ALAMBIC FUNDS

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Going Viral: The Cost of Pandemic or Panic and the Novel Corona Virus (COVID-19)

Government reports are questionable, the science is in hypothesis-stage and historical analogies don't quite fit, ***but just how the coronavirus epidemic/pandemic plays out may determine the success (or failure) of investors' portfolio decisions over the next year (or two).***

We have a non-consensus view on the outbreak, believing that the most likely outcome (50%) is a mild global pandemic lasting up to two years. Consensus projects containment within 6 months, but we give that lower probability (35%). Whatever the outcome, the economic reaction will be determined by the level of anxiety (or panic), rather than the human toll, tragic though that may be. We expect the severity and impact of the outbreak to be 3 to 4 times that of a normal flu season, and although there is a small chance (15%) that it will be even more severe, it will almost certainly not be as bad as the Spanish Flu outbreak of 1918.

Initially, we expect markets to continue to rally as China's success in slowing the outbreak continues. Full eradication in China, however, seems unlikely thanks to the relatively high proportion of mild cases and the fact that asymptomatic transmission has now been confirmed. Over time, the focus will shift to other countries, particularly those that are less developed, where the outbreak is likely to take firmer hold. When that occurs, the rate of case growth is likely to climb again.

We therefore believe that expectations of a sharp slowdown followed by a V-shaped recovery are misplaced. As factories re-open and the economy resumes "normal activity", the Chinese economy will certainly improve from its current virtual standstill. But, resumption of activity risks a reacceleration of the outbreak over the next 1-2 months. Meanwhile, the true impact of China's slowdown will start to ripple through global markets, just as the virus does the same. Ultimately, it will be these economic ripples, not the number of cases, that will determine the extent of the damage to equity markets.

Alambic Insights

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Albert Richards launched Alambic Investment Management, L.P. in 2006, with over 20-years of equity research experience and a lifetime technical acumen. Bert and Brian Thompson, Bert's longtime friend and colleague from the PhD program at MIT, started the firm to bring thoughtful human insights to the design, development and operation of systematic investment strategies. Now with a 8-year track record, the team launched their first product, an equity market neutral hedge fund in 2011.

Before starting Alambic Investment Management, Bert perfected the art of tearing apart financial statements to find value and opportunity. As a sell-side analyst and head of research within two large global investment banks, Bert became adept at identifying and quantifying the key drivers of equity valuation and company quality as well as the behavioral pitfalls that create market opportunities.

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Recently renamed COVID-19, by the World Health Organization, the novel coronavirus has been widely compared to SARS, MERS and Ebola. These historical analogies, however, are examples of contained outbreaks. Should this one "get away" (and there are signs that it already has), other pandemics such as the Spanish Flu of 1918, Asian Flu of 1957, Hong Kong Flu of 1968 and Swine Flu of 2009 would be much more apt comparisons. Further, the effects are likely to be more severe, as there is evidence that COVID-19 has a higher mortality rate than all of these except Spanish Flu.

Developed markets are behaving as if the crisis is over, the respective stock indices are now generally back to (or above) their levels of three weeks ago, and the "buy the dip" moment seems to have come and gone. But while no one is hoping for a pandemic, evidence supporting the market optimism is shaky at best. SARS-like containment remains possible, but we don't think it's probable, and hence this may be the beginning of a much more difficult, and lengthy journey. April has been cast as the month the outbreak is expected to be over (and we hope it is), but evidence suggests it could instead be when the global impact hits its stride.

In the following pages, we analyze where the outbreak stands today in historical, epidemiological and economic contexts, and why we believe a mild global pandemic with far-reaching economic damage is more likely than quick containment and further market ascent. We begin with our Bull, Base and Bear Cases.

Bull, Base and Bear Case Forecasts

Bull Case (35%): The outbreak is reasonably quickly contained (like SARS and MERS), and remains geographically-concentrated in China with scattered cases in a number of other countries. China's GDP growth dips to around 3.5% in Q1 and then recovers quite robustly over the remainder of the year. Global growth is negatively impacted by 0.5%, similar to SARS, and the economic damage is mostly "contained" in H1 2020. Q1 2020 U.S. growth is projected to be 1.2%-1.5% and improving thereafter. In our view equity markets have already priced in this outcome.

Base Case (50%): A mild global pandemic (similar to Asian Flu of 1957 and Hong Kong Flu of 1968), starting slowly, lasting 1 or 2 seasons (years) and curtailed with eventual vaccine development. China has initial success in slowing the rate of progression significantly, and global equities continue to rally in response, but progress stalls as the country goes back to work and human interaction increases. Countries where the virus has already arrived (*e.g.*, Hong Kong, Singapore, South Korea and Europe) find COVID-19 difficult, if not impossible, to eradicate, as many patients suffer only mild-to-moderate symptoms. Over the next several months, the virus becomes embedded in a number of developing countries (like African nations, which are home to 1 million expat Chinese), which become an ongoing source of outbreaks in the developed world. Chinese growth dips to 2.0%-2.5% YOY in Q1 and the rebound back towards 5% per year is slower than expected. Anxiety levels outside China increase, further slowing global economies by a 0.75%-1.25% annual rate, and recession risks increase for both Europe and the United States. Equity markets struggle, ending down for the year, credit spreads widen, interest rates remain low and the Fed is impotent in trying to accelerate growth. While unpopular, this outcome is not unlikely – but the market seems to be discounting it altogether.

Bear Case (15%): A moderate pandemic that accelerates over the next 6-12 months as containment actions fail to sustainably slow the global spread despite China's initial successes. The human toll is 4x-8x a normal flu season, and anxiety turns to mild panic with the resulting shifts in consumer behavior causing Chinese growth to drop to around 3% for the year (challenging its financial system) while the United States and Europe are pushed close to, or into, outright recessions. Equity markets reverse course meaningfully, credit spreads widen and financial stress increases for levered firms. Inflation threatens to pick up as governments

resort to even larger deficit spending. Watch what happens in Singapore for how this might play out – they already have 67 cases and 8 are in intensive care, a very worrying ratio, and containment is challenging.

Note that we do not have the "Spanish Flu Outcome" included in any of our cases, first because COVID-19's mortality rate seems significantly lower, and second because of advances in disease treatment and vaccine development. Should morbidity turn out to be higher than we forecast, risks would increase.

Containment or Pandemic? Evidence Points Towards Pandemic

In our opinion, the key investment question is "Containment or Pandemic?". A contained outbreak, such as SARS, MERS and Ebola, generally has a fairly quick impact, a fairly robust rebound, and a limited geographic spread. To date, nearly every analysis we've seen is predicated on the assumption that it will be a contained outbreak. While still possible, we do not believe this is probable.

A pandemic is longer-lasting (generally 2 years), and it comes with a much wider geographic spread. We believe a mild global pandemic is significantly more likely than containment, as COVID-19 has multiple epidemiological similarities to past pandemics. Below are some of the largest pandemics of the past century. We believe the Asian Flu of 1957 and the Hong Kong Flu of 1968 are the most apt comparisons, with the much more severe Spanish Flu of 1918 (thankfully) much less likely, and the Swine Flu of 2009 an inappropriate analogy because of its unusual, and extremely low, mortality rate.

Pandemic (Subtype)	*Dates*	*Estimated Deaths*	*Estimated %Infected*	*US Deaths*	*Estimated Mortality*	*Source/Location First Noticed*
Spanish Flu of 1918 *(H1N1)*	1918-1920	30-50m	33%	500-675k	10-20%	Unknown/ Unknown
Asian Flu of 1957 *(H2N2)*	1956-1958	1.0-1.5m	25%	70k	0.25%	Wild Ducks/ Guizhou, China
Hong Kong Flu of 1968 *(H3N2)*	1968-1970	150-575k	15-20%	33,800	0.20%	Evolved from H2N2/ Hong Kong
Swine Flu of 2009 *(H1N1/09)*	2009-2010	150-575k	25%	13,000	0.02%	Eurasian, North American pig flus/ Veracruz. Mexico
COVID-19 *(nCov)*	2019 - ??				0.5-1.0%	Bats via pangolin/ Wuhan, China

Sources: Wikipedia, CDC – deaths, infection % and mortality rates are very rough estimates based on additional inputs from a range of academic papers.

China's efforts notwithstanding, containment will largely be decided by whether the virus migrates to uncontrollable regions. We are already seeing disturbing case growth in Hong Kong, Singapore and Thailand – and even growth in Europe is concerning. But these are all relatively developed regions, with resources, control and a chance of containment. What will happen if the virus gains a foothold in Vietnam, India, Africa or South America? Indeed, it may already have – we just can't know because of a lack of testing (Japan hasn't even tested all the passengers on the quarantined cruise ship in Yokahama harbor). If the virus

spreads to the developing world, it will be a gamechanger for both the world economy and global equity markets, because ***if COVID-19 becomes established in the developing world there is virtually no way the developed world will be able to keep it out.***

In terms of potential human impact, COVID-19 seems to in the middle of the most notable pandemics of the past century. Although its transmission rate appears in line with the seasonal flu, and reports suggest that – like seasonal flu – most deaths have been in older individuals (60+) and those with existing medical conditions, comparisons with the seasonal flu are highly misleading because of a difference in mortality rates. If COVID-19's mortality rate is 0.5%-1.0% (and there is a lot of uncertainty around this figure), it is much more deadly than seasonal influenza (0.10% or less), which means that, even with improved detection, monitoring and treatments we could still see an mortality impact that is 3x-5x that of a normal flu season.

While comparisons with Swine Flu of 2009 (officially called pandemic H1N1/09 virus) are tempting if for no other reason that it was the most recent pandemic (and the source of considerable, but eventually unwarranted, panic), we believe these may understate the overall impact because of a dramatic difference in mortality rate: the mortality rate of Swine Flu, ultimately 0.02%, is unusually low. From a virulence standpoint, however, there seems to be a lot of similarities. Swine Flu infected about 60 million people and thus a potentially worst-case outlook would be 60 million Americans with COVID-19, which, without mitigation, could result in 500,000 to 1 million deaths. We believe this will be prevented, most likely with a vaccine – but not without a lot of angst along the way should the virus get a firm foothold here. The U.S. also doesn't have China's authoritarian defenses – can you imagine trying to quarantine Houston?

While we have faith in a vaccine being the eventual solution if containment fails, it will take months, if not years, of development. COVID-19 hasn't displayed the ability to rapidly mutate like seasonal influenza (yet), so a vaccine could be a very viable medium-term solution, albeit with plenty of time for economic damage to be inflicted during development and testing. In addition, while we remain hopeful, healthy skepticism seems appropriate for any of the anecdotal "cures" reported in the popular press.

Even if the virus is eventually contained in China, we believe the economic impact will be stronger and longer than most current projections. We find it at least equally likely that COVID-19 escapes containment, either through higher-than-expected virulence, the effect of asymptomatic transmission, or by infiltrating lesser-developed regions of the world. The 2009 Swine Flu originated in Mexico and became a pandemic by escaping containment. Should this happen with COVID-19, the downturn could be bigger and more global, and the recovery less certain.

China has essentially forced its economy into a near stand-still as it tries to stem the spread. It now faces a dilemma; re-start the economy and risk the virus re-accelerating or continue to exercise control over a population now struggling to get adequate food and medicine and risk a much more meaningful slowdown or a financial crisis. We're glad we're not the ones trying to navigate those waters, but we don't see either path resulting in a simple and short hit to growth followed by a strong rebound. If there is even a 10% chance that the virus is not contained in China, buying at market highs carries a great deal of risk.

Balancing Concern and Panic

The criticism heaped on the response and coverage of the 2009 H1N1 outbreak provides important context for the assessment of news and information related to COVID-19. Generally referred to as 2009 Swine Flu, WHO was accused of spreading unnecessary panic about an outbreak that turned out to be quite mild from a health point of view. A good article on the extent of that panic can be found here. As a result, WHO must be vigilantly considering how to target the level of alarm with COVID-19 – too high (as, with hindsight, was the

case with the 2009 Swine Flu) risks unnecessary social and economic damage – too low risks letting the virus get out of control (as was the case initially in Wuhan, although through no fault of WHO).

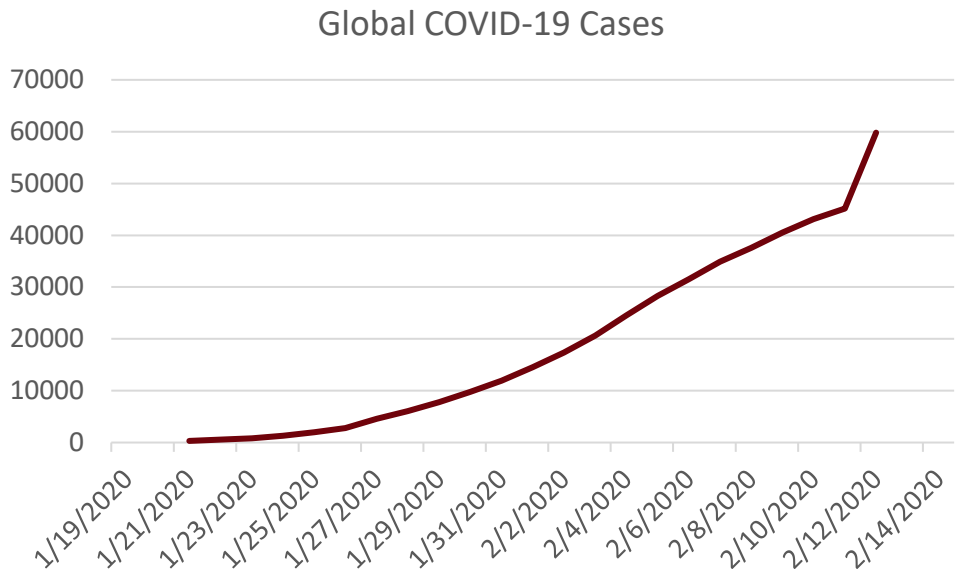
As with the 2009 Swine Flu outbreak, "pandemic panic" may cause more economic damage than the pandemic itself. Although relatively mild from a health point of view, Swine Flu nonetheless shaved an estimated 0.5% from Global GDP. With COVID-19, investors should be as concerned about the level of panic as they are about its direct health effects. The market has been conditioned to expect the best possible outcome (and "buy the dip"), but if the mood flips the impact on the market could be sharp and lasting. At present, the combination of WHO (we believe) downplaying the severity of the situation and investors' "favorable outcome" bias seems to be taming the panic. Bad news regarding either virus progression or poor short-term economic results could shift the mood quickly.

That said, despite our more bearish-than-consensus opinion, our goal is to present a balanced view of the data, and to point out some of the risks should things go poorly – not to inspire panic. This too, shall pass.

How Extensive is the Outbreak So Far?

The simple answer is "pretty extensive" in China, and "mild, but steadily growing" in the rest of the world. We are particularly concerned about Singapore, Thailand and South Korea in the near term, and about the developing world over the longer term. We believe that if COVID-19 gains a foothold in any lesser-developed country, it's "game over" for containment and the focus will shift to a vaccine race, elongating the outbreak and exacerbating its economic effects.

Globally, and as shown below, total confirmed cases are now over 60,000 (and still growing rapidly, although at a slower pace than a few weeks ago), well past the SARS epidemic of 2002/03 (8,100 cases) and also past the West African Ebola outbreak of 2013-2016 (28,646 cases). Along with the possibility that WHO is downplaying the significance, there is also the possibility that numbers from China are being dramatically understated, if for other reason than a lack of test kits.



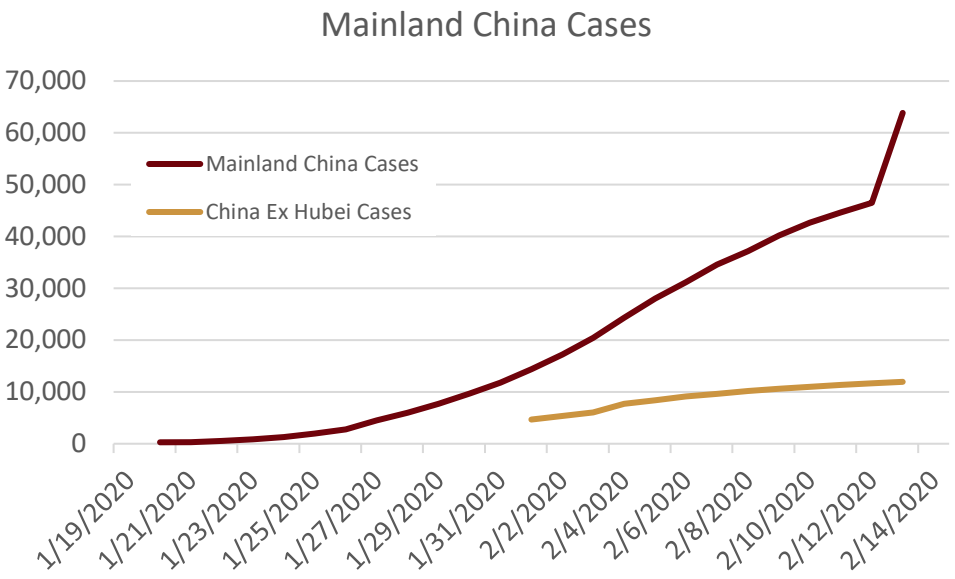
Source: World Health Organization

Data integrity is an important consideration in any detailed modelling and no less so when it comes to COVID-19. With any epidemiological study, it is difficult to get consistent data, and when the data collectors

are also in the front lines of a medical, humanitarian and social drama, it is difficult to make data integrity a priority. The Chinese have been diligently delivering daily statistics, but there is i) some anecdotal evidence that calls into question the integrity of these figures, and ii) no shortage of conspiracy theories, doctored videos, fake websites, etc. that will give any view you want (and probably a few that you don't want).

We admit that we don't have any special insights as to which dataset is "true" and which is doctored, manipulated or just plain made up. This said, there are a couple of logical places to start. First with the official Chinese government statistics – these can be found in a variety of places, including the official website (use Google Translate), and an online dashboard put together by Johns Hopkins University (this can be frustratingly slow to update, so treat the most recent numbers with caution). Another summary website, seems to update the figures relatively shortly after release, and finally, the most comprehensive source is WHO's website, which has both a dashboard and daily briefings on disease progress.

Even the official Chinese figures, questionable as they may be, do not paint a particularly comforting picture. In China alone, total "confirmed cases" are well over 60,000, with over 50,000 of these coming from Hubei. The progression of reported cases in mainland China is shown below, and while there has been a slowdown in the rate of growth, we are still a long way away from containment.



Source: World Health Organization

February 5th was the first day that the growth rate of new daily cases in China declined (roughly 3,900 new cases were reported on February 4th vs 3,700 in February 5th), and there has been a further stabilization/decline in reported new cases since then. This brought the reported daily percentage increase down to 6%-8% after running slightly below 20% for several days in a row. A 6% daily increase still implies a doubling of reported cases every 11 or 12 days, so further reductions remain necessary.

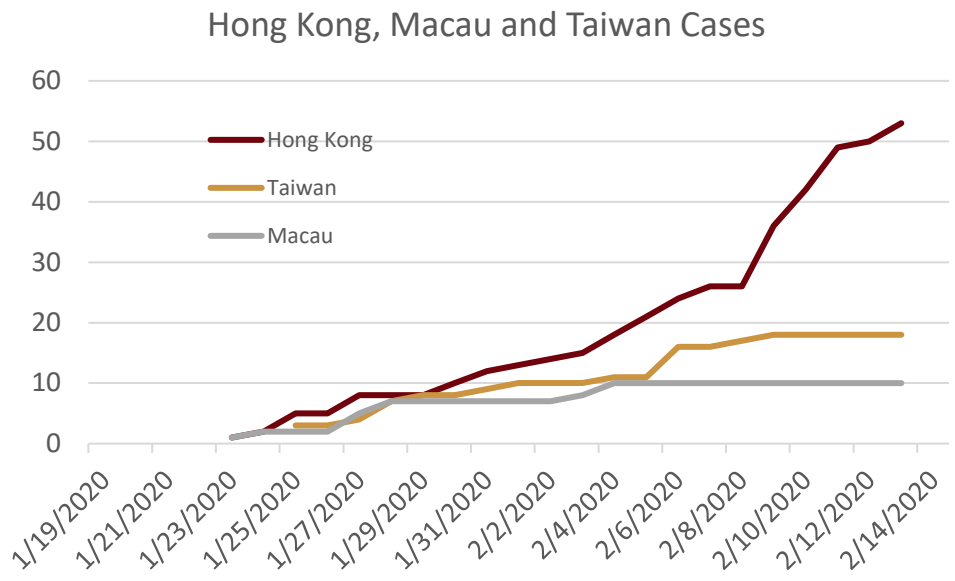
More recently, there was a very large, one-day jump in Chinese case counts. ***This was the result of the province of Hubei switching from a "confirmed test" standard to a "symptom-based standard" for counting the number of cases***, most likely due to a shortage of test kits. Further similar revisions similar are likely.

While the decline in daily (reported) new cases in non-Hubei China is encouraging, there are a few reasons to be skeptical. First, the changes appear a bit too uniform from province to province – one would expect a bit more variation depending on local conditions. Second, the quick decline in new case growth in response to

government efforts seems inconsistent with the incubation period of the virus. Finally, the rate of increase in case counts seems suspiciously low. Over a recent 5-day period, Hong Kong and Singapore cases doubled, Hubei's were up 50%, and yet the other Chinese provinces reported increases of around 20% - a seemingly stunning achievement as far as containment goes relative to the highly sophisticated efforts of, say, Singapore.

While China is in the news, we believe case growth elsewhere is more important, because ex-China numbers provide better indication of i) whether containment is possible, ii) the virulence of the disease, and iii) mortality rate. We examine a number of different countries below, all while noting that some statistics are likely highly reliable (*e.g.*, Singapore and Hong Kong, in our opinion), whereas others may not be as consistent or complete.

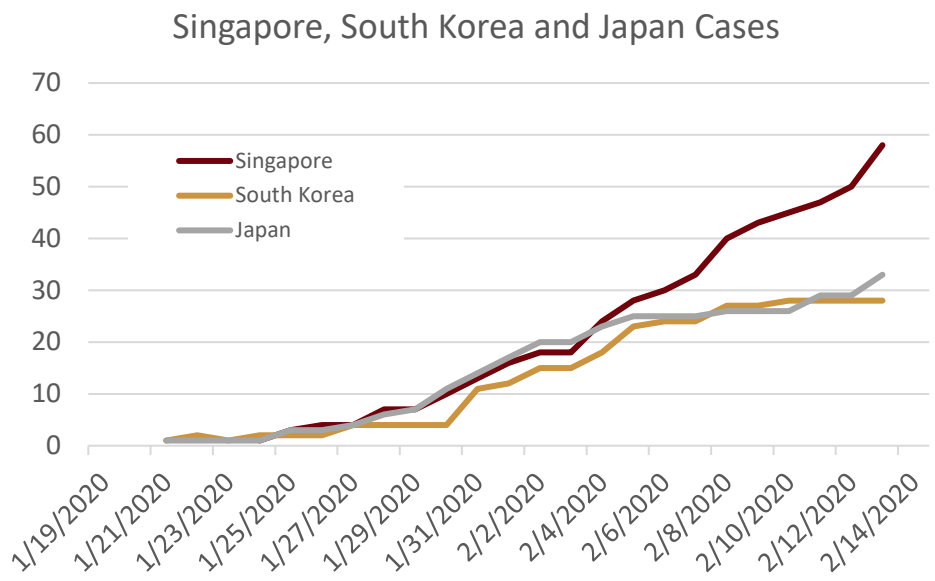
Cases in the China-connected areas of Hong Kong, Macau and Taiwan are shown below. These have also been growing, albeit from a low initial base. The largest number of confirmed cases are in Hong Kong, which is already in recession and which is particularly vulnerable to COVID-19 due to its high population density (some Hong Kong apartment blocks look like vertical cruise ships). The growth in Taiwan was also concerning, although it seems to have slowed recently. While there are currently only 18 confirmed Taiwanese cases, there are another 1,470 on a list of suspected cases (a number that recently increased by 71 in one day). Cases in Macau, meanwhile, have been steady at 10 for several days. While we don't have any concrete evidence of misreporting, the figures do seem low relative to the developments in the surrounding regions, and we also note that any increase in cases could have a devastating impact on the world's gambling capital, already closed for 2 weeks because of the outbreak (so there's a strong economic incentive to hide the truth).



Source: World Health Organization

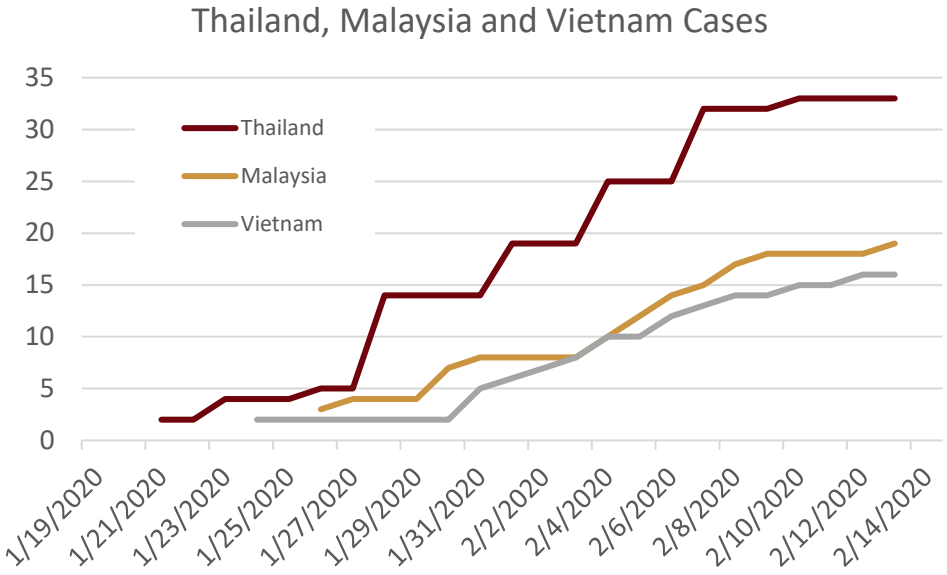
The data from Singapore, South Korea and Japan, shown below, excludes the cases (now 218!) from the cruise ship docked in Yokahama, Japan. Initial cases in these countries were the result of infected individuals traveling from China – mainly visiting Chinese nationals, but also locals returning from travel in China. More recently, there have been more person-to-person infections in these regions, a distinctly concerning development. Of these totals, the rapid rise in Singapore is concerning, particularly since there are now

cases of individuals who have never been to China contracting the virus while visiting this city-state (further details below).



Source: World Health Organization

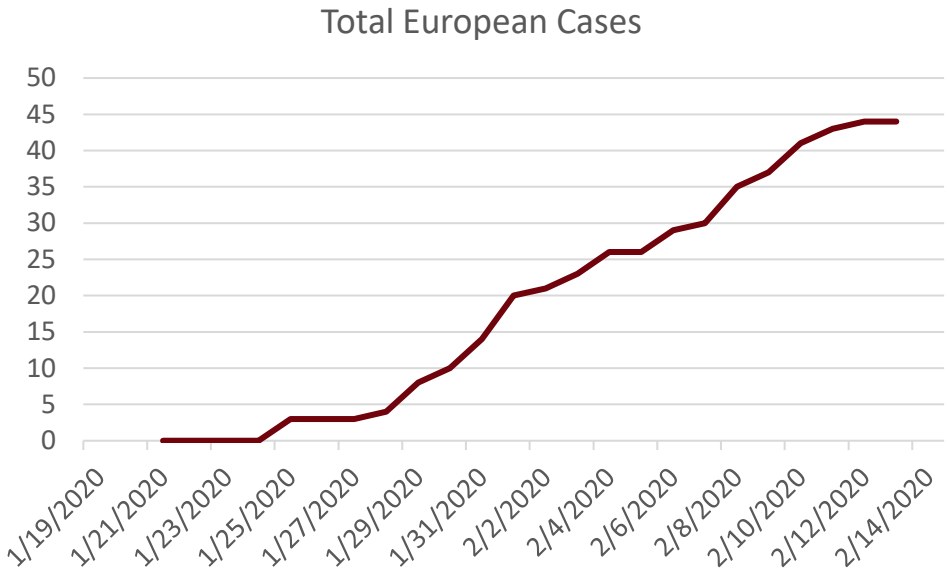
Cases in Thailand, Malaysia and Vietnam, shown below, Thailand stands out not just because of its relatively high case-count, but also because it (like Singapore) has been identified as the infection source for a foreign patient who never visited China (in this case it was a woman from Korea). Thailand is, of course, a major tourist destination for visitors from around the world, with nearly 40 million annual visitors (including roughly 10 million from China and over 1 million from the United States), so we would not be surprised to see an increase in such cases (hence we find the recent plateau perplexing, particularly relative to Singapore & HK).



Source: World Health Organization

There is solace in the fact that the case numbers in these last six countries are all quite low, with a combined total of about 175. Good news from a containment perspective, as authorities can both effectively isolate the infected, and extract considerable detail in their recent contacts. Singapore, in particular, has done an impressive job, going so far as to list the recent travels of the new patients in the local press. So, it's too early to give up hope on containment, particularly in the more developed countries. But we would note that the combined total of 175 cases is roughly equal to the total number of reported cases in China in mid-January. While the China figure was probably understated, it highlights just how fast this virus can move in just 3-4 weeks.

We were struck by the chart of total European cases, shown below, as the reported case numbers by country seem quite benign (a few here, a few there), but when taken in aggregate the resulting picture is concerning. Although most of these cases originated with travelers from or visitors to China, Singapore has emerged as the source of a number of infections, despite having acted swiftly and decisively to contain the infection. Given the extensive nature of some infected individual's travels, we wouldn't be surprised to see an acceleration of the case load as we pass the incubation period for the virus.



Source: World Health Organization

What Are the Symptoms?

The most obvious symptoms of COVID-19 are fever, cough and shortness of breath or other breathing difficulties. According to WHO, around 80% of cases exhibit relatively mild symptoms, whereas 15% develop pneumonia and 3%-5% require intensive care – some of whom succumb to the virus. The sickness seems to last about 14 days. It is spread via airborne and surface particles and the incubation period seems to vary from 2 to 11 days, with a reported mean value of 6.5.

Taiwan recently reported the first asymptomatic COVID-19 infection (details here), although it remains unclear whether or not the patient is infectious (more recently, the U.S. CDC confirmed asymptomatic transmission). Somewhat surprisingly, data on the duration of the virus is somewhat scant. While China has been reporting "cured and discharged" statistics, these have lagged (far) behind the number of confirmed

cases. Singapore has reported details on some of their discharged patients, and there seems to be a gap of around 11 days between the date of infection confirmation and the date of discharge.

How Contagious is COVID-19?

Our impression is that COVID-19 is "pretty contagious, but certainly not measles". One measure of a virus's virulence is what experts call the reproductive number, designated R0 or "R-naught". Quite simply, this is the average number of new infections that are caused by each infected person.

Various initial estimates for the R0 o COVID-19 have varied from 1.4 to 4.1, quite a broad range but understandable given the dearth of data. This puts COVID-19 near the contagiousness of seasonal flu, which generally has R0's in the 1-3 range. To put this in context of other constrained outbreaks, Ebola's estimated R0 is between 1.5 and 2.5, SARS estimates vary from less than 1 to 2.75, and the much more toxic MERS had a reported R0 of around 1.0. Meanwhile, polio and smallpox are significantly more contagious with R0's in the 5-7 range, and for measles it is an amazing 12-18.

So why is COVID-19 more difficult to contain if it's R0 is near that for SARS and MERS? The answer is two-fold: first, it has already been spread far and wide, and, second, many of the victims only have mild symptoms and hence infect others without seeking treatment. SARS and MERS were extremely deadly, and nearly everyone infected was hit hard with symptoms. This put them into hospitals, where their movements could be restricted and the effective R0 reduced. COVID-19 presents in many patients like a normal seasonal respiratory illness, and it is easy for those with mild symptoms to hope/medicate it out of their way while spreading it on to the wider, and perhaps more vulnerable, community. Indeed, we speculate that this is the reason the Chinese authorities have been "rounding up" anyone with even a mild fever in Hubei and putting them in quarantine centers. It's not that they need treatment, rather they need to be isolated from other, healthy individuals lest they pass on the virus.

The 2009 Swine Flu, an uncontained pandemic, had an estimated R0 of 1.46 to 1.48 – a figure at the lower end of COVID-19 estimates. However, while the relatively low R0 for 2009 Swine Flu suggests that it may have been contained if efforts had started sooner, Veracruz, Mexico, where the outbreak originated did not have sophisticated medical monitoring systems at that time. The Mexican government tried closing most of Mexico City's private and public facilities, but by then it was too late. R0 estimates for the 1918-1920 Spanish Flu, which found its way to almost every corner of the earth, range from 1.4 to 2.8, with a mean of 2.0 (again similar to that for COVID-19).

While R0 is a scientific way to describe virulence, it is highly variable and dependent on factors that are not easily controlled, like population density, severity of symptoms, the "liquidity" of the disease-specific transmission paradigm, and how long it lingers outside of a host. Even though we are quants, we find it helpful to lean on anecdotes to gauge this panic. Our first example is the case of a Chinese woman from Shanghai, who visited the German headquarters of auto-parts supplier Webasto SE and touched off a cluster of 10 cases – 8 Webasto employees and two of her Chinese co-workers, as well as two children of one of the workers (the Shanghai woman had visited her parents in Wuhan before her trip). While this is just one case, the implied R0 is at least 8, which makes it seem quite contagious. It was initially reported that the woman was asymptomatic when she infected her coworkers (which would have been an extremely worrying development), but this was later found to be false.

Our second example is the Diamond Princess, a 3,700-passenger cruise ship currently quarantined in Yokohama (south of Tokyo) after 10 people were found to have the coronavirus – apparently all caught from an 80-year-old Hong Kong man who tested positive for the virus after disembarking in late January (potentially an R0 of 10). The 10 cases were removed from the ship, and it was initially placed on a 2-week quarantine – but another 10 cases subsequently emerged, again implying fairly high contagiousness. On February 6th, it was announced that a further 41 cases were found on the ship, bringing the total to 61, and this figure has more recently more than doubled to 174, including 24 Americans. Amazingly, only about 450 of the 3,700 passengers have even been tested for the virus due to a shortage of test kits.

- https://www.reuters.com/article/us-china-health-japan-cruise/twenty-virus-infections-on-cruise-ship-in-japan-passengers-confined-to-cabins-idUSKBN1ZZ360
- https://www.straitstimes.com/asia/east-asia/coronavirus-another-41-on-japan-cruise-tested-positive-nhk
- https://www.kron4.com/health/coronavirus/at-least-24-americans-among-135-infected-with-coronavirus-on-diamond-princess-cruise-ship/

The cruise ship example above has prompted considerable speculation in our office. Does the 2-week quarantine re-start every time another case is discovered? If this is the case, those poor passengers (reportedly confined to their often-cramped cabins) could be in for quite a wait. And who in their right mind would board a cruise ship is this is a potential outcome? In addition to the Diamond Princess, three other cruise ships have hit coronavirus issues, the Westerdam (docked in Cambodia after being denied entry to ports in Japan, Taiwan, the Philippines and Thailand), the World Dream (quarantined for 5 days in Hong Hong, no confirmed cases) and the Anthem of the Seas (held in port in New Jersey, all 27 people screened were cleared). We can only assume that the people hopping on cruise ships these days are the same ones that are bidding up this market, as they both seem to have extremely high levels of risk tolerance.

- https://www.cnn.com/2020/02/05/asia/coronavirus-cruise-quarantines-intl-hnk/index.html

Finally, there are increasingly more reports of COVID-19 cases that were contracted by people visiting countries other than China. To the best of our knowledge, the first is the case of a transmission like this was a Korean woman who contracted COVID-19 while visiting Thailand, and the second is a UK individual who contracted the illness in Singapore, and who then went on to infect a number of additional individuals at a ski chalet in France. As a result, in order to track the spread, health professionals/officials would need to screen patients who haven't even visited China – this also implies that the ability of the virus to jump national boundaries easily surpasses any government attempts to close borders and/or restrict travel (although travel restrictions may still make sense if they slow the spread of the disease). It also has major implications for the spread of the virus even if China's attempts at containment are successful.

- https://www.straitstimes.com/asia/east-asia/coronavirus-south-korean-woman-travelling-home-from-thailand-tests-positive-for-virus
- https://www.telegraph.co.uk/news/2020/02/06/coronavirus-uk-third-patient-tests-positive-deadly-illness/

This leads us to the conclusion that "the cat is probably out of the bag" despite China's heroic/autocratic efforts to curb the virus within the country. Containment complications will compound as the virus spreads to regions with more vulnerable populations and less-sophisticated healthcare systems (indeed, it possibly

already has) and/or to populations that are less willing to be quarantined (Would you go to the "containment center?"). This means that, over the next weeks and months, we may transition from forecasting the timing of the eventual containment to dealing with a pandemic, even if China is successful in bringing down its infection levels. Any evidence of containment in China may soon be superseded by rising case counts elsewhere.

If the virus spreads significantly from China, vaccination will be the best hope for containment. Vaccine science has come a long way, but it is worth noting that Ebola was first identified in 1976 and there have been numerous outbreaks since then (the largest being in 2013-14), yet vaccine approval in the United States didn't occur until December of 2019, and to date only about 100,000 people globally have received it. While scientific advances have shrunk development times, we are probably looking at months, not weeks, before any sort of product is through development, testing and dissemination – even on an accelerated timetable. A good summary on vaccine development can be found here:

- https://www.statnews.com/2020/02/06/cepi-coronavirus-vaccine-development/

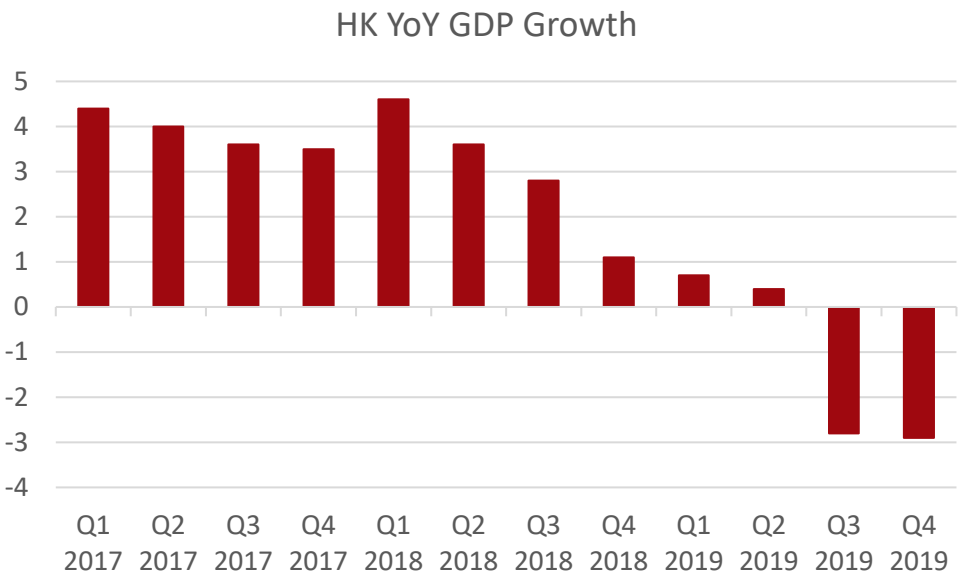
Potential Economic Impact in China

The economic impact of a single sick individual is relatively small, but due to fear and behavioral changes of the healthy, the effect increases exponentially as the number of sick rises. From an infection point of view, SARS was quite limited, infecting just over 5,000 people in mainland China before it was relatively quickly contained. COVID-19, in contrast, is now infecting that many people every two days – and its effect is being seen throughout China as opposed to being primarily concentrated in just a few provinces (even though Hubei is clearly the epicenter).

So far, the "panic pandemic" has also been mostly confined to China. As a result, economic activity in China, while perhaps not "coming to a screeching halt," has been significantly curtailed. Rather than relying on official statistics (which haven't been collected, let alone released, for the timeframe in question), we resorted to social media to gauge what is going on "on the ground." Wuhan is an effective ghost town, as widely reported across the mediascape. But economic activity in Shangai and Beijing is also frozen, at least from a consumer activity (and probably consumption) point of view. Videos of the empty streets of these to metropolises can be found here:

- Beijing: https://www.dailymotion.com/video/x7rkj5t
- Shanghai: https://www.youtube.com/watch?v=hTDMRtvxGc0
- Beijing: https://www.youtube.com/watch?v=QRZTlYNjmso

While not a scientific analysis, these videos do not reflect an economy that has merely eased from 6.0% growth to 4.5% growth. As a reference point, we look at the trend in Hong Kong GDP as it became increasingly influenced by the anti-government protests over the course of 2019. We start with a chart of year-over-year GDP growth, by quarter:



Source: Trading Economics

The Hong Kong economy was under strain before the protests, which began in March of 2019 but didn't gather steam until Q3, and the decline in growth from Q2 to Q3 was probably due to more than just the protests, but we believe they were the primary factor as shops were often closed and consumers pulled back spending. Even though the protests were not widespread throughout the City (they were instead generally concentrated in a few areas), the change in growth from Q2 to Q3 last year was nearly 300 basis points. Contrast this to the videos of Beijing and Shanghai, where nearly everything seems to be shut down throughout both cities. Even with a resumption of activity as the country partially returns to work, it would seem to us that – should the current situation continue – a 300 basis point hit to the growth rate would be an optimistic outcome.

Reports are now beginning to trickle in as China tried to return to work on Monday, February 10th post the virus-extended Lunar New Year holiday. Here are a few of the highlights we've collected from the press:

- Beijing subway traffic was reported i) at about 50% of normal on Monday, and ii) "largely empty".
- Most shops, restaurants and cafes remain shut (the services sector accounts for more than half of the country's GDP).
- Schools in Guangdong, Anhui, Zhejiang, Heilongjiang, Jiangsu, Shandong, Hebei, Jiangxi, and Inner Mongolia, as well as Shanghai and Chongqing will remain shut through the end of February, further hampering the return of migrant workers to the cities.
- Labor shortages are reported at shipyards, and packaging materials are in short supply.
- Foxconn and Apple declined to comment on when production would restart, and one analyst estimated Q1 smartphone production would be down 10%.
- Ford and GM said their Chinese facilities would slowly ramp up production over several weeks.
- The municipal government in Shanghai said only 70% of the city's manufacturers were taking steps to resume production.
- The China Development Forum, the country's premier economic and business gathering, has been postponed indefinitely.

- Consumer prices in China jumped, with overall inflation coming in at 5.4% year-over-year, and food prices up 20.6%.

Should this type of news continue, we would not be surprised to see a decline close to 400 basis points.

Although there are substantive differences from the outbreak 100 years ago, it is interesting to look at the economic impact of the Spanish Flu. While general economic data was pretty much unavailable back in 1918, the St. Louis Federal Reserve has published an interesting account of the outbreak. While the report does not speculate on the overall economic cost of the pandemic, it does report select comments from the local press at the time, some of which were:

- Merchants in Little Rock say their business has declined 40 percent. Others estimate the decrease at 70 percent.
- The only business in which there has been an increase in revenue is the drug store.
- Physicians report they are kept too busy combating the disease to report the number of patients and have little time to devote to other matters.
- Out of a total of about 400 men used in the transportation department of the Memphis Street Railway, 124 men were incapacitated yesterday.
- The Philadelphia city morgue has had as many as ten times as many bodies as coffins.

While these quotes are now 100 years old, we are struck by how much they seem to resemble current life in Wuhan and our hearts go out to the people suffering through this.

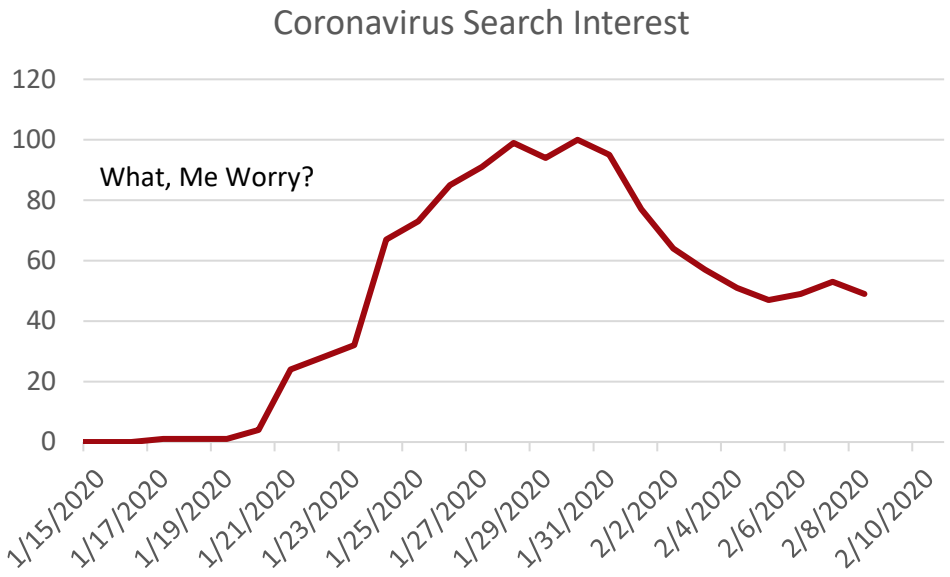
Potential Economic Impact Outside of China

In addition to the larger and longer impact on the Chinese economy we believe that global effects will be more significant than current economic forecasts. Many initial reports compared COVID-19 to SARS, both from a human and an economic perspective. We've already discussed how the comparison on a human level is misplaced, but we also believe the comparison of economic toll is misplaced.

First, COVID-19 has already infected over five times as many people as SARS did, and the number is still growing. Our best guess is that "pandemic panic" probably grows with the square of the number of people infected, which would suggest the level of concern is already 25 times higher. Based on the current situation in China, this seems about right. As the economic impact is likely linked to the level of panic as opposed to the actual human toll, and ***as China has grown it's economic output from $1.7 trillion at the time of SARS to $14 trillion today, we think the ripple effects will be much larger than they were in 2003.***

Some of the ripple effects are already being felt in countries with noticeable numbers of COVID-19 infections, particularly places like Thailand, Singapore and South Korea, and while panic levels are still quite restrained, this could change quite rapidly. For example, this recent headline in the UK: "Frantic Hunt for Coronavirus GP's Patients as Outbreak Fears Grow" (OK, it was from The Sun, but it does have a high readership). Should European cases continue to grow, we expect anxiety levels, and their associated market impact, to grow even faster.

The United States, meanwhile, seems to have moved on from its brief worry about the outbreak. Whether it was the Oscars, Tesla's rip or "Pelosi's Tear", other events now seem to have captured the imagine of the American investor. This can even be seen in Google Trends for the word "coronavirus", shown below:



Source: Google Trends

After peaking in late January, interest in coronavirus has dipped considerably. Interestingly, the peak in search interest corresponded quite closely with the bottom in the equity market. Our question now is, what happens to both if U.S. cases start to increase noticeably or – heaven forbid – there are deaths on U.S. shores from the virus? While we seem to have dealt with the few cases that emanated from China quite well, as the virus spreads to other parts of the world, our ability to keep it out will likely diminish. With our expectation of global containment below 50%, we believe additional U.S. infections are a question of when, not if.

Even if America does manage to keep COVID-19 out, China's problems are already beginning to infect the global economy. Here are a few international reports:

- Nissan said it would shut it assembly line in Kyushu, Japan for four days due to parts shortages.
- Hyundai and Kia Motors have both announced it is temporarily stopping production at its factories in South Korea because of shortages of Chinese parts.
- Fiat Chrysler has said one of its European plants may be forced to close due to a parts shortage.
- Sony, Amazon, Nvidia, NTT DoCoMo and others have announced they are canceling their attendance at the Mobile World Congress in Barcelona, Spain.
- Most major airlines have canceled most, if not all, flights to mainland China.

If fears of a pandemic don't worry the American investor, we believe the economic consequences eventually will. A recent CNBC survey of 11 forecasters found that first-quarter GDP estimates now average just 1.2% - down a full point from the fourth quarter. But there's always the rebound to look forward to (back to "Buy the Dip"), and expectations are for a recovery back to 2.0% in Q3. Without containment, those recovery expectations may need to be pushed out several quarters.

For the most part, other forecasts assume the virus is contained. As we stated earlier, while this is still possible, we don't believe it's probable. In the event of a global pandemic, current growth forecasts may turn out to be quite high. At a minimum, the global economy should slow more than currently forecast with our central case being a decline of 0.75%-1.25% at an annual rate. Although we are not forecasting it, should the number of U.S. cases start expanding rapidly there is even a chance that the U.S. economy is pushed into a recession (part of our "bear case" which carries a low probability). Finally, the World Bank reportedly estimated that a "severe" pandemic (more along the lines of the Spanish Flu, something we are not expecting) could shave 500 basis points off global growth. All this suggests that there are meaningful risks in chasing equity markets to ever-higher levels.

We finish with a point on timing. Near term, we think the news out of China will be positive – reflecting either their successful containment efforts, some manipulated data from non-Hubei provinces, or both. Other countries (but we don't believe all) may well eradicate the virus, even if temporarily – another potential source of good incremental news. Meanwhile, while we believe international spread is likely unstoppable, the initial progression will likely be slow, happening one individual at a time. Hence it may be several weeks, if not a few months, before the path to a pandemic becomes clear (if it happens – we do still place a 35% probability on containment). So while we do believe the world has a problem, it won't necessarily be evident in a few days or even a few weeks. But given the potential downside, now is not the time for complacency. So, be careful out there. And wash your hands. Frequently. With soap.