influenza pandemic represents a dilemma for investors (and strategists). The uncertainty is extreme: uncertainty over the likelihood of pandemic; uncertainty over the timing of pandemic; and uncertainty over the virulence of pandemic. However, even accepting the risk of a virulent pandemic in the near-term may be small, we believe it is important to establish a framework for assessing some broader implications of various avian flu scenarios.

### The beginning: human-to-human transmission

Figure 1 above provides a “schematic” flow chart to plot likely market responses to the various scenarios. If and when there are chains of sustained human-to-human H5N1 transmission, we would expect pandemic fears to rapidly develop.

#### Initial phase: uncertainty

At this point politicians, businessmen and the wider public would likely respond in the time-honoured manner: not travelling, avoiding contact with other people, staying indoors. With SARS in early 2003, precautionary policy measures (border closures) and reduced labour/shopper mobility began to slow economic activity. Equities would likely be sold off, and bonds rally as investors seek safe-havens. This response is shown at the top “uncertainty” phase of the schematic.

#### Mild pandemic: buying opportunity

If the *potential* virus proves low-virulent, as with SARS, we would expect economies to bounce back from the temporary disruption, equity markets to rally (potentially quite strongly) and bond prices to reverse. This is shown schematically in Figure 1 as a “beta-buying opportunity.”

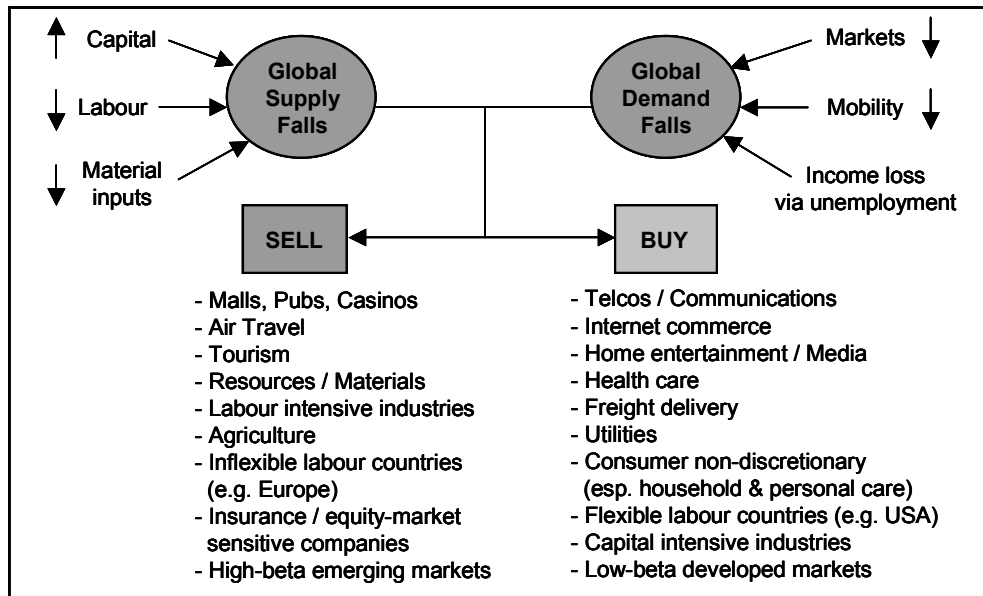
#### Virulent pandemic: everything changes

In this *potential* low-event risk, worst-case scenario, global policy responses, and individuals’ natural desire to avoid person-to-person contact would result in large supply and demand effects, shown schematically in Figure 2 below. We would expect global economic activity to decline, raw material prices to collapse, risk aversion to rise, monetary policy to ease, and interest rates to fall.

A framework for  
 assessing various avian  
 flu scenarios

A low virulence sell-  
 down = an excellent  
 beta buying opportunity

Figure 2. H5N1 Avian Influenza — Strategic Implications of POTENTIAL Virulent Human Pandemic



Source: Citigroup Investment Research

**Outlook worse than SARS**

*A high-virulence sell-down = labour/capital substitution & wealth effects*

At a minimum, we may imagine a more extensive and protracted SARS environment, with multiplier effects to countries less infected (e.g. Australia) via trade and relative price linkages. A sustained period of labour immobility would result in a more intensive use of capital and technology, including, importantly, internet-based commerce, and weaker demand from the loss of employment. Weaker markets over a longer period of time would reinforce the slowing in demand via both confidence and wealth effects.

In stock terms, there would be front-line winners (pharmaceutical, hospital, sanitary), front-line losers (airlines, hotels, luxury goods); and, if and when the pandemic spreads, second-line winners (telecoms, internet, utilities), and second-line losers (oil, metals & mining, travel, hospitality).

Figure 3. H5N1 Avian Influenza — Strategic Implications of Possible Virulent Human Pandemic

Front-Line		Second-Line	
Losers	Winners	Losers	Winners
<b>Airlines</b> (American, Continental, United, Qantas, British Airways, Lufthansa, Air France)	<b>Drug companies that make antivirals</b> (Gilead Sciences, Roche, GlaxoSmithKline)	<b>Oil majors</b> (BP, Total, Shell)	<b>Cleaning product makers</b> (Henkel, P&G, Reckitt Benckiser, Ecolab, Clorox, Kao Corp)
<b>Luxury Goods</b> (Nieman Marcus, Tiffany, Richemont)	<b>Drug companies that make vaccines</b> (Sanofi-Aventis, CSL)	<b>Insurers</b>	<b>Mining &amp; Metals</b> (Anglo-American, BHP Billiton, Rio Tinto)
<b>Hotels</b> (Marriott, Hilton, Starwood)	<b>Hospital/ Healthcare</b> (Tenet, Community Hospitals, Rhoen Klinikum, Generale de Sante in Europe)	<b>Travel &amp; Hospitality Industry</b>	<b>Telecoms</b> (AT&T, Deutsche Telekom, BT)
<b>Insurers</b> (AXA, Metlife, Prudential, Sun Life)	<b>Cleaning product makers</b> (Henkel, P&G, Reckitt, Ecolab, Clorox, Kao Corp)	<b>Brewers</b> (SABMiller, Ambev)	<b>Infrastructure utility stocks</b> (Snam Retegas, National Grid, Enagas, Gaz de France)
<b>Shopping malls</b> (Simon Property, General Growth, Macerich, Westfield)	<b>Home entertainment providers</b> (Nintendo, Blockbuster)	<b>Cyclical sectors: pulp &amp; paper, chemicals</b>	<b>Internet technology companies</b> (eBay, Google, Yahoo)
			<b>Defensive sectors: pharmaceuticals</b>

Source: Citigroup Investment Research.

## Preparing for An Unquantifiable Risk

- **No-one knows exact risk:**
  - **When will a humanly transmissible virus emerge?**
  - **How virulent will it be?**

### Spread by migratory birds

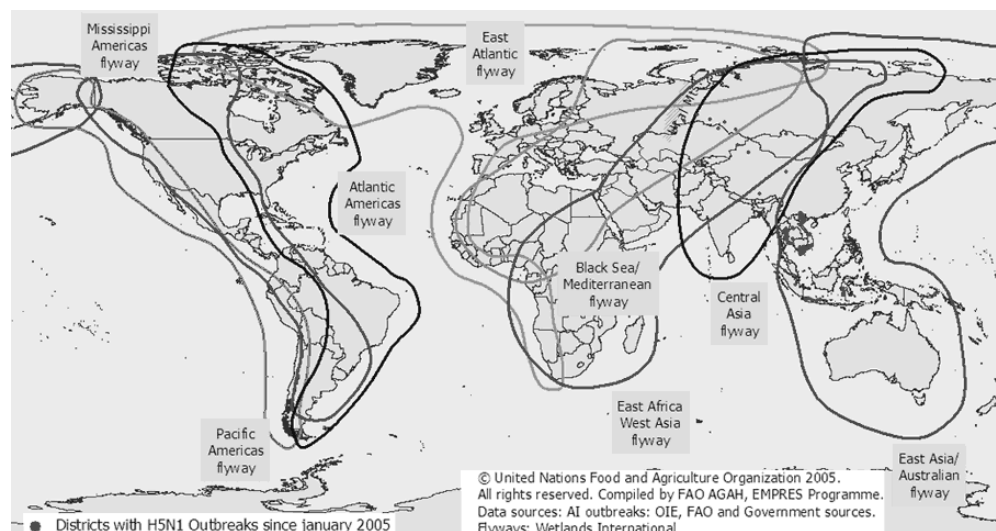
Two years after causing tens of millions of chickens to be culled, H5N1 avian influenza virus has become endemic – established a permanent foothold - in large parts of Asia, where it is carried by domestic and wild ducks and migratory waterfowl that don't show signs of illness but shed the virus. From there, seasonal migration patterns are spreading the H5N1 virus ever further afield, including to Russia and Europe.

This migratory spread increases the risks of the virus eventually mutating into a form that is readily transmissible from person to person — a “human H5N1 virus” — thus creating the conditions for a pandemic.

### Human-to-human transmission expected, but when?

To date, no sustained chains of human-to-human transmission have been reported, but some scientists say it is a question of *when* this will occur, not *if*. The Geneva-based World Health Organisation has issued a detailed pandemic preparedness plan and governments around the world have begun stockpiling antiviral drugs and expanding vaccine production capacity.

Figure 4. Avian Flu — Migratory Pathways



Source: Food and Agriculture Organisation of the United Nations (FAO).

## Why H5N1 would be different from SARS

A potential human H5N1 virus would have several key differences to the coronavirus that caused SARS:

- 1) H5N1 would be **much more easily transmissible** — Influenza viruses are airborne, easily transmitted by a cough or a sneeze; SARS was droplet-borne: only close face-to-face contact transmitted SARS.
- 2) Carriers of H5N1 would be **infectious before falling ill** — People infected by influenza viruses are infectious before they themselves are sick. This means the basic measures that helped control SARS, such as fever-checks, airport-screening and isolating sick people, would be of little or no use against a possible human H5N1 virus.
- 3) Influenza has a **much shorter incubation period** — SARS's incubation period is 10 days, giving time to trace contacts and quarantine suspects. Influenza has a 2-to3-day incubation period, so these measures would be useless. "Once pandemic influenza begins to spread internationally, it will be unstoppable," says the WHO.
- 4) As a result, H5N1 **could potentially spread to all five continents within weeks** — Once SARS became virulent in early 2003, it spread from South China to Hong Kong, Vietnam and Canada within three weeks. A human H5N1 virus could potentially move faster and further, carried by intercontinental jets.

## Four possible scenarios

While it is impossible to quantify the exact risk the world is currently facing, as no-one can assess either the likelihood of the avian H5N1 virus mutating into a humanly transmissible form, or the likely virulence if such a mutation did occur, from an epidemiological viewpoint, there are four main potential outcomes:

- **Gradual evolution of a humanly transmissible strain, by 2008** — A series of adaptive mutations give H5N1 avian virus the ability to move efficiently between humans, though no-one can predict how virulent it will be;
- **Rapid evolution of transmissible strain in 2006** — Adaptive mutations are quicker; again, it is impossible to say how virulent human H5N1 might be;
- **Reassortment event in 2006** — H5N1 avian influenza and human influenza swap genes inside a person infected by both viruses. Having human genes may make this virus less virulent, but no-one can say for sure;
- **H5N1 never becomes humanly transmissible** — H5N1 avian influenza virus is unable to mutate into humanly transmissible form.

## Economic impact: mild pandemic or virulent pandemic?

Should a humanly transmissible H5N1 virus spark a pandemic, the economic effect will be determined by its severity: will it be mild or will it be virulent?

If the pandemic is mild, we would expect the world's health authorities and scientists to be able to master it, like SARS or the 1968 influenza pandemic. In our view, such an epidemic would have only a short-term economic impact.

However, if the pandemic is virulent: highly contagious and also very harmful for humans, we believe a lasting effect on economies could be expected – with the largest economic impact likely to be felt in countries with low expenditure on health, where doctors and nurses may have less resources to care for their patients, or sufficiently protect themselves.

## Why Tamiflu may not work, or not for long

In recent weeks and months, there has been a global run on Roche's antiviral drug *Tamiflu*. We would make two points: Firstly, there is no clinical data proving *Tamiflu*'s effectiveness against current H5N1 avian influenza, let alone against future strains of H5N1. Secondly, use of *Tamiflu* by a large minority in a wider population without the drug creates near-ideal conditions for *Tamiflu*-resistant strains to emerge. The virus cannot be eradicated quickly due to the many people who won't have access to *Tamiflu*; simultaneously the virus will have near-unlimited exposure to people on different regimes of *Tamiflu* — a Petri dish for *Tamiflu*-resistant strains to emerge and prosper.

## Ten things the WHO wants you to know about pandemic influenza

### 1. Pandemic influenza is different from avian influenza.

Avian influenza refers to a group of influenza viruses that primarily affect birds. On rare occasions, they can infect other species, including humans. The majority of avian influenza viruses do not infect humans. An influenza pandemic happens when a subtype emerges that has not previously circulated in humans. Avian H5N1 is a strain with pandemic potential since it might adapt into a strain that is humanly transmissible.

### 2. Influenza pandemics are recurring events.

Three influenza pandemics occurred in the 20th century: “Spanish influenza” in 1918, “Asian influenza” in 1957, and “Hong Kong influenza” in 1968. The 1918 pandemic was exceptional, killing an estimated 40–50 million people — one of the deadliest disease events in human history. Later pandemics were milder, with an estimated 2 million deaths in 1957 and 1 million in 1968.

### 3. The world may be on the brink of another pandemic.

Health experts have monitored a new and extremely severe influenza virus – the H5N1 strain – for almost 8 years. The H5N1 strain first infected humans in Hong Kong in 1997, causing 18 cases and 6 deaths. Since mid-2003, this virus has caused the largest and most severe outbreaks in poultry on record. Since December 2003 over 100 human cases have been laboratory-confirmed in 4 Asian countries, and more than half of these people have died. Fortunately, the virus does not jump easily from birds to humans or spread readily and sustainably among humans.

### 4. All countries will be affected.

Once a fully contagious virus emerges, its global spread is considered inevitable. Countries might, through measures such as border closures and travel restrictions, delay arrival of the virus, but cannot stop it. The pandemics of the previous century encircled the globe in 6 to 9 months, even when most international travel was by ship. Given speed and volume of international air travel today, the virus could spread more rapidly, possibly reaching all continents in less than 3 months.

### 5. Widespread illness will occur.

Because most people will have no immunity to the pandemic virus, infection and illness rates are expected to be higher than during seasonal epidemics of normal influenza. Current projections for the next pandemic estimate that a substantial percentage of the world’s population will require some form of medical care. Few countries have the staff, facilities, equipment, and hospital beds needed to cope with large numbers of people who suddenly fall ill.

### 6. Medical supplies will be inadequate.

Supplies of vaccines and antiviral drugs – the two most important medical interventions for reducing illness and deaths during a pandemic – will be inadequate in all countries at the start of a pandemic and for months thereafter. Inadequate supplies of vaccines are of particular concern, as vaccines are considered first line of defence for protecting populations. On present trends, many developing countries will have no access to vaccines throughout the duration of a pandemic.

### 7. Large numbers of deaths will occur.

Historically, death rates during pandemics have varied greatly, depending on the number of people who become infected, the virulence of the virus, the characteristics of affected populations and the effectiveness of preventive measures. All estimates of the number of deaths are purely speculative until the pandemic virus emerges. WHO uses a conservative estimate – from 2 million to 7.4 million deaths – based on the comparatively mild 1957 pandemic. Estimates based on a more virulent virus, closer to the one seen in 1918, are much higher.

### 8. Economic and social disruption will be great.

Past pandemics have spread globally in two and sometimes three waves. Not all parts of the world or of a single country are expected to be severely affected at the same time. Social and economic disruptions could be temporary, but may be amplified in today’s closely interrelated and interdependent systems of trade and commerce. Social disruption may be greatest when rates of absenteeism impair essential services, such as power, transportation, and communications.

### 9. Every country must be prepared.

WHO has issued a series of recommended strategic actions for responding to the influenza pandemic threat. The actions are designed to provide different layers of defence that reflect the complexity of the evolving situation. Recommended actions are different for the present phase of pandemic alert, the emergence of a pandemic virus, and the declaration of a pandemic and its subsequent international spread.

### 10. WHO will alert the world when the pandemic threat increases.

WHO works closely with ministries and public health organizations in surveillance of influenza strains. A system that can detect emerging influenza strains is essential for the rapid detection of a pandemic virus. Six phases have been defined to facilitate pandemic preparedness planning, with roles defined for governments, industry, and WHO. The present is phase 3: a virus new to humans is causing infections, but does not spread easily from one person to another.

*–World Health Organisation, Geneva*



## Avian Flu: where next?

### Citigroup analysis suggests four main possible outcomes:

- 1) Evolution of humanly transmissible strain by 2008;
- 2) Rapid evolution of transmissible strain in 2006;
- 3) Reassortment event in 2006; and
- 4) It's all a bad dream: H5N1 never becomes humanly transmissible.

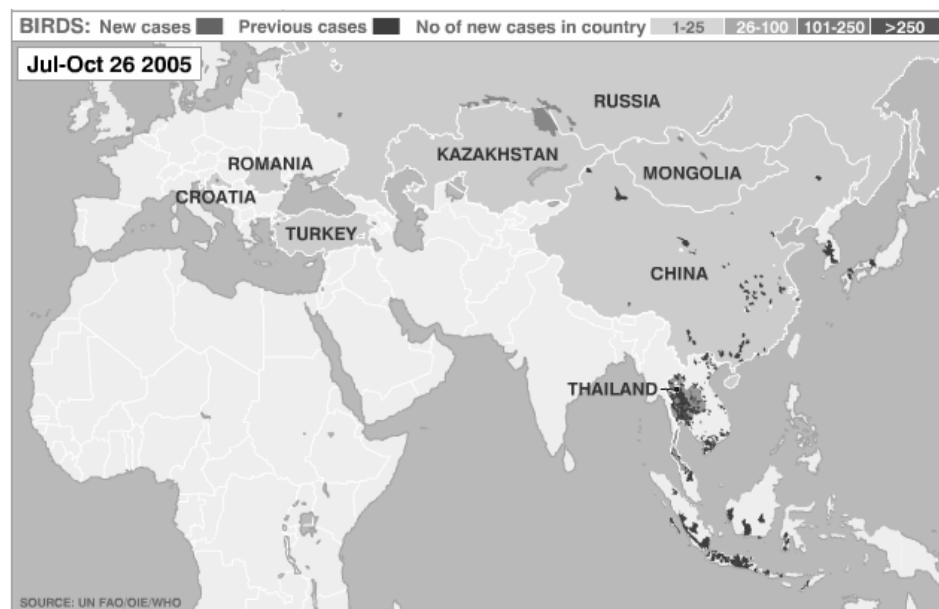
### Slow mover to date, but greatest risk in Asia

While the virus has spread far in geographic terms, it has not evolved into a threat for humanity as quickly as some epidemiologists had feared. That said, our analysis suggests that the greatest risk of a potential human H5N1 virus emerging is not from European birds that may become infected in coming months. In fact, the larger risk comes from Asia, where chicken, ducks and pigs often live in close proximity with humans under less-than-ideal sanitary conditions: a mixing-bowl for the evolution of new viruses.

### Expanding clusters of cases

While it is impossible to predict if or when a human H5N1 virus will emerge, one of the signposts may help monitor the level of risk: clusters of cases. In adaptive mutation, the avian H5N1 virus will undergo a series of mutations until it is capable of efficient human-to-human transmission. This process will most likely be signalled in increasing clusters of cases that initially burn out rapidly, but gradually the chains of human transmission last longer and longer until the virus “picks the lock.” Monitoring clusters of cases in the most affected countries, including China and Vietnam, will be crucial to assessing the risk.

Figure 5. Avian Flu — Recent Incidence of H5N1



Source: Food and Agriculture Organisation of the United Nations (FAO).

**Figure 6. H5N1 Avian Influenza — Documented\* Human Cases**

	Indonesia		Vietnam		Thailand		Cambodia		China		Turkey		Iraq		Total	
	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths	Cases	Deaths
Dec 03 - Mar 04	0	0	23	16	12	8	0	0	NA	NA	0	0	0	0	35	24
Jul 04 - Oct 04	0	0	4	4	5	4	0	0	NA	NA	0	0	0	0	9	8
Dec 04 - present	4	4	63	19	5	2	4	4	14	8	12	4	2	2	104	43
<b>Total</b>	<b>4</b>	<b>4</b>	<b>90</b>	<b>39</b>	<b>22</b>	<b>14</b>	<b>4</b>	<b>4</b>	<b>14</b>	<b>8</b>	<b>12</b>	<b>4</b>	<b>2</b>	<b>2</b>	<b>148</b>	<b>75</b>

Note: This refers only to laboratory-confirmed cases.

Source: World Health Organisation, Geneva.

## Morbidity and mortality

Two factors determine the effect of an epidemic: The *morbidity*, or percent of people exposed to a virus that become infected, and the *mortality*, or percent of infected people who die.

### Morbidity: Low so far

So far, H5N1 avian influenza has limited morbidity for humans. Millions of infected poultry in Asia exposed thousands of farmers and poultry workers, but less than 150 human infections have been documented. This likely understates actual morbidity but even so the morbidity remains low.

#### 1918-19 Spanish flu: Morbidity c25%

Scientists' current thinking about the 1918-19 Spanish flu pandemic is that it was most likely caused by an avian virus, which became humanly transmissible through adaptive mutations and had an estimated morbidity of 25%.

### Mortality: High, but should fall

The mortality of H5N1 avian flu is high in current documented cases, but it only includes the mortality of patients who fell seriously ill; patients with moderate infections were often not tested for H5N1 and so are not included in the statistics.

#### 1918-19 Spanish flu: Mortality 2.5%-5%

The historical record is not perfect, but current estimates of the mortality of the Spanish flu range between 2.5% in the US and as high as 5% in other countries.

## Virus similar to 1918-1919 Spanish flu

Scientists believe the 1918-1919 Spanish flu was an entirely avian virus — equivalent to what H5N1 would be if it becomes humanly transmissible via a process of adaptive mutation. However, there is no record of highly-pathogenic avian influenza at the time, so the current virus may potentially be inherently more dangerous than any virus in 1918-1919.

### Two waves

The first wave of the Spanish flu in 1918 was highly contagious, but with low mortality. Adaptive mutations first made the virus more infectious and then more deadly. Uniquely, the 1918 flu pandemic infected mostly young adults in the prime of life, while mortality was lower in the usually susceptible age cohorts of the very young and very old.

## **Four possible scenarios**

The fundamental difficulty in trying to assess the risk of H5N1 avian influenza is that no-one can quantify 1) the likelihood of the virus becoming humanly transmissible 2) when this may occur or 3) how virulent the resultant “human H5N1 virus” may be.

Hence there is a range of scenarios how H5N1 avian influenza might develop. As a frame of reference, we discuss four different possible outcomes:

- **Gradual evolution of humanly transmissible strain, by 2008** — H5N1 avian influenza gradually evolves into a humanly transmissible form by 2008 after a series of adaptive mutations give it the ability to move between humans. It is impossible to say how virulent this strain might be: as a pure avian virus that is highly pathogenic among birds, it could potentially be very pathogenic for humans, but we won’t know until it happens.
- **Rapid evolution of transmissible strain in 2006** — The adaptive mutation process is quicker: H5N1 avian influenza evolves into a humanly transmissible form by 2006. Again, it is impossible to say how virulent human H5N1 might be.
- **Reassortment event in 2006** — The H5N1 avian influenza virus and human influenza virus meet and swap genes (reassort) in a person who is infected by both viruses. The new virus is as infectious as the common flu. Given that this virus contains genes of the human influenza virus, it may be less virulent than a purely avian H5N1, but this is speculation.
- **It’s all a bad dream: H5N1 never becomes humanly transmissible** — The H5N1 avian influenza virus proves unable to mutate into a form that is readily transmissible from person to person. This is theoretically possible. Given human influenza viruses come from avian influenza viruses, given H5N1’s wide range in nature today and given the gradual mutations it has already undergone, most epidemiologists assign very little probability to this scenario.

***“In the absence of a pandemic, almost any preparation will smack of alarmism, but if a pandemic does break out, nothing that has been done will be enough”***

***— Tony Abbott, Australian Minister for Health***

## Avian Flu: what can be done?

- **Limited options to fight potential human H5N1**
- **Antiviral drugs — difficult to develop, no current treatment proven effective**
- **Vaccine — usually the best option, but development time 6 months, and worldwide capacity only enough for 4-5% of global population**

### Medical options: Antiviral drug or vaccine

Medically, there are two ways to fight a virus - with an antiviral drug or vaccine.

#### 1. Antiviral drugs

Some reports suggest that Roche's antiviral influenza drug *Tamiflu* (oseltamivir) may be effective against H5N1 if administered in the early phases of the disease. Oseltamivir's mode of action — a neuroaminidase inhibitor that interferes with a virus's replication — suggests that it may have some effect in slowing down viral infection, but this has not been conclusively demonstrated for H5N1.

Nevertheless in November 2005, Roche reported that over 60 countries have ordered Tamiflu stockpiles to date. Our compilation of news releases from 11 governments has pegged the backlog stockpiling orders at approximately 117 million treatment courses from these countries alone (see Figure 7 below). These include 46 million courses that are expected to be ordered by the U.S. government for delivery in 2006/07.

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**Figure 7. Government Tamiflu Stockpiling Orders**

<b>Country</b>	<b>Tx courses (#MMs)</b>	<b>Population (%)</b>
United States	46.0	16
Japan	15.0	12
United Kingdom	14.6	25
France	14.0	20
Canada	8.6	17
Germany	12.0	14
Italy	2.0	3
Hong Kong*	1.7	25
Finland	1.3	25
Norway	1.2	10
New Zealand	0.8	20
<b>Total</b>	<b>117.2</b>	

\* Expected order (not all doses will be for Tamiflu; some may be filled by GSK's Relenza).

Source: Roche, Gilead Sciences, and Citigroup Investment Research.

Roche in 2005 recorded \$1.56 billion in global sales of Tamiflu - \$790 million of which was for pandemic stockpiling by governments around the world. For 2006 meanwhile, Roche has guided for \$852-\$930 million in pandemic sales.

**Figure 8. Tamiflu Pricing for Stockpiled Finished Product and API**

Treatment course	Price in Euros
Tamiflu product, developed countries	€ 15.00
Tamiflu product, less developed countries	€ 12.00
Tamiflu API, developed countries	€ 7.70
Tamiflu API, less developed countries	€ 7.00

\* 1.1764 \$/Euro conversion rate as at 11/09/05.

\*\* Less developed countries under the World Bank classification of Low Income and Lower-Middle Income countries.

Source: Company reports.

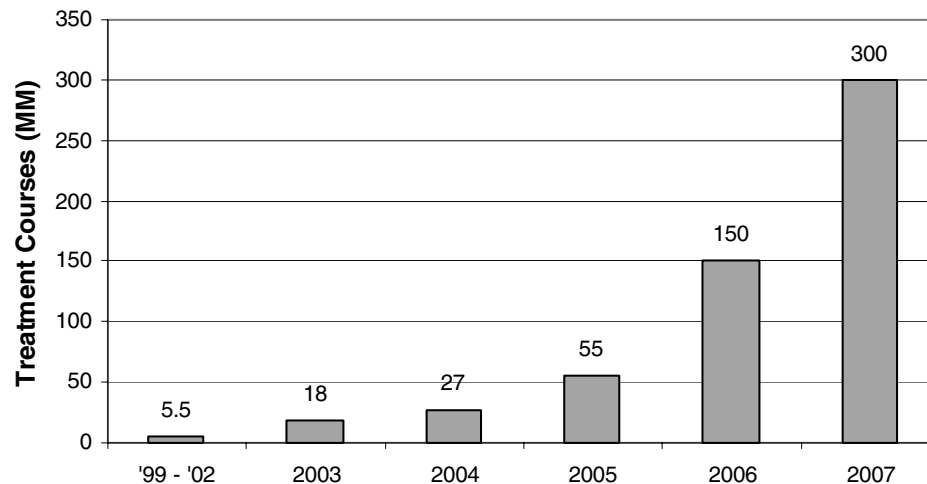
Furthermore, given increasing seasonal demand and orders from the remaining 50+ governments for pandemic planning purposes, we believe that there will be ample demand to meet our \$1.5 billion Tamiflu sales estimates in 2006 and 2007.

**Figure 9. Worldwide Tamiflu Sales Estimates**

Year	2006E	2007E	2008E	2009E
Tamiflu sales (\$MM)	\$1,500	\$1,500	\$750	\$750

Source: Citigroup Investment Research.

While concerns over Roche's ability to produce sufficient quantities of Tamiflu have put a lid on sales, Roche has identified 12 global partners to assist in manufacturing Tamiflu stocks and announced in December 2005 that it was well on its way to increasing production capacity to 300 million doses by 2007. As capacity constraints are now gradually easing there may be upside to our sales estimates.

**Figure 10. Roche's Historical and Expected Expansion of Manufacturing Capacity**

\* 2006 and 2007 capacity based on Company plans as of 9 November 2005.

Source: Company reports.

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## 2. Vaccine: The best option

Generally, the best protection against a virus is a strain-specific vaccine. Some viral vaccines can be straightforward to develop and produce. They consist of killed virus cells. When injected into healthy patients, these vaccines elicit the formation of antibodies that confer immunity against the disease itself.

### **Lengthy process**

Vaccines typically take years to develop due to the difficulties of cultivating cell lines, titrating the dosage and ensuring the vaccine is innocuous. If the virus mutates, creating similar but not identical strains, a vaccine that protects against one strain may not work against another. This is why current influenza vaccines are “trivalent:” a mixture of three influenza strains from last winter.

That said, all influenza A viruses can be characterized by two types of protein spikes that cover their surfaces: hemagglutinin (HA) of which there are 15 subtypes, and neuraminidase (NA) of which there are nine subtypes. The WHO recommends that antigens effective against H5 be stockpiled so as to speed the process of developing an effective vaccine if and when a humanly transmissible H5N1 strain emerges.

---

### **Vaccine production capacity: A fraction of global need**

Global production capacity for vaccines is a fraction of what would be needed for a pandemic. In the past 20-30 years, many drug companies have moved away from vaccine production, which is capital-intensive and low-margin compared with other therapeutic areas.

In 2004, we estimate the supply of trivalent vaccines worldwide was 280-300 million doses. This would cover around 4% of the global population — provided the vaccine could be administered in one shot (many vaccines have a two-dose schedule).

### **Potential H5N1 vaccine: Severe constraints**

At the risk of going into too much detail, there are a number of unique obstacles and limits to the possible development and mass production of H5N1 vaccine, including:

- **H5N1 too lethal** — Traditional vaccine production grows an inactivated virus in chicken embryos. H5N1 is too lethal for this — it kills the embryos — so the lethal genes must be removed by *reverse genetics*, which takes time and relies on patented (i.e. proprietary) technologies.
- **Biosafety requirements** — H5N1’s virulence requires testing be done under conditions of maximum biosafety, limiting the facilities at which scientific work can be done.
- **Not enough chicken eggs** — There is potentially a chicken and egg problem. If or when highly pathogenic H5N1 spreads beyond its current range, it would threaten domestic poultry with infection or culling. However, fertilized eggs are crucial to mass-producing influenza vaccine

---

### **Likely response if human-to-human transmission starts**

Over the past year, health authorities around the world have prepared pandemic preparedness plans in the event that human-to-human transmission of H5N1 starts. These include three main measures:

#### **1. Shower the area with antivirals**

The first defense would be to distribute antiviral drugs widely in the affected area, in the hope of strengthening people’s defenses against H5N1 infection.

## 2. Restrict travel

The second measure we would expect authorities to take would be to restrict travel in and around the initially affected area in order to confine the epidemic. This might not stop the epidemic, but at least would slow it down.

### Risk: Perverse incentive structure

The trouble with travel restrictions, or quarantines, is that they are all-but-impossible to uphold. If H5N1 evolves into a form that is transmissible from human-to-human, the most rational response of any individual in the affected area would be to get as far away as possible, even at the cost of breaking a law or quarantine. This is good if the individual is not infected. However, if he or she is already infected, they would merely transport the virus into new areas (and influenza carriers are contagious before they fall sick themselves).

## 3. Limit gatherings

If a humanly transmissible H5N1 evolves, standard pandemic preparedness plans call for authorities to limit public gatherings at which the virus could be transmitted. As in the case of SARS, schools and markets could be shut, and the population could be expected to avoid public places.

---

## International travel restrictions likely

Countries outside of the immediately affected area are watching closely, and some countries could be expected to impose travel bans. In 1918-19, the only country that avoided the full blow of the influenza pandemic was Australia, which imposed a strict maritime quarantine.

### Key goal: Buying time

In today's interconnected world, travel bans to and from infected areas would most likely not succeed in permanently keeping H5N1 out of any country. However, travel restrictions could slow the spread of the virus significantly, providing time for national and international health authorities to develop countermeasures. Slowing the virus down would still be a great help as one of the complications of a pandemic is the overwhelming demands on health care. If the buildup or peak of the pandemic could be blunted, lives would be saved.

---

## President Bush Swings into Action

US President George Bush on December 30, signed into law \$3.8 billion in funding for avian flu preparedness - about what we expected but less than the \$7.1 billion requested by Bush in a proposal announced last November.

### Avian Flu Funding

About \$3.3 billion of the \$3.8 billion is broadly defined as being for the Public Health and Social Services EmergenPcy Fund to improve pandemic preparedness. We expect that a significant proportion of the \$3.3 billion will be used for the purchase of antivirals such as Roche and Gilead's Tamiflu and Glaxo's Relenza and for yet-to-be-developed vaccines. The specifics of the funding will likely be discussed and debated in the coming weeks. We note that the \$3 billion in funding

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is available for multi-year spending. Therefore, dollars that are not spent this year can be used in subsequent years.

The remainder of the avian funds will provide international assistance, monitoring and tracking, and research and development. About \$350 million will provide for upgrading state and local response capacity, including the planning and exercising of pandemic response plans by state and local officials; \$241 million for international activities, disease surveillance, vaccine registries, research, and clinical trials; and \$50 million to increase laboratory capacity through the Centers for Disease Control.

According to the law, the Department of Health and Human services (HHS) will have the flexibility to use the balance of the funds to support other core preparedness activities, such as expanding the domestic production capacity of influenza vaccine, developing and stockpiling of pandemic vaccine, stockpiling of antivirals and other supplies for the Strategic National Stockpile.

### **Liability and Compensation**

The legislation Bush signed into law provides certain immunity from liability lawsuits to manufacturers of pandemic countermeasures. To be sure, a liability lawsuit against a company could move forward under the law if a company is shown to have engaged in wilful misconduct where, for example, the company knew something was wrong with the product that it brought to market. Still, the law says that Food and Drug Administration (FDA) approval to sell the avian flu product in the U.S. can be used as a part of the defense in a liability lawsuit.

Democrats and even some Republicans have criticized the liability protections as allowing manufacturers of drugs and/or vaccines to escape responsibility for gross negligence or even criminal acts. They contend that the language provides a broad immunity for pandemic flu vaccines, other countermeasures, and a broad class of other products, including products that have received full FDA approval and are used everyday by patients.

The law authorizes the creation a fund to compensate people injured after being treated or vaccinated for avian flu product shield under the liability protections. Congress, however, still needs to appropriate money for that fund.

### **Spending in 2006...**

In recent congressional testimony, the Bush Administration said it would like to spend the \$3.3 billion allocated for pandemic flu on the following activities.

- \$1.76 billion for vaccines, with \$1 billion being used for cell-based technology.
- 20 million courses of antivirals this year, and 44 million courses by 2008. We estimate the price tag at \$525 million.
- \$350 million for state and local preparedness.

### **... Bush's FY'07 Budget Request**

The legislation passed by Congress and signed by Bush provided slightly over half the money sought by the President in his initial proposal. In his fiscal 2007 budget proposal submitted to Congress February 6, Bush requested \$2.3 billion for the next phase for countermeasure preparedness. He is seeking the money as part of the administration's National Strategy for Pandemic Influenza and has called for the money in the form of an allowance.



Submitting the budget request in the form of an allowance is a political strategy designed to make the proposal more attractive to Congress. That's because an allowance builds the funding request into the baseline of the budget, making it appear as though Bush isn't asking for additional money that would increase federal budget deficits if it weren't offset by cuts in other spending.

As part of the \$2.3 billion request, Bush is seeking \$50 million to improve the FDA's ability to review applications to win rapid U.S. marketing approval for experimental pandemic influenza vaccines and drugs.

The remaining money would be used to provide pandemic influenza vaccine to every man, woman and child within 6 months of detection of sustained human-to-human transmission of a bird flu virus; ensuring access to enough antiviral treatment courses sufficient for 25% of the US population; and enhancing the federal, state and local as well as international public health infrastructure preparedness.

We think the administration may again face resistance to additional funding in the House of Representatives. However, it's too early to rule out passage of legislation, which may come closer to the November elections. In addition, a significant event, such as identifying a bird carrying avian flu virus in the U.S., would likely weaken resistance to additional funding.

The administration is currently discussing whether, how and under what conditions to make vaccines and antivirals from U.S. government stockpiles available to other parts of the world if a bird flu outbreak occurs abroad.

Currently, the Department of Health and Human Services is in the process of issuing requests for information and requests for proposal from industry.

## An Australian Perspective

"In the absence of a pandemic, almost any preparation will smack of alarmism. If a pandemic does break out, nothing that's been done will be enough, even the very extensive precautions that the Australian government has so far taken . . ."

"The Australian Health Department's "high estimate", based on the Centre for Disease Control modelling, is for 44,000 deaths, 148,000 hospitalisations and 7.5 million people seeking medical attention in the first three months of a pandemic... a 120 per cent increase in the population death rate, 8 per cent increase in the overall hospitalisation rate and 28 per cent increase in the demand for medical services in the first three months is a daunting prospect, even if the chance of one occurring in any one year in only 10 per cent. . ."

"The government in May this year, ordered 50 million syringes, 40 million surgical masks and 303 ventilator machines for public hospitals, distributed 30,000 pandemic influenza kits to doctors, and purchased thermal screeners which could be operating at international airports within hours. . ."

"Australia now has the world's largest stockpile on a per capita basis of antivirals, but that is only sufficient to protect Australia's estimated one million essential service workers for six weeks only, not the likely six month duration of any pandemic. . ."

"The Government is liaising with Qantas about possible arrangements for repatriating Australians who wish to return home in the event of a pandemic... although the Government would have to consider whether to close borders, and the adequacy of and possible enforcement of home or hotel quarantine for exposed people. . ."

"Perhaps the world will be spared this suffering, but almost certainly, preparing thoroughly for disasters which don't eventuate will help prepare for those which do. . ."

**– Tony Abbott, Australian Minister for Health & Ageing,  
Presenting at the Pandemic Flu Conference, Ottawa, 25 October 2005**

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## Economic Impact

- **If humanly transmissible H5N1 emerges, demand is expected to fall off first, as with SARS**
- **If H5N1 continues to affect mostly birds, minor impact expected**
- **Citigroup Pandemic Sensitivity Index highlights vulnerability of different Asian countries**

### Wide uncertainty

Estimating the economic cost of a potential future H5N1 pandemic is clearly speculative: we don't know *if* it will occur, *when* it may occur or *how virulent* the "adapted-to-humans-H5N1 virus" might be. In this section, we discuss two possible scenarios in detail: a worst-case scenario, in which a humanly transmissible H5N1 virus emerges, as well as a best-case scenario, under which H5N1 stays a mostly avian virus, occasionally jumping from poultry to humans, but not going person-to-person in any sustained way.

### 1. Worst case: H5N1 humanly transmissible

Epidemiologists' largest fear is that H5N1 avian flu may become transmissible between people through adaptive mutation or reassortment with a human influenza strain.

#### A global problem, not an Asian one

Were this to occur in the near future, the economic consequences could be both larger than SARS and global. The 1918 Spanish flu spread to most parts of the globe in six months — when intercontinental travel was by sea. That influenza also recurred in three separate waves over two years. If a potential human H5N1 virus leads to several distinct waves, this would extend the economic impact through time — and worsen it. With low supplies of a vaccine likely, at least initially, quarantine and treatment with antiviral drugs would be the initial defense. Health and quarantine facilities, though, could be quickly overwhelmed.

#### WHO projections

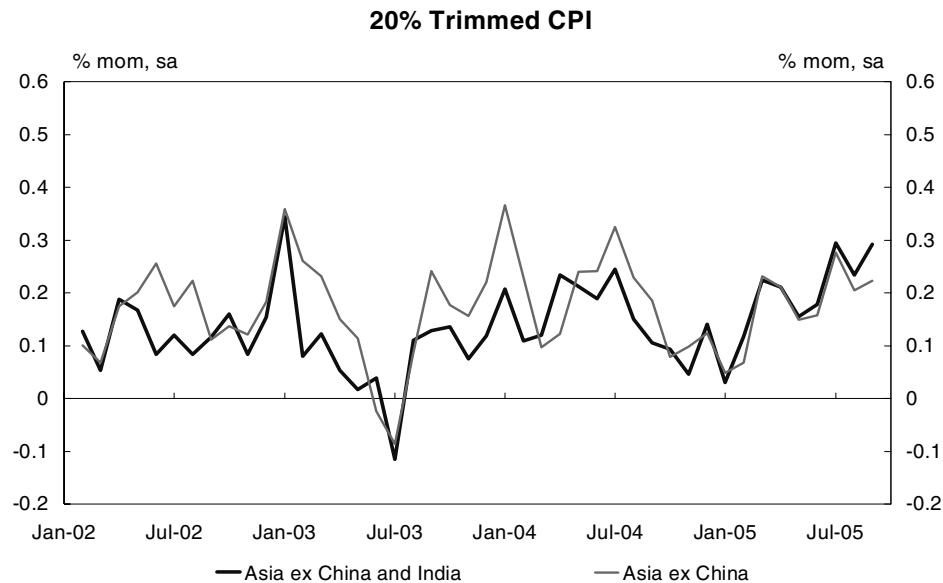
The WHO has estimated that an avian flu outbreak akin to the flu pandemic in 1968 would lead to as many as seven million additional flu deaths. The 1918 Spanish Flu, which scientists now say was an avian virus that acquired human transmissibility through adaptive mutation, killed 2.5-5% of the world's population — a percentage that, if applied to today's world, would correspond to 180 to 360 million deaths.

#### Other economic disease models: BSE in UK, Plague in India

Other disease outbreaks provide some further benchmarks. The World Health Organization (WHO) estimates that the British economy lost about US\$5.75bn, 0.5% of GDP, including US\$2bn in lost beef exports, as the outbreak of BSE and

new variant Creutzfeldt-Jakob disease in the United Kingdom in 1995 led to a mass slaughter of cattle, drastically cut beef consumption and imposed a three-year EU embargo against British beef. In 1994, a locally contained outbreak of plague in Surat, India, was estimated to have cost India some US\$2bn as panic sparked a sudden exodus of half a million people from the region, shut down entire industries, eg aviation and tourism, and caused several countries to freeze trade with and travel from India.

**Figure 11. SARS was a Deflationary Shock for Asia**



Source: CEIC, Citigroup calculations.

### First of all: demand effect

Taking SARS as our model, we would expect demand to fall sharply as consumers spontaneously avoid contact with others to reduce the chance of infection. As a result demand would likely contract more than supply, making a pandemic a deflationary event for the world (Figure 11 shows the decline in core prices in Asia coincident with SARS). Higher medical and fiscal spending would only partially offset this.

### Quantifying SARS's impact

The demand effects of SARS were severe, though, mercifully, short-lived. Lee and McKibbin estimate that had SARS persisted for a year, Hong Kong's GDP would have lost 5.5ppt, while that of China would have lost 2.4ppt. The World Bank puts the loss of GDP due to SARS at 2% of East Asia's GDP (not annualized). The Asian Development Bank has looked at the possible effects of an avian flu outbreak in East Asia and estimates an outbreak like the 1968 Hong Kong flu in infection rates and mortality would cut East Asia's GDP by about 2.6%-6.8% of GDP, depending on the duration of the disruption to demand.

## Supply effect expected too

Unlike SARS, virulent people-to-people bird flu would almost certainly disrupt supply through the death and absenteeism of workers.

### Macroeconomic model: estimating impact of more deaths

We also attempted to estimate the economic impact of a reduction in the labor force from flu deaths. Using a global macroeconomic model, the Oxford Economic Forecasting Model, we reduced the labor force by 2-3% - consistent with the 1918 Spanish Flu's estimated total mortality rate of 2.5%. Most countries show an additional 1-3ppt loss in GDP due to a shrinking labor force. Note that the 1957 and 1968 pandemics had much lower mortality rates, close to 0.5%, an indication of just how speculative any economic forecast is.

Figure 12. Estimated Loss (in % of GDP) from SARS and Bird Flu (March to August 2003 Period)

	China		Taiwan			Thailand		
	FX Income from Tourism	Retail Sales	Tourism Revenue	Income:	Personal	Tourism Revenue	Income:	Personal
				Eating/Drinking Places	Consumption Expenditure		Eating/Drinking Places	Consumption Expenditure
Actual	1.1	38.0	0.5	19.4	63.0	1.2	4.9	57.0
Potential*	1.9	38.3	1.0	19.8	63.7	1.7	5.2	57.3
Est. Sars Loss	0.8	0.3	0.5	0.4	0.7	0.4	0.3	0.3
Est. Bird flu loss								
at 50% of Sars loss	0.4	0.2	0.2	0.2	0.3	0.2	0.2	0.2
at 25% of Sars loss	0.2	0.1	0.1	0.1	0.2	0.1	0.1	0.1
at 10% of Sars loss	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0

Note: In Indonesia, tourism revenue counted for 2.5% of GDP in 2002. This compares to Thailand's 5.9%. \*Potential income estimated by growing the March to August period by the year-on-year growth rates of the previous six months.

Source: Citigroup calculations from CEIC-provided data.

Figure 13. Selected Countries—Livestock Share in GDP (Percent)\*

	Indonesia	Malaysia	Taiwan	Thailand	Vietnam
Livestock (% of GDP)	2.13	1.96	0.3	1.1	5.4

Note: Dates vary: Indonesia - 2004, Thailand - 2001, Vietnam - 2000 and rest are as of 2003.

Source: CEIC for Indonesia, Malaysia, Thailand and Vietnam. United Nations Food and Agriculture Organization for Vietnam, Citigroup estimate for Taiwan.

## 2. Best-case: H5N1 not humanly transmissible

In our best-case scenario, H5N1 does not become easily transmissible from person-to-person, relying on direct contact between infected birds and humans instead. This relatively unusual mode of transmission limits its spread through people — unlike SARS. As a result, the disruptions of human contact that SARS induced are smaller, even if the disease continues to spread to more countries. This is consistent with the pattern we have seen since the disease's re-emergence in December 2003. Most tourists, shoppers and diners can easily avoid infected chicken with little change in their daily routines. This was not the case with SARS, given the initial uncertainties about the method of transmission when the outbreak began. Benchmarking against SARS, then, should imply an even smaller effect than was seen in 2003 (see Figure 12 above).

## Bad for poultry farmers, marginal overall

With limited effects on tourism and other services, we are left with the direct effects of the loss to poultry farmers of their livestock and the follow through to exporters, domestic traders and consumers.

As a first measure of exposure, we show the importance of livestock to GDP (see Figure 13 above). For two reasons this is an overestimate of the direct loss. First, not all livestock are chickens. Second, not all provinces are infected and hence subject to culling. The loss in farmer incomes should be lower than the value of the culled chickens as governments in affected economies have offered compensation. Of course, this compensation is not itself costless, but it is unlikely to have a material effect on interest rates and assumes that no other spending is curtailed. Farmers owning pigs or cattle may also see somewhat higher income due to higher demand for chicken substitutes, further limiting the aggregate effect.

The World Bank has recently estimated that the costs of H5N1 in affected Asian countries have been less than 0.5% of GDP, but with a bigger effect on the poor who keep poultry as a source of food and income.

**Figure 14. Health Care Expenditures Per Capita; Physicians Per Capita**

	Health Expenditure, Total (% of GDP)	Health Expenditure per Capita (US\$)	Physicians Per 100,000 People (1990-2002)
China	5.5	49	144
Hong Kong	4.4	950	132*
India	5.1	24	48*
Indonesia	2.4	16	16*
North Korea	2.5	22	297*
South Korea	6.0	532	140
Malaysia	3.8	143	66
Philippines	3.3	30	123
Singapore	3.9	816	163
Thailand	3.7	69	37
Vietnam	5.1	21	48
US	13.9	4887	270
High income: OECD	10.8	2884	273
World	9.8	500	141*

Notes: \*1995 data from World Bank. \*\*1999 data from World Bank. Other data as of 2001

Source: CEIC, World Development Indicators, United Nations Development Program unless specified otherwise in notes.

## Citigroup Pandemic Sensitivity Index

### What we don't know

The preceding analysis of the economic impact of potential human H5N1 is heavily assumption-reliant: based on two sets of assumptions about *when* a pandemic may occur, *how virulent* the virus may be — and *whether* the pandemic will occur in the first place.

### Going on what we know

In addition to sketching potential outcomes from these two opposite and unquantifiable scenarios, we seek to provide an empirical frame of reference by investigating some facts: how vulnerable, or how prepared, different countries are to a *possible* H5N1 pandemic.

We have gathered data on different indicators of pandemic vulnerability listed below — and add them together to provide an aggregate **Citigroup Pandemic Sensitivity Index**, illustrated in Figure 18 on page 23:

- **Healthcare spending** — Higher healthcare spending typically comprises larger drug budgets, better medical facilities and more hospital capacity, all of which will be crucial in the event of an H5N1 human virus;
- **Doctors per capita** — Clearly, the more doctors, the better;
- **Tourist arrivals** — More tourist arrivals signify higher risk to a potential human-to-human virus;
- **Livestock's share in GDP** — Less livestock signifies less exposure to H5N1 should the virus remain primarily an avian (and poultry) virus;
- **Share of very old and very young in population** — These age cohorts are typically most vulnerable to influenzas;
- **Rural population share** — More rural inhabitants means more interactions with domestic and wild birds, and higher risk; and
- **Governance rankings** — During SARS, we found that a country's standing in the global governance rankings was a good proxy for its ability to take decisive action in the face of a nascent epidemic.

**Figure 15. Tourist Arrivals as a Percentage of National Population**

	Tourist Arrivals	Tourist Arrivals/Population (%)
China	108,000,000	7
Hong Kong	15,536,839	227
India	3,367,980	0
Indonesia	4,467,021	2
Korea	4,753,604	10
Malaysia	10,576,915	42
Philippines	1,907,226	2
Singapore	8,322,098	196
Taiwan	295,0342	13
Thailand	10,082,109	16
Vietnam	2,429,700	3

Note: India, Singapore and Taiwan data as of 2004, rests are as of 2003.

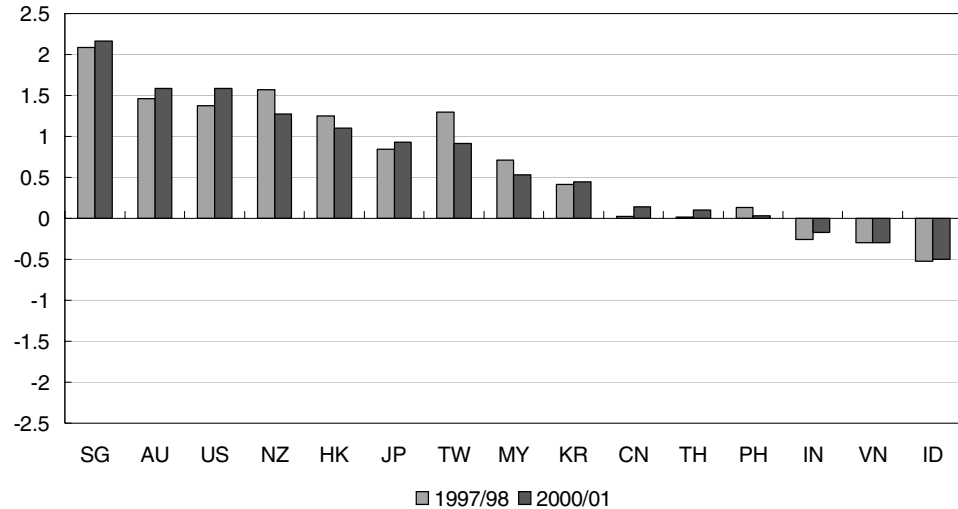
Source: CIEC, World Development Indicators.

**Figure 16. Population under 14, over 65 and Rural Population (%)**

	Population under 14 (%)	Population over 65	Rural Population (%)
China	23.6	7.3	61.4
Hong Kong	15.7	11.5	0
India	32.3	5.1	71.7
Indonesia	29.5	4.9	54.5
Korea	20.7	7.5	19.7
Malaysia	32.8	4.4	36.2
Philippines	35.8	3.9	39.0
Singapore	20.7	7.6	0
Taiwan	21.6	9.2	42.5
Thailand	22.8	6.6	68.1
Vietnam	30.5	5.3	74.2

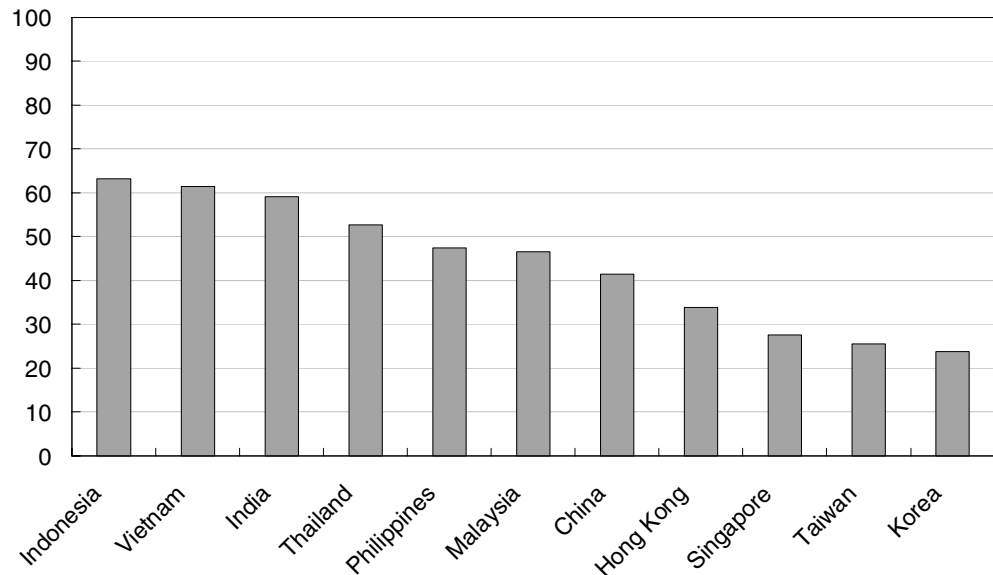
Note: Data as of 2003.

Source: CIEC, World Development Indicators, ADB (Taiwan).

**Figure 17. Government Effectiveness a Useful Proxy for the Responsiveness to Public Health Crises**

Note: Government effectiveness is one of the four indicators of governance, an indicator that is oriented so that higher values correspond to better outcomes, on an aggregate scale from -2.5 to 2.5.

Source: D. Kaufmann and A. Kraay, 2002: Growth Without Governance.

**Figure 18. Avian Flu Pandemic Sensitivity Index for Asian Countries**

Note: The index is out of 100, where a lower reading suggests that the country is less sensitive to an avian flu pandemic

Source: ADB, DGBAS and Department of Health data for Taiwan, and World Development Indicators.

## Pandemic Sensitivity: conclusions

In conclusion, our index indicates that, besides the currently affected countries, India and Indonesia are also sensitive to an avian flu pandemic, as both are countries characterized as high rural shares, agricultural dependent and with less developed healthcare systems.

Aside from this, the general impression from our data is that there are not terribly meaningful differences when various factors are combined. Low income/low healthcare expenditure countries tend to benefit from having lower tourist arrivals

per capita (though this may be less of a benefit than with SARS given the higher contagiousness with flu). Wealthier countries tend to have older populations.

### **Governments matter**

Looking back at different countries' response to SARS, perhaps a more important distinction may be seen in the ability of various countries to marshal their public health systems to meet the challenge of a communicable disease. In general, countries' responses corresponded to general government effectiveness.



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## Global Currency Markets

- **Only a virulent global pandemic is likely to have significant effects on currency markets - a mild pandemic would be expected to show short-lived speculative spikes in “safe haven” currencies**
- **However, should a virulent H5N1 pandemic emerge, it could slow global economic growth down significantly and thereby hurt global capital flows**
- **This should weigh on current account deficit countries’ currencies and lead current account surplus countries’ currencies to rise**
- **Within these two categories, differential effects will be determined by vulnerability to global growth trends, and differential effects of the pandemic itself**

### **A mild case of the flu: short-lived safe haven flows**

An Avian flu pandemic is likely to have limited effects on global currencies unless it is virulent and slows global growth significantly. While a milder pandemic may trigger speculative flows into “safe haven” currencies like the Swiss franc (and perhaps the U.S. dollar), such effects are likely to be short-lived.

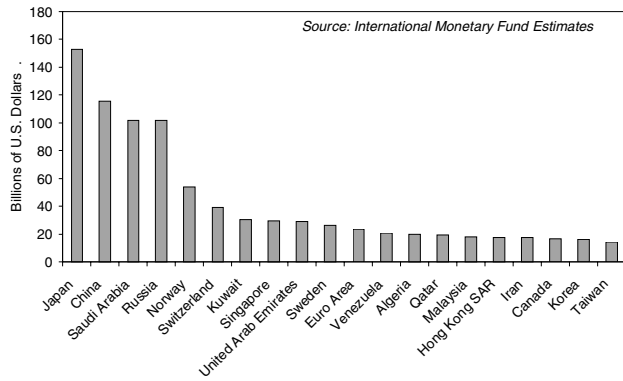
### **A more virulent case: rising risk aversion**

A more virulent global pandemic that has a measurable impact on global growth is likely to have more significant and lasting effects on currencies, with the largest beneficiaries being currencies with strong external payments positions. Additionally, those countries more exposed to global growth cycles are likely to witness a greater negative effect on their currencies.

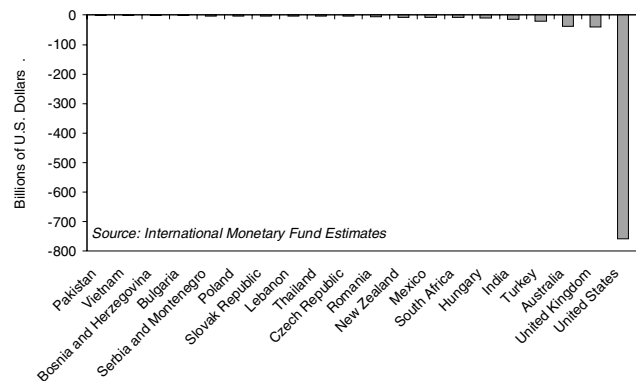
#### **Current account deficit countries at risk**

Current account deficit countries are likely to see their currencies suffer during a global slowdown, while current account surplus countries may see their currencies appreciate. A slowdown in the global growth cycle, especially if its onset is sudden as might be the case in a severe global influenza pandemic, would likely raise risk aversion globally. As risk aversion rises, global capital flows slow, since foreign investment is generally seen as more risky than domestic investment. A long-term downtrend in global investors preferences for domestic assets has enabled an expansion of larger current account deficits, most notably in the United States. However, cyclical fluctuations can cause sizeable deviations from that trend, leading to sharp depreciations among debtor countries. Conversely, the currencies of countries with current account surpluses may face pressure to appreciate, as a rise in preferences for domestic assets may create difficulties in “recycling” external surpluses.

**Figure 19. Top 20 Current Account Surpluses, 2005**



**Figure 20. Top 20 Current Account Deficits, 2005**



**US dollar the most exposed**

Were a virulent flu to break out in the near future, the biggest current account debtor is the United States. Its currency might suffer the most, as its deficit is more than three times greater than all other external deficit countries’ combined, and recent years have already seen signs of strain. Other countries that are vulnerable because of current account deficits today include the United Kingdom, Australia, New Zealand, South Africa. and Mexico. The primary surplus country beneficiaries of currency appreciation are likely to be Sweden, Norway, Switzerland, the euro area, and Japan.

Within these groupings, however, there may be differential currency effects based on exposure to growth. Countries seen as more vulnerable to a global growth slowdown may see their currencies underperform. High-flying emerging market economies with improved fundamentals that are based on the global economic boom, and in particular the commodity boom, may suffer even with large current account surpluses. Whereas the perceived resiliency of economies such as the United States and United Kingdom may limit to some extent current-account-deficit-induced weakness in their currencies.

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## Market Strategy: SARS as a Roadmap

- **SARS proved to be local — H5N1 avian flu risks being global**
  - **Risks higher: during SARS, global growth helped avoid worst-case scenario for Asian economies**
- **Epicentre of SARS: Hong Kong, where stockmarket fell 10% in six weeks, only recovering when it was clear the worst had passed**
- **During SARS, worst-affected sectors were the domestic, real estate, banks and consumer; health care and utilities outperformed**
  - **Post-SARS, technology, real estate and consumer outperformed**
- **Based on P/BV, Asian equities would have to fall 34% to reach the lows seen during SARS**

### Applying historical precedent

Asia ex-Japan has already been through one epidemic: SARS. In our view, that provides a roadmap of sorts as to how markets respond to unquantifiable, scary and life threatening events.

#### Similarities and differences

While the experience of SARS offers potential parallels in terms of market reaction, valuations and sector performance, investors should note that a *potential* humanly transmissible H5N1 would likely be very different from SARS.

#### Local vs Global

SARS was mostly a local problem, specific to Asia ex-Japan — though Canada also suffered. Even in the region, not all countries were affected, the worst-hit places being China, Hong Kong, Singapore and Taiwan. Therefore, local economy plays suffered most during SARS: consumer stocks, real estate and tourism. The global economy was largely unaffected, providing vital support to Asia.

#### Risk: weak external and internal demand

As a result, if H5N1 should turn into a humanly transmissible virus and spread internationally, Asia ex-Japan would face the combination of both weak external and internal demand. This is a huge departure from what occurred during SARS.

#### Not in prices

Currently, Asia is not pricing in anything like a re-run of SARS. Measured on P/BV, equity valuations are some 34% above the SARS lows.

#### Domestic sectors worst-hit, defensive stocks least affected

The sectors which were most affected during SARS were predominately domestic stocks, real estate, banks and, consumers. Defensive sectors outperformed: utilities and health care names. For the recovery plays, invert the list.

## **SARS in three stockmarkets**

We have illustrated the impact of SARS on the three most affected Asian stockmarkets — Hong Kong, Singapore and Taiwan — in Figure 21 - Figure 23 on the opposite page.

### **Key measure: new cases per day**

During SARS, the main measure used to track the epidemic's progress was the daily increase in number of probable SARS cases, published by local authorities and the WHO, and illustrated graphically on the Left-Hand Scale of our charts.

### **Hong Kong: the epicentre**

Of the three markets, Hong Kong was the most affected (see Figure 21). It was hit first and had the highest number of cases, so logically the stockmarket suffered the most. The Hang Seng stock index dropped almost 10% between mid-March and the end of April. The index's recovery began only when it became clear that the number of new cases was on a sustained downwards trend. Weekly new cases peaked in early April at 550; stockmarket recovery began at 220 cases and falling.

### **Singapore: affected, but less so**

From the beginning, Singapore was less affected by SARS than Hong Kong (see Figure 22). SARS cases were lower to begin with and rapid, tough government action caused case numbers to decline rapidly as early as mid-March. Then bad luck intervened: some patients at one hospital had been misdiagnosed and not isolated, so they infected others and reported case numbers shot up again.

The stockmarket priced the real risk efficiently: peak-to-trough decline was barely 5% or half of Hong Kong's drop.

### **Taiwan: later, a special situation**

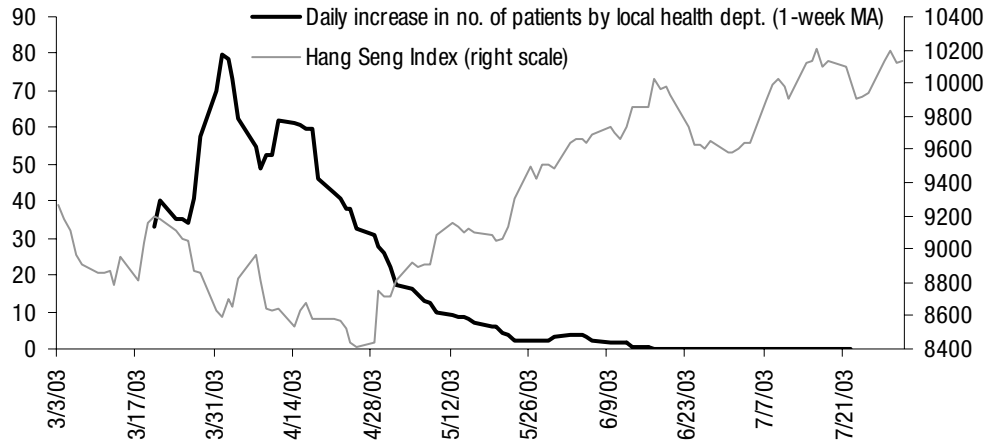
Initially, Taiwan was much less affected than Hong Kong and Singapore, with only a handful of cases. However, negligent medical care allowed still-infectious patients out into the community, and new SARS cases accelerated in late April, just when Hong Kong and Singapore had got their epidemics under control.

Again, we would argue that the stockmarket priced the real risk efficiently: a sharp drop when new cases accelerated in late April, but then sideways movement despite SARS cases accelerating. Investors knew from Hong Kong and Singapore that the real epidemic risk was minimal: better medical care would solve the problem.

### **NB: some Iraq effect**

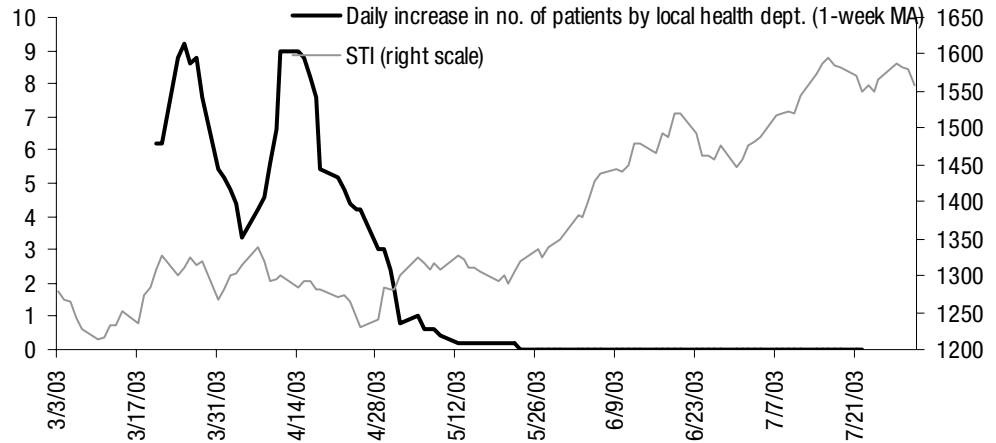
Investors should note that at the time of the SARS outbreak, Asian markets were already declining due to uncertainties surrounding the War in Iraq — US President Bush had declared war on March 19th.

**Figure 21. Hang Seng Hong Kong Market Performance During the SARS Outbreak**



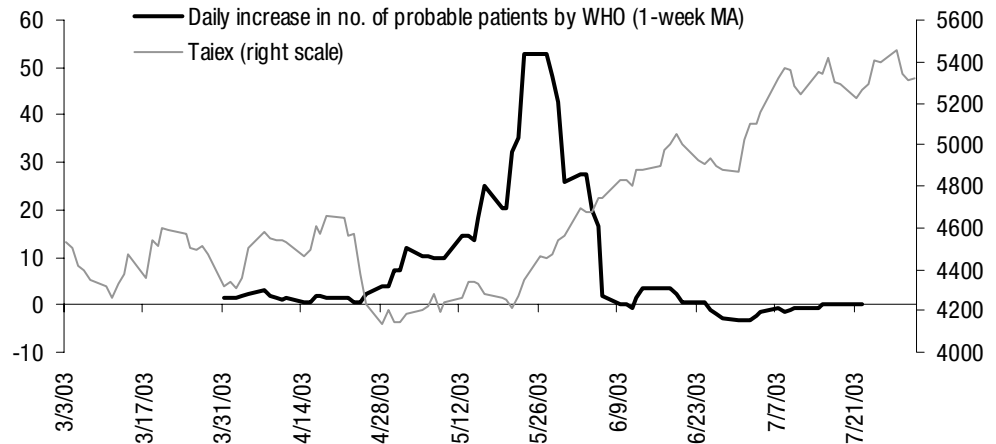
Source: CEIC, Citigroup Investment Research

**Figure 22. Singapore Market Performance During the SARS Outbreak**



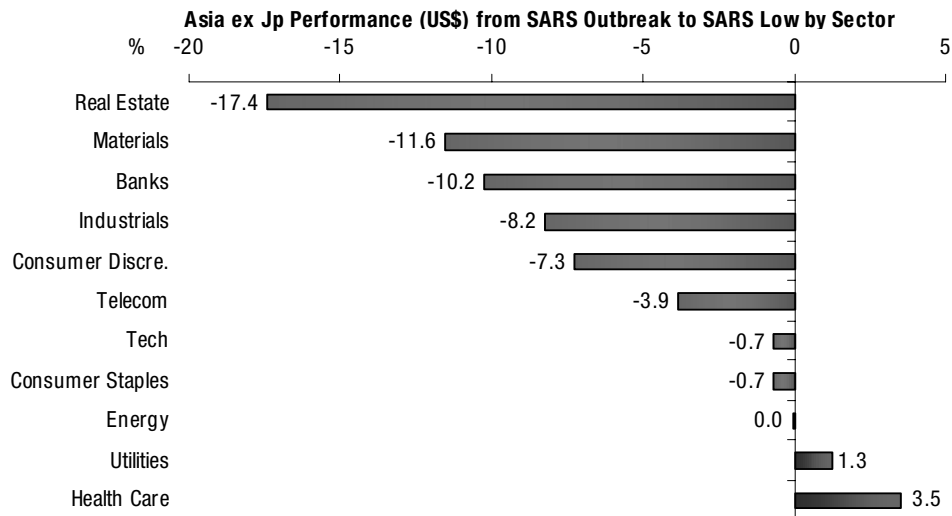
Source: CEIC, Citigroup Investment Research

**Figure 23. Taiwan Market Performance During the SARS Outbreak**



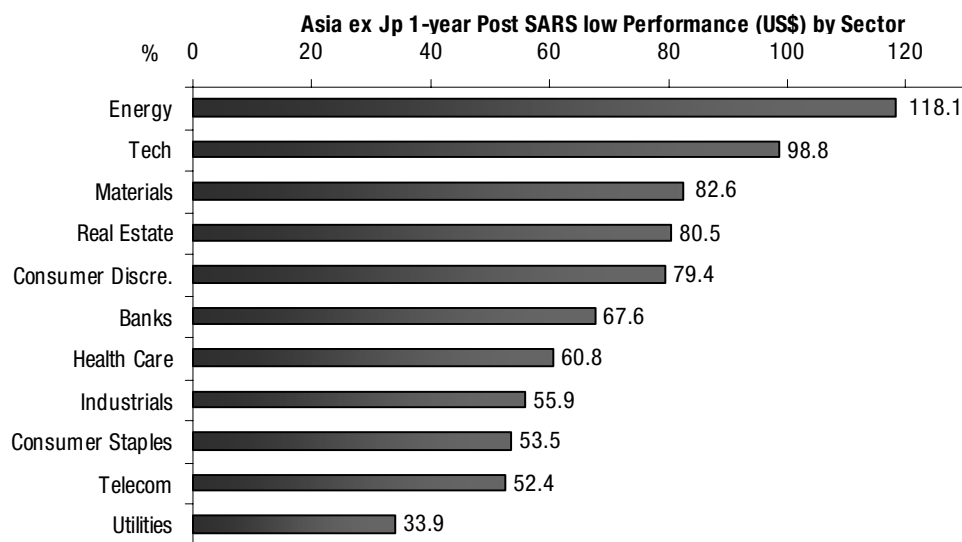
Source: CEIC, Citigroup Investment Research.

**Figure 24. Sector Performance During the SARS Outbreak**



Source: MSCI, Citigroup Investment Research.

**Figure 25. Sector Performance Post the SARS Outbreak**

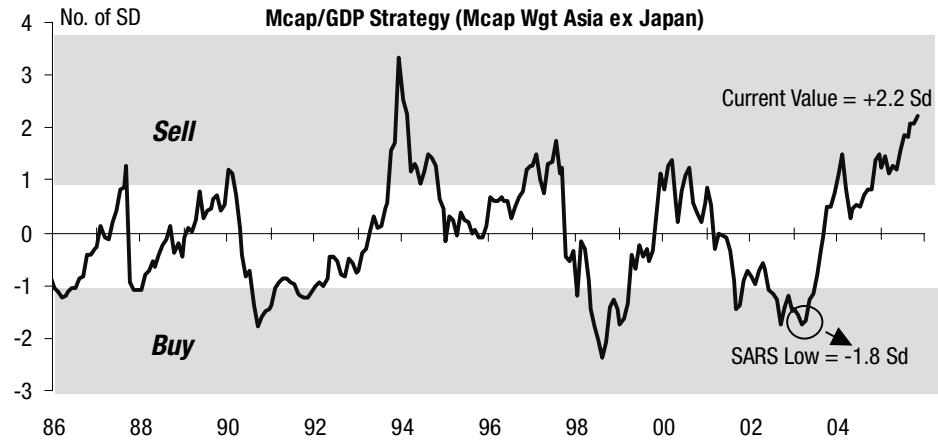


Source: MSCI, Citigroup Investment Research

## SARS in Sectors

As illustrated in Figure 24 above, domestic sectors fell most during SARS. Real estate fell by 17% as fear pushed investors away from big investment decisions. Material stocks fell on slowing growth and banks declined on higher bankruptcy risk. Least affected were technology (down 30% in the previous 12 months), energy and consumer staples. Utilities and health care rose — unsurprisingly.

After SARS, the hardest-hit sectors naturally showed the best overall performance: technology, the archetypal beta play, energy (helped by firm oil prices), real estate, consumer discretionary and banks. During this time the domestic economy stocks also gained due to US dollar weakness, providing a further reflationary boost.

**Figure 26. Asia Ex-Japan — Market Cap/GDP, 1986-2005 (Standard Deviations from Mean)**

Source: CEIC, Datastream, Citigroup Investment Research

### Market valuations today versus SARS — night and day

We believe Asian ex-Japan markets are pricing in very little bad news, so a *potential* outbreak of H5N1 Avian Flu could lead to substantial market declines.

Measured by market cap to GDP, these markets are 2.2 standard deviations above their historical average, as illustrated in Figure 26 above. During SARS, this ratio stood at minus 1.8. (Historically, in Asia ex-Japan, buying the markets at minus 1 S.D market cap to GDP, and selling them at plus 1 has led to 17.7% return p.a. over the last 25 years vs. 8.8% for the market.)

Using another approach, we have compared current price-to-book-value ratings for markets and sectors, and compared them with the low point reached during SARS — shown in Figure 27 below. Asia ex-Japan as a whole would need a P/BV drop of 34% to get back to the SARS lows. In terms of sectors, the biggest downside would be in real estate (49% drop needed), industrials (41%) and consumer discretionary (38%). Telecoms and utilities have the least downside.

**Figure 27. Asia Ex-Japan — Price/Book Value**

	SARS Low Apr-03	One Year After SARS	% Chg	Current	Upside/ Downside (%)
<b>MSCI AC Asia ex JP</b>	<b>1.2</b>	<b>1.8</b>	<b>47.2</b>	<b>1.9</b>	<b>-34.4</b>
Hong Kong	1.0	1.5	49.0	1.6	-38.3
Singapore	1.2	1.7	36.5	1.7	-29.0
Taiwan	1.5	2.1	45.0	1.9	-22.6
Energy	1.4	2.4	74.2	2.2	-37.3
Materials	1.1	1.5	42.5	1.4	-22.9
Industrials	0.9	1.2	38.9	1.5	-40.8
Consumer Discre.	1.4	2.1	52.1	2.2	-37.7
Consumer Staples	1.7	2.4	35.7	2.8	-37.5
Health Care	2.7	4.0	49.6	4.2	-36.7
Banks	1.3	1.9	45.0	1.8	-30.0
Real Estate	0.5	0.9	69.1	1.1	-49.0
Tech	1.9	2.8	53.1	2.5	-26.9
Telecom	1.9	2.4	25.1	2.3	-16.0
Utilities	1.2	1.5	25.4	1.5	-20.6

Source: MSCI, Citigroup Investment Research

## Sector & Stockpicking ideas

- **Several sectors expected to be immediately affected if human H5N1 emerges:**
  - **Likely losers include airlines, airports and travel companies, as well as luxury goods stocks**
  - **Expected winners: pharma stocks, hospitals, medical supplies**
- **In potential second line:**
  - **Most exposed: materials & metals, oil companies, cyclical sectors, travel & hospitality industry**
  - **More defensive: pharma stocks, telecoms, staple goods**

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### Stockpicking ideas

Should a human H5N1 pandemic emerge, equities can be divided into two groups:

#### Front-line losers and winners

Companies in sectors that are directly affected by the pandemic. **Airlines, hotels and luxury goods** stocks in the initially affected area will likely to be the first to suffer from cancellations, falling sales and a rapid move to net losses, as with SARS. By contrast, we would expect **pharmaceutical** companies, **hospital** chains and **sanitary** companies to benefit by fighting the pandemic.

#### Second-line losers and winners

If and when the pandemic spreads, we believe some sectors and companies will be less affected than others. Those most affected include the travel and hospitality industry, oil stocks and mining & metals companies. The sectors less exposed to a spreading pandemic include telecoms companies, internet commerce and utilities. Still, there would be relative winners, including defensive sectors such as pharmaceuticals and utilities (bond-proxies).

Figure 28. H5N1 Avian Influenza — Strategic Implications of Possible Virulent Human Pandemic

Front-Line		Second-Line	
Losers	Winners	Losers	Winners
<b>Airlines</b> (American, Continental, United, Qantas, British Airways, Lufthansa, Air France)	<b>Drug companies that make antivirals</b> (Gilead Sciences, Roche, GlaxoSmithKline)	<b>Oil majors</b> (BP, Total, Shell) Insurers	<b>Cleaning product makers</b> (Henkel, P&G, Reckitt Benckiser, Ecolab, Clorox, Kao Corp)
<b>Luxury Goods</b> (Niemann Marcus, Tiffany, Richemont)	<b>Drug companies that make vaccines</b> (Sanofi-Aventis, CSL)	<b>Mining &amp; Metals</b> (Anglo-American, BHP Billiton, Rio Tinto)	<b>Telecoms</b> (AT&T, Deutsche Telekom, BT)
<b>Hotels</b> (Marriott, Hilton, Starwood)	<b>Hospital/ Healthcare</b> (Tenet, Community Hospitals, Rhoen Klinikum, Generale de Sante in Europe)	<b>Travel &amp; Hospitality Industry</b>	<b>Infrastructure utility stocks</b> (Snam Retegas, National Grid, Enagas, Gaz de France)
<b>Insurers</b> (AXA, Metlife, Prudential, Sun Life)	<b>Cleaning product makers</b> (Henkel, P&G, Reckitt, Ecolab, Clorox, Kao Corp)	<b>Brewers</b> (SABMiller, Ambev)	<b>Internet technology companies</b> (eBay, Google, Yahoo)
<b>Shopping malls</b> (Simon Property, General Growth, Macerich, Westfield)	<b>Home entertainment providers</b> (Nintendo, Blockbuster)	<b>Cyclical sectors: pulp &amp; paper, chemicals</b>	<b>Defensive sectors: pharmaceuticals</b>

Source: Citigroup Investment Research.



## Sector & Stock Commentary Guide

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## **Gilead Sciences (GILD; 1H; US\$59.09)**

Recall that in the fall of 2005, the World Health Organization (WHO) issued a warning about a finding that a strain of the avian flu virus (A/H5N1) could infect humans, thereby causing widespread concerns about the potential for a global epidemic. A positive for Gilead/Roche's *Tamiflu*, since the drug along with vaccination will likely pose the first line of action in avian flu treatment and prevention efforts. In line this, in November 2005 Roche reported that over 60 countries have ordered Tamiflu stockpiles to date. Our compilation of news releases from 11 governments furthermore, has pegged the backlog stockpiling orders at approximately 117 million treatment courses from these countries alone.

Notwithstanding this, in the out-years Gilead is planning to field a specialty sales force to supplement Roche's primary care focused force. In addition, increased spending on marketing and direct-to-consumer advertising and approval for the prevention of influenza in children aged 1-12 years should make Tamiflu a bigger seller during the annual flu season. Our current \$1.5 billion in sales in 2006/07 reflects an estimated \$500 million in end-user sales for the seasonal flu during each year. However, starting in 2008, we anticipate that sales of Tamiflu could reach \$750 million for seasonal use alone.

Also recall, Roche and Gilead settled their royalty dispute in November 2005 – earlier than expected – and in turn raising the effective royalty on Tamiflu for Gilead. The royalty is stepped up every \$200 million in sales in a calendar year and increases from 14% to 22%. In practice, this will result in an average royalty of approximately 18-19%, up from 11% previously.

**Figure 29. Structure of Tamiflu royalty rates in a given calendar year**

Sales level (\$MM)	\$0 - \$200MM	\$200MM - \$400MM	> \$400MM
Royalty rate (%)	14%	18%	22%

Source: Company reports.

By our analysis, every \$100 million in Tamiflu sales could translates into \$0.03 to Gilead's bottom line. On the heels of theses robust Tamiflu royalties and the company's healthy HIV business, we rate the shares of Gilead Sciences Buy/High Risk.

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## **GlaxoSmithKline (GSK.L; 1L; £15.07)**

GlaxoSmithKline (GSK) has already prepared a mock H5N1-based avian 'flu vaccine, with rapid scale up potential once the antigens are known, and has in *Relenza* an alternative anti-viral to Roche's *Tamiflu*.

### **Vaccine and Relenza leverage**

GSK's current trivalent (three antigen) flu vaccine capacity is around 35-40m doses in Dresden, Germany, of which 30m were sold in 2005. Investment in additional capacity will increase this to a planned 80m by 2008. The acquisition of ID Biomedical in Canada brings an immediate 12m doses, expected to rise to 75m by 2007. Thus by 2007/8 GSK should have capacity for up to 155m trivalent doses, perhaps equivalent to 300m univalent pandemic vaccine doses, given that yields will inevitably be lower for a new antigen. GSK is using its proprietary adjuvant, which should boost the response to a lower dose of antigen, and permit a

greater supply of vaccine. The problem is knowing which antigen to scale up, since there is not as yet an avian flu virus infectious and transmissible easily from human to human. The company has filed a prototype H5N1 vaccine with the FDA and plans a similar filing in Europe during 2006. This covers all aspects of vaccine production, excluding the specific antigens. Once the antigens are identified, full production and launch could be achieved in 3-4 months.

The company has a leading position in vaccines outside the US and only this year had its flu vaccine *Fluarix* approved in the US. *Fluarix* sales in 2005 were £106m (of which £8m were in the US). We currently forecast sales of all vaccines to nearly treble between 2005 and 2010E, from £1,389m to £3,512m without any assumption of any pandemic sales.

*Relenza* is an inhaled anti-viral with similar, if lower, efficacy to *Tamiflu*. Sales were £5m in 2005. Efficacy of the active drug substance has been demonstrated against avian flu in vitro. It is an inhaled product, meaning that it is much more difficult for additional contract capacity to be brought on stream because of the need for demanding formulation skills. The company has plans to double capacity but has not given any further details. GSK has received orders from several governments.

The broad strength and depth of the vaccines business is a core component of our Buy/Low risk (1L) investment recommendation for GSK. It impacts existing product growth and pipeline elements, although is heavily skewed to the latter.

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## **Roche (ROG.VX; 1M; SFr195.90)**

Roche is clearly benefiting from government pandemic ordering for its antiviral treatment *Tamiflu*. Roche achieved SFr300m sales from *Tamiflu* in 2004 and is currently guiding to between SFr1 - 1.2bn for 2005. Despite concerns over effectiveness against avian flu and potential resistance, it is currently one of only two antiviral options available on the market for governments to stockpile in case of a pandemic. Roche has been working to increase their own capacity to manufacture the drug and recently stated that by the end of 2006, it will be in a position to produce 300 million treatments (a ten-fold increase over 2004). The company is also in talks with a number of other companies e.g. generic companies over forming potential partnerships to expand worldwide supply.

Roche has received and state that they can fill pandemic stockpile orders or letters of intent for *Tamiflu* from 30 countries worldwide. These include the UK, Finland, Norway, Switzerland and New Zealand where the governments are ordering enough *Tamiflu* to cover between 20 - 40% of the population. The big swing-factor is the US which has not yet placed a significant order. However, President Bush's pandemic flu plan which was unveiled at the beginning of November, proposes setting aside \$1bn for stockpiling antivirals (effectively *Tamiflu* and GlaxoSmithKline's *Relenza*) of which we would expect *Tamiflu* to gain the majority share.

*Tamiflu* per se, is not a key element of our Buy thesis on Roche, as we believe it is the margin leverage being driven by the increasing sales from the oncology portfolio which underpins the value in the company. However, *Tamiflu* is a potential short-term incremental positive, particularly with Rocephin undergoing genericisation in the US. We forecast SFr1.2bn *Tamiflu* sales in 2005 rising to SFr1.4bn in 2006 with potential further upside from US pandemic ordering.

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## **Sanofi-Aventis (SASY.PA; 3H; €70.85)**

Sanofi-Aventis is one of the best-positioned companies to benefit from the move towards developing an avian flu vaccine. The company is currently working on an H5N1 influenza virus vaccine under a \$100m contract from the US Department of Health and Human Services (HHS). This vaccine is, by necessity, formed against a current H5N1 strain. Sanofi-Aventis has previously produced 2 million doses of bulk vaccine for the HHS. Sanofi-Aventis is also sponsoring clinical trials in France on an H5N1 vaccine and has contracts in place / is in discussion with a number of other governments and health agencies regarding vaccine production.

Due to the limitations on producing avian flu vaccines in chicken eggs, Sanofi-Aventis has formed a strategic alliance with Crucell to further develop and commercialise a new influenza vaccine based on Crucell's proprietary PER.C6 cell line technology. In April 2005, Sanofi-Aventis was awarded a \$97m contract from the HHS to accelerate development of a cell-culture vaccine, part of which was delivering a feasibility plan for the construction of a US-based and licenses cell-culture production plant for supplying up to 300 million monovalent influenza vaccine doses annually.

President Bush's pandemic flu plan proposes setting aside \$1.2bn for HHS to purchase vaccines for 20 million people and an additional \$2.8bn for accelerating cell culture technology. Sanofi-Aventis could benefit from both of these initiatives.

We currently forecast total global influenza vaccine sales of €575m for Sanofi-Aventis in 2005 rising to €800m in 2010.

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## **Chugai (4519; 2M; ¥2,315)**

Chugai, 50.1% owned by Roche, is benefiting from Japanese pandemic ordering.

The current stockpile target of the government is 250 mn capsules (25mn people's worth on a five day ay prescription basis). Central government will stock 105 mn capsules, local government will stock 105 mn capsules, 40mn capsules will be counted as a distribution stocking. In 2005, central government had stocked 700,000 capsules. In 2006, Chugai estimate that central government will stock 74 mn capsules. In 2007, Chugai estimate that central government will stock 30 mn capsules and local government will stock 105 mn capsules.

Roche Group has announced a price of €1.50 per capsule for governments, and converting at ¥140.15/€, this amounts to ¥210.22. This is a 42.1% discount to the tariff price of ¥363.7. Assuming shipments at ¥210.22, we calculate a sales contribution of ¥44 n in total , which is 14% of annual sales.

We rate the shares of Chugai Pharmaceutical Hold/Medium Risk (2M), with a ¥2,500 target price. Chugai merged with Nippon Roche in October 2002 to form a new company under the Roche group. In addition to the mainline products of the former Chugai (hematopoietic Epogin, and hematopoietic Neutrogin), the company has products from the old Roche Japan, such as the anti-influenza Tamiflu and the anti-cancer franchise (Furtulon, Xeloda, antibody Rituxan, and antibody Herceptin), making it the fourth largest domestic player. The most promising product under development is the company's own antibody MRA. MRA is a treatment for autoimmune disorders such as rheumatoid arthritis that we feel has the potential to become a blockbuster, with peak annual global sales of around ¥80bn. In January 2005, Roche began global Phase-3 trials of the drug in the US and Europe.

The company has begun marketing the drug in May 2005 as a treatment for Castleman's disease, which is rare in Japan, and hopes to expand its indications to include rheumatism in 2007. We expect the company to release the drug in the US and Europe in 2008. In anti-cancer treatments, Chugai is developing Avastin and Tarceva from Genentech and these have been recognized for their effectiveness overseas. We expect these treatments to show growth in the domestic market as well. Although the fundamentals are quite healthy, we are of the view that the good news is already incorporated in the share price.

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## European airlines & airports

The flag carrier airlines—**British Airways** (BAY.L; 1H; £3.27), **Lufthansa** (LHAG.DE; 1H; €13.79), **Air France** (AIRF.PA; 1H; €19.74), **Iberia** (IBLA.MC; 2M; €2.31)—who operate mostly long-haul international routes, are particularly exposed to traffic and revenue declines should Avian 'flu reach pandemic status, similarly to SARS in 2Q03. Passenger traffic fell by 30% on routes to Asia during this quarter, and in the peak of the crisis, traffic declines were much greater.

The exact analysis of the traffic impact was complicated by the Iraqi War, which occupied most of the first quarter of 2003. In total, passenger traffic fell by 4% for these airlines (excluding the low fares airlines), with declines on Asian and Canada routes (approx. 25% of a typical flag carrier revenue base) being partially offset by normal growth on domestic, European and trans-Atlantic routes. If Avian flu is confined to Asia, then we would expect a similar impact. If it is more widespread, however, we would expect passenger declines of 30-50% on routes to the affected regions, which would be a worse situation than during SARS. During SARS, both leisure and business traffic were equally affected with many companies banning travel to the affected areas, except for crucial reasons only. Most air travel in and to/from Asia during SARS were people returning home and those visiting friends and relatives, apart from the brave, of course. We would expect a quick return to traffic should medication start to work and once the news story is relegated from being the number one media story on TV and in newspapers. Traffic was generally strong for nine months after the outbreak of SARS as leisure and business travellers resumed their travel plans. We would not expect air traffic to decline completely over the long-term, even if the pandemic lasts a long time. At least 50% of air travel is non-discretionary and this base traffic would be expected to remain. This includes most business traffic and most visiting family traffic. Vacationers may decide to make their holidays closer to home.

### Flag carriers versus short-haul low-fare airlines

Share prices of those airlines most affected could decline substantially. The combination of the Iraq War and SARS served to halve the share prices of the flag carriers, although most of the impact was war-related, making it hard to discern the specific SARS impact. For British Airways, we estimate that SARS caused the share price to fall by around 10-15%. Net losses would be expected for most carriers. Some, already weakened by record oil prices and increasing competition, could be forced into bankruptcy, accelerating the eventual consolidation of the industry into the just the top 3-4 airlines with the largest natural catchment areas. SARS offered a good entry point into the quality airlines, such as British Airways, Lufthansa and Air France. We would expect the same, assuming the flu is short-

lived. The best-performing airlines during SARS were the short-haul low-fares airlines with the leanest cost structures – **Ryanair** (RYA.I; 1M; €7.79) and **easyJet** (EZJ.L; 2H; £3.79). We would expect this to be repeated should avian flu develop, unless of course Europe itself becomes an epicentre for the pandemic. One possible offset of the flu would be lower oil and jet fuel prices due to reduced demand, but this is just a small consolation for a sector whose earnings could be substantially negatively affected by avian flu.

### **Airports less exposed**

The airports—**Copenhagen Airports** (KBHL.CO; 2M; Dkr1,829), **Fraport** (FRAG.DE; 2M; €64.45), **Vienna International Airport** (VIEV.VI; 2M; €66.12), are likely to fare better than the airlines, who often maintain their schedules but have to lower ticket prices to entice some volume. Airports have higher profit margins and usually have regulatory structures that enable them to recoup any losses due to one-time events via increased airport fees in subsequent years.

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### **Luxury goods**

Given the uncertainty surrounding avian flu, it remains difficult to make a sensible assessment of the impact of the luxury goods sector in general and **Richemont** (CFR.VX; 1M; SFr58.65) in particular.

We would make several core observations. Firstly the exposure of global luxury goods to international travel patterns (notably at the high ticket Richemont group) will likely give the sector above average vulnerability to a pandemic. Secondly, the industry does generally retain pricing power, so all but the worse outcomes would likely be accompanied by cost cutting, but not deep stock impairments. Even in the face of SARS, sharp exchange rate deterioration, the Iraq war and terrorism threats the industry did not see widespread stock clearance and markdown. However, that was not enough to negate the poor revenue trends.

Historic precedent suggests that Richemont has delivered constant currency sales growth of 4x GDP. If we use this as a start point for sensitivity analysis we can make the following (highly speculative) analysis.

For an estimated 1% hit in global GDP, historic relationships would imply a 4% deterioration in constant currency sales at Richemont. Our analysis of fixed and variable cost suggest that if no management action were taken, EBIT would fall by 14%. Two points need to be made. Firstly variable cost would not flex in line with revenue declines. In reality, variable costs could be cut much faster. In contrast, a flu pandemic would likely produce travel patterns that are far more extreme than those merely implied by the traditional relationship to changes in GDP. This could, under extreme circumstances make the P&L very substantially more sensitive than is implied by the simplified analysis above. One illustration of this would be the experience of the Gulf war when travel patterns fell over 15% and Richemont experienced a near 20% constant currency sales decline for a 3 month period.

It follows the stock market has attributed very low odds of a flu pandemic since Richemont shares have not responded to fears. In the absence of any realistic way off attributing odds to a pandemic we have some sympathy with this - and indeed Richemont's recent P&L trends have been highly impressive. We retain a Buy target CHF55 but acknowledge that risks are rising.

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## Household & Personal Care

The household and personal care industry would contain ‘winners’ and ‘losers’, were a pandemic flu to erupt. From a European perspective, we believe two winners would be **Henkel** (HNKG\_p.DE; 2L; €91.70) and **Reckitt Benckiser** (RB.L; 2M; £20.62), while **Clarins** (CLRP.PA; 2M; €50.00) would likely suffer.

Henkel and Reckitt manufacture branded household cleaning products, ranging from clothes detergents and insecticides (in the case of Henkel) to surface cleaners and air fresheners (both companies). We believe the natural reaction of people in areas affected by bird flu would be to clean more frequently and, most probably, to increase the amount of product used while cleaning, in the hope that a higher concentration of cleaning products would increase the disinfectant power.

In addition to their core household cleaning franchises, each company has additional business lines that might benefit from increased demand with an outbreak. Henkel does a significant business with soap and body wash products and has a large equity stake in **Ecolab** (ECL.N; 2L; US\$36.05), a U.S. industrial janitorial business. Reckitt has a large OTC medication business known for its cold and flu and general pain analgesics, and is set to expand the business following the planned BHI acquisition.

Both companies have significant market share in major markets around the world. Henkel is stronger in Eastern Europe/Middle East, Reckitt in Australia. Depending on the location of a flu outbreak, other more regional household care companies such as **Clorox** (CLX.N; 3M; US\$61.34) or **Kao Corp** (4452.JP; 1M; ¥3,150) could also benefit.

In contrast, we believe prestige cosmetics manufacturer Clarins would likely suffer from any disease outbreak that curtailed international air travel. Approximately 10% of Clarins sales come from the duty free channel, which would suffer from a slowdown in passenger volume. Moreover, as prestige cosmetics are generally distributed through a limited number of department stores, we think there is the additional risk that consumers would eschew trips to large department stores/shopping centres, which can be tiring to navigate and involve interacting with large numbers of potentially infected people, and would instead nip into smaller local stores to buy beauty essentials. **Estee Lauder** (EL.N; 1M; US\$37.03), the American prestige cosmetics firm, might also suffer for the same reasons as Clarins.

## Metals & Mining

Given the global nature of mining industry and metals demand it is highly likely the sector would trade down firstly on sentiment and the subsequent revision in global growth forecasts, lowering metals demand and negatively impacting the earnings outlook and hence share price performance of the mining sector.

If we assume the flu is likely to hit Asia first this could have a significant impact given that approximately 30 percent of metals demand comes from China alone. With the mining sector currently experiencing peak earnings and valuations, a hit to the area of marginal growth would be significant.

Within the group, our analysis suggests the larger, diversified miners, **Anglo American** (AAL.L; 1M; £20.50), **BHP Billiton** (BHP.AX; 1M; A\$23.60) and **Rio Tinto** (RIO.AX; 2M; A\$67.95). BHP and RIO are more exposed to the growth

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markets of Asia through their exposure to the bulk commodities, iron ore and coking coal, which are utilised in the Asian steel industry. Anglo's share price performance may be more support by its more defensive portfolio which includes diamonds and platinum.

Among the smaller cap miners we think that **Lonmin** (LML.L; 1M; £22.00) might be best placed to weather the storm, for similar reasons as Anglo American.

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## European hospital sector (NR)

Our analysis suggests that the hospital sector would be a likely beneficiary of a possible human H5N1 virus. Hospital admissions soared in all three flu pandemics of the previous century — indeed, in 1918, hospital capacity was rapidly exhausted. In Europe, the main hospital stocks are **Rhoen Klinikum** (RHKG.DE; Not Rated; \$1.9 billion market capitalisation) in Germany; **Capio** (CAP.ST; Not Rated; \$1.4 billion), with operations in the Nordic region, the UK and France; and three hospital chains in France: **Generale de Sante** (GDSF.PA; Not Rated; \$1.4 billion), **Orpea** (ORP.PA; Not Rated; \$1 billion) and **Medipep** (MEDE.PA; Not Rated; \$520 million).

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## Telecoms

Telecom traffic is generally immune to any macrofactors and it is hard to identify any feature of an epidemic that would alter our models. External events generally only affect telecoms when there is an interruption to supply (i.e. in an earthquake) or where there is a sudden demand shift with which networks cannot cope (e.g. September 11 2001 attacks). It is possible that if more workers stay at home network usage would rise, but since access fees dominate the revenue pie (per minute charges are less than 20% of fixed line telecom revenues) we cannot see this being material. So a sustained, non-sudden epidemic is unlikely to affect the sector.

This view assumes there is not a sustained economic slowdown, in which case business telephony rates will fall. There is a weak correlation between economic performance and telecoms: for example **Deutsche Telekom** (DTEGn.DE; 2M; € 14.00) has had lower growth rates than **Eircom** (EIR.I; 2H; €2.21).

Since late 2001, when valuations returned to more sensible levels telecom stocks have tended to outperform in periods of market weakness. There are no names we would recommend for such a strategy.

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## European Utilities sector

Utilities are one of the classical choices for investors when defensiveness is needed in equity markets. However, utilities are not all the same and their defensiveness varies according to the type of “utilities business” they are in. For example there is a group of utilities whose main source of profits is power prices and generation of electricity. As experience shows, in most European electricity markets, power prices are linked to oil and gas prices and because of this there is an element of cyclicity in their valuation: when European economies grow and fuel costs rise, these utilities benefit from selling their electricity at higher prices and vice versa when economies stagnate. In this latter case, we argue, this sub-category of utilities will not fare well.



However, there is another group of utilities, defined as Infrastructure stocks, that since their activities are fully regulated and their cash flows set by the local regulators through tariffs, they provide investors with a predictable and safe stream of cash flow and as such are the most likely to benefit from a fall in bond yields. As experience shows, for Infrastructure stocks the correlation between dividend yields and bond yields exceeds 70% whilst for the most cyclical utilities the correlation is lower. Amongst the Infrastructure stocks we would highlight, **National Grid** (NGL.L; 12M; £5.94), the UK water utilities, **Snam Retegas** (SRG.MI; 2M; €3.62), **Terna** (TRN.MI; 1L; €2.19), **Red Elettrica** (REE.MC; 1L; €27.24), **Enagas** (ENAG.MC; 1L; €16.64), **Gaz de France** (GAZ.PA; 2H; €29.40) and **Elia** (ELI.BR; 2L; €30.95)

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## European Oils sector

The origins of the current \$50-60/bbl oil prices undoubtedly lie on the demand side of the equation. Between 2000 and 2004, global oil demand increased by some 6.5mmbpd, of which 75% was in the non-OECD, and 25% in China. In fact 2004 saw rampant demand from China running at a rate close to 1.6x GDP, while US gasoline demand continued its secular upwards trend. This all coincided with fairly average supply growth, to remove any buffer of spare oil production capacity in the global oil markets. We estimate the net impact of these factors has currently reduced spare capacity to just 2% of demand, compared to a 'normal' surplus of around 5% of demand for much of the past decade. We would not expect a "normalisation" of oil prices for any substantial period of time until spare capacity started to rebuild - preferably to historical average levels. The problem is... the supply side of the equation looks unable to deliver this spare capacity in the near term, beset as it is with problems of offsetting decline rates in mature provinces, bringing onstream complex greenfield investments, or restoring supply after major disruptions (a la Gulf of Mexico).

In this environment, the focus inevitably shifts to the demand side, and to any signs of weakening consumption. In this context, Avian flu presents a serious risk. Near term, sharp reduction in airline travel would be felt immediately in demand - jet fuel consumption accounts for c.10%, or 8.5mmbpd of global oil consumption. Moreover, the risks to Asian demand - which has been the engine of consumption growth in recent years, are pivotal in the direction of oil prices over the medium term. The key point remains that close to 60% of the incremental demand barrel is directed towards transportation uses, and severe constraints on global mobility will have a huge impact on oil demand..

From a sector specific standpoint, it is worth highlighting that the recent bout of profit taking has been pretty indiscriminate, and that although secular themes such as the need to keep oil investment levels high will be unchanged, this points to the likelihood that there would not to be much in the way of a safe haven in the oil sector against a demand-led sell off. Bear in mind that oil price consensus for 2006 is already running at \$57/bbl levels. We argue that ultimately, OPEC will succeed in exerting its influence in stalling the fall in oil prices, because the marginal cost of supply is now materially over US\$30/bbl. We would anticipate currently that prices stabilise near our long run oil price estimate of US\$37.5/bbl Brent. With the sector discounting close to this level in current valuations, we would argue that buying opportunities would again emerge in the oil sector.

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## **Australian Healthcare**

### **CSL Ltd (CSL.AX; 1M; A\$54.80)**

In February CSL announced that their initial two dose clinical trial (400 patients) using a 15 microgram ( $\mu\text{g}$ ) antigen vaccine to the H5N1 avian virus produced an adequate immune response. The initial trial confirms that CSL could 'act now' if needed. Further trials (800 patients) will refine dose.

The Australian government has now placed a \$16.6m / 5m dose stockpile order that is likely to be filled 2HFY06. Vaccine manufacturers are 'scarce' and other nations are seeking access. Given the Australian funding of the project CSL is obligated to give priority to Australia; this may force Australia's hand to place a more significant stockpile order. The shelf life is uncertain, but could be 2 years, implying repeat orders. The USA has a >US\$100m vaccine stockpile order with Sanofi.

There is some suggestion that the vaccine be provided to the Australian population as a intermediate protective measure (would require 40m doses); this might 'buy some time' if a pandemic were to occur, as then a specific virus strain would be identified and specific vaccine produced. We also suspect that Flu Season 2005 will see higher uptake of conventional flu vaccine. This is supported by the recent announcement by the EU Health Commissioner who advised member nations to administer the standard flu vaccine to vulnerable portions of the population such as the elderly. Health officials apparently believe that the standard flu vaccine may help immune response should the bird flu strain link with the 'normal' flu.

If an initial outbreak were to occur, we would expect CSL to commence manufacturing a vaccine utilising the specific strain/current dose, with production of first lots expected to take 6 weeks, and sufficient volume for the Australian population within 3 months.

The company has advised that "community service" will be a key consideration in provision/pricing. The company is taking enquiries from other nations.

### **Ansell Ltd (ANN.AX; 1M; A\$10.92)**

We have confirmed reports of stockpiling of latex gloves by government and health authorities. ANN has indicated that they are experiencing a slight increase in sales of some products, exam gloves in particular. These are low margin gloves, which are being stockpiled in modest numbers along with other consumable supplies such as face masks. This is in line with what occurred during the SARS crisis.

In the event of an outbreak, ANN could expect a larger rise in sales resulting from higher than normal exam glove usage.

### **Biota (BTA.AX, NR)**

BTA has licensed their anti-viral Relenza to GSK; the product works by blocking the action of the viral enzyme associated with influenza, thus preventing the virus from infecting healthy cells nearby. The drug inhibits the spread of both the influenza A and B viruses and can be taken as a prophylactic or immediately upon the onset of flu symptoms. The Australian government is known to have stockpiled up to ~\$100m of this category of drug (primarily competitor Tamiflu). Both drugs appear to be in short supply according to media reports although we note that product has been available from time to time in late CY05 BTA receive a

7% margin on GSK sales of Relenza. The company continues to report that demand is exceeding supply although sales or production figures have not been released. GSK opened a new Australian production line for Relenza in Australia in January of this year with plans for a second line to be opened in the near future. Total cost of the expansion is ~AUD\$30m

The following orders are known to have been placed:

- French Government confirms Relenza stockpile of 9m units over the next two years (the product normally sells for between \$25 and \$30 in France).
- German Government has ordered 1.7 million units as announced in August 2005.
- Hong Kong government placed order for 150,000 packs.
- US Government has ordered 84,300 packs.
- Netherlands Government has placed order for undisclosed volume.
- Australian government ordered an additional 1.6m courses in December 05 at a cost of ~A\$40m. Previously Australia had a very small holding of around 25,000 courses.

There have been several media reports of other Relenza stockpiling orders by various countries, including the US, Canada, and certain European countries, but these orders remain unconfirmed or unquantified. Biota is seeking details of all Relenza orders and production plans from GSK.

The effectiveness of Relenza against Bird Flu remains a topic of debate. The Australian Government has granted Biota an additional A\$100,000 for testing of the drug against additional bird flu strains. GSK have conceded publicly that Relenza is not as suitable as Tamiflu for stockpiling in case of pandemic or epidemic; we believe this relates to shorter shelf life.

**Resmed (RMD.AX; 2M; A\$5.33) &  
Fisher & Paykel Healthcare (FPH.NZ; 2M; NZ\$3.80)**

ring the SARS crisis, China placed a US\$5m order for the RMD variable positive airway pressure device (VPAP) device. We understand that the (VPAP) and other respiratory devices are able to assist treatment of a flu related respiratory conditions. The VPAP devices have specifically been used to quickly expand hospital respiratory units. Though we are not aware of any specific orders, there is the possibility that devices could be ordered for stockpiling in anticipation, together with masks. If shown to be effective, the initial outbreak of a pandemic would see a corresponding increase in RMD or FPH VPAP sales.

**Australian Domestic Healthcare**

**Diagnostics**

In the preparatory phase prior to any breakout, it is feasible that a slightly higher than normal level of diagnostic services will be ordered by doctors. Pandemic identification to facilitate early action is viewed the key to successful casualty reduction. This will be achieved through the use of pathology (blood and tissue tests) and radiology (diagnostic imaging was key to diagnosis during SARS).

If a small to medium outbreak were to occur in Australia, we would expect significant increases in the level of diagnostic ordering with appropriate government funding. A full onset would most likely absorb all available diagnostic capacity (including the 'worried well') and force medical professionals to rely on more basic methods of diagnosis.

#### **Private Hospitals**

In an initial outbreak, GPs and emergency rooms of public hospitals will serve as the triage facility prior to hospitalisation. Only a few private hospitals have emergency rooms. It is likely that in the early stages of a breakout, suspected cases will be directed to large government run hospitals set up as quarantine or isolation areas. Few if any patients would be referred to private facilities in an environment of government control – GPs will be well versed in pandemic control by this point.

In a full onset scenario, all available medical facilities could feasibly be utilised for treatment but would be most likely overwhelmed in any case. Private hospitals make money from utilisation of their operating theatres; it is likely that all non-emergency hospitalisation will cease. Payments to private hospitals would be a matter of insurer and government negotiation but 'flu treatment/recovery' would likely be at the reduced 'day rate'.

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### **Australian Insurers**

An avian flu pandemic would, most likely, have a significant impact on life insurers with the impact by company likely to depend on whether that company was long mortality or longevity. A company, for example, that has a significant term life book is likely to be long mortality while those companies with a significant lifetime annuities book are more likely to be long longevity. In general most of the listed life insurers seem more likely to be long mortality than longevity which means an avian flu pandemic could have significant negative consequences. One mitigating factor would be that avian flu seems more likely to be an issue for the young and elderly, sectors of the population that are more likely to be uninsured for mortality risk. If the pandemic were to originate in Asia, then AXA (AXA.AX; 2M; A\$5.75) would appear to be particularly at risk of adverse consequences given most of its products in the region contain a significant protection element. It would be particularly unfortunate for AXA if avian flu were to cause significant deaths in Hong Kong.

Perhaps the biggest risk of all for life insurers, however, lies not on the liability side but on the asset side of the balance sheet, with the threat of collapsing equity markets. This risk would also apply to general insurers and fund managers which are also exposed to the equity market either in their shareholders' funds or in relation to the fee income they derive.

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### **Latin America**

So far, Latin America has been isolated from any evidence of avian flu and there is confidence, which seems justified, that the region may remain that way. Naturally, of course, the risk that avian flu arrives in Latin America eventually may be high, such that current confidence in the region's relative isolation may prove to be complacent.

Nevertheless, in the event that Latin America is isolated from the virus, we would highlight the likely following effects on regional markets:

- Latin American equity markets will benefit relative to Asia, which appears likely to be worst affected by avian flu. At the margin, investors would be encouraged to increase relative weightings in Latin America.
- Mexican equities (which are highly dependent on domestic demand and the US economy) should hold up better than Brazil (which is much more dependent on the commodity cycle and specifically China). Chile would suffer from cross-currents, as its economy is the region's most dependent on Asia, but is also seen by investors as a safe-haven.
- Certain domestic activities in the region (some of which are currently growing strongly) would be likely to continue largely impeded, such as homebuilding in Mexico (which could be seen as a defensive sector in this sort of event).
- On a global avian flu pandemic, our relative calls in the region would be Overweight in Mexico, Neutral in Chile and Underweight in Brazil.

### **Stock Selection - Defensive Names**

Given that Latin America is likely to be less affected by avian flu than, perhaps, any other region in the world, a list of defensive names in Latin America should be interesting to investors. Such a list would include stocks such as: **Cemex** (CX; 1L; US\$59.54 - cement, Mexico), **Walmex** (WMMVY; NR - retail, Mexico) and **Corporacion Geo** (GEOB.MX; 1M; P\$33.00 - homebuilding, Mexico).

### **Sells/Underperforms**

Within the region, we would see the following sectors and stocks as negatively affected by a global avian flu pandemic:

- *Transportation:* especially **Lan Airlines** (LFL.N; 3M; US\$39.22 - Chile). **Embraer** (ERJ; 2H; US\$39.90 - Brazil), would be affected, but less so as it manufactures regional (not long-haul) jets and so should be less exposed than other aircraft manufacturers;
- *Tourism:* **Asur** (ASR; 1M; US\$35.80 - Mexico);
- *Resources/Materials:* we would expect the mining companies to be the worst affected: **Antofagasta** (ANTO.L; 1M; US\$35.36 - Chile) and **Southern Copper Corp** (PCU.N; 2H; US\$79.38 - Peru), both of which have copper exposure and **CVRD** (RIO\_p.N; 1M; US\$38.66 - Brazil), which has mainly iron ore exposure;
- *Oil/gas:* This sector is also likely to be hurt given that a flu pandemic is likely to lead to a reduction in demand for oil due to a slowdown in the global economy and a reduction in air travel. The companies likely to be hit in Latin America would be: **Petrobras** (PBR; 3H; US\$86.05 - Brazil) and **Tenaris** (TS; 1M; US\$172.25 - Argentina) the latter of which is a pipe manufacturer);
- *Food:* A natural major loser from such a pandemic would be **Bachoco** (IBA; 2H; US\$17.10 - Mexico), which is a chicken producer.

### **Buys/Outperforms**

There are several attractive names in the region in sectors that should act defensively in the face of an avian flu pandemic:

- *Telecoms and Media:* **Telmex** (TMX; 1L; US\$22.75 - Mexico), the defensive incumbent fixed-line operator in Mexico; **Televisa** (TV; 1M; US\$75.08 - Mexico), the leading media company in Mexico;
- *Consumer non-discretionary:* The best names here are also in Mexico: **Walmex** (WMMVY; NR – Mexico, retail) the leading retail chain, **Modelo** (GMODELLOC.MX; 2L; US\$3.32 – Mexico, beverages), the most defensive beverage company with a global brand and **Gruma** (GMK; 2M; US\$12.15 – Mexico, Food), a leading food manufacturer;
- *Bank:* Banks should also be fairly defensive in an environment of slower growth and, most likely, lower interest rates. In Latin America, the best banks to hold would be: **Banco Itau** (ITAU4.SA; NR - Brazil) and **Banorte** (GFNORTEO.MX; NR - Mexico);
- *Utilities:* This should be a defensive sector. Within our narrow coverage of the sector, we would highlight **Sabesp** (SBS; 3S; US\$19.25 – Brazil, water utility).

# Notes

# Notes



# Notes

**ANALYST CERTIFICATION****Appendix A-1**

We, Bruce Rolph and Robert Bonte-Friedheim, research analysts and the authors of this report, hereby certify that all of the views expressed in this research report accurately reflect our personal views about any and all of the subject issuer(s) or securities. We also certify that no part of our compensation was, is, or will be directly or indirectly related to the specific recommendation(s) or view(s) in this report.

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