

The Four Horsemen

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Adapted from a lecture given by the author on 7 July 2021 as part of the Institute of Policy Studies-Nathan Lectures delivered at National University of Singapore, this essay explores four mega trends—demographics, inequality, technology, and climate change—that are already presenting both challenges and opportunities to humankind, and how Singapore is positioned to address these trends.

There are some fundamental changes sweeping across the world. *The Book of Revelation* speaks of four horsemen emerging at the dawn of the apocalypse. Interpretations of what they signify vary, but in most accounts the four horsemen symbolise conquest, war, famine, and death. If the horsemen represent fundamental changes to the old order, then the four horsemen today capable of bringing about such change are demographics, inequality, technology, and climate.

Ageing demographics, rising inequality, technological disruption, and climate change will together precipitate the biggest economic and societal transformation the world has seen since the Industrial Revolution. Whether they lead to apocalypse or provide the impetus for Renaissance depends on how the global community and individual nations respond to them.

The fifth horseman

Given what we are going through today, is there a fifth horseman that we should consider, that is, pandemic? Epidemics and pandemics have ravaged the world for centuries, with the bubonic plague in the Middle Ages estimated to have wiped out 30-60% of Europe's population. In the last two

decades we have seen epidemics caused by SARS, MERS, Ebola; to name a few. Since early 2020, the world has been battling the COVID-19 pandemic, which has infected more than 180 million people and taken nearly 4 million lives.

Are we on the cusp of a new age of pandemics? Increased interaction between humans and animals, urbanisation and overcrowding, global connectivity, even climate change, have emerged as risk factors for what some experts believe may be new pandemics occurring more frequently, perhaps every 10 years or so.

Even if we are not looking at more frequent pandemics, COVID-19 is here to stay. Earlier in 2021, the UK-based scientific journal *Nature* asked more than 100 immunologists, infectious disease researchers, and virologists working on COVID-19 whether the virus could be eradicated. Almost 90% of the respondents said no; instead COVID-19 will become endemic—meaning that it will continue to circulate in pockets of the global population for years to come (Philips 2021). Locking down large parts of the economy or closing borders in an effort to bring infections down to zero is futile.

In the endemic stage, COVID-19 will become less fatal or debilitating. Populations will acquire herd immunity against the virus from mass vaccination and extensive natural infection. Several effective treatments are now available that can reduce disease severity and mortality. In the endemic phase, the number of infections roughly stabilises and societies tolerate the seasonal illnesses and deaths they bring. In fact, seasonal flu still claims roughly 650,000 lives per year globally (World Health Organization 2017). Even in Singapore, seasonal flu is estimated to result in about 520,000 outpatient visits, 1,500

hospitalisations, and 600 deaths each year (Ng et al. 2002, 182; Ang et al. 2014, 1655; Chow et al. 2006, 118).

Countries that learn and adapt how to live in an endemic COVID-19 world will do better than those who do not.

The willingness of populations to get vaccinated will be a critical success factor. Estimates vary but countries will need to vaccinate 75-90% of their populations to reach herd immunity (D'Souza and Dowdy 2021; Weixel 2020). Herd immunity does not mean no one gets infected or no one dies of COVID-19; but by greatly reducing the risks of severe disease and death, it considerably enhances a country's ability to thrive in a world where COVID-19 is endemic. Unfortunately, misinformation has led to considerable vaccine scepticism in many parts of the world.

Countries that take a risk management approach and avoid the extremes of zero-tolerance or laissez-faire will do better. Countries that have chosen strategies of zero or very low tolerance for infections will have a hard time reopening their economies. Sound risk management is also key in responding judiciously to the occasional spikes in infections that will occur from time to time. Not imposing any safe management measures, especially if significant sections of the population have not been vaccinated, risks bringing on a renewed epidemic. On the other hand, closing borders and imposing lockdowns in response to every new outbreak will severely affect livelihoods with little or no gain in lives saved.

Singapore is well-placed to make the transition from pandemic to endemic COVID-19. Singapore's strategy for now is to contain new transmissions until the population is largely vaccinated. Letting up restrictions prematurely

will only prolong the pandemic situation, as many countries are tragically finding out. Moving on, we must learn to live with seasonal outbreaks with less draconian containment measures that minimise the impact on economic and social life. Testing, tracing, and therapeutics will be key to achieving this: testing to pick up new infections quickly; tracing to identify and contain potential clusters; and therapeutics to treat and restore to health those who get infected. We must aim to make the recovery rate for COVID-19 close to that of seasonal flu. Then, we can live without fear.

Our aim must be to restore economic and social activities to pre-COVID-19 levels. What will be different are likely a baseline level of safe management measures such as mask-wearing and safe distancing in riskier settings or periods of heightened alert; new social norms such as not coming to work when not feeling well; and improved ventilation and fresh air exchange in our buildings. Every sizeable organisation ought to have a business continuity plan in case some form of mobility restrictions is re-imposed. This will be a key dimension of economic resilience.

In fact, pandemic resilience could be a new source of competitive advantage for Singapore. In a post-COVID-19 future, there will be a premium on trust and stability, on countries that can handle crises well with minimal disruption to economic activity. Global business leaders who talk to the Economic Development Board (EDB) and the Monetary Authority of Singapore (MAS) opined that Singapore's handling of the pandemic has strengthened its relative position as a resilient place to do business.

Let me now move on to the four horsemen that are likely to have an even deeper and longer-term impact on the world and pose much larger challenges to Singapore.

The first horseman: demographics

The first horseman—demographics—is the most predictable of the four. His path is pre-determined and we know where he is heading.

The world is getting older. People are having fewer children and living longer. A half-century of evidence suggests that in all prosperous countries where women are well-educated and free to choose whether and when to have children, fertility rates fall significantly below replacement levels (Pradhan 2015; “A School for Small Families” 2019). Policy interventions by various countries to reverse the decline in fertility have generally not succeeded (Brainerd 2014). The combination of declining fertility and rising life expectancy means that in the next few decades, the population of most of the world outside Africa will plateau and begin to fall for the first time in modern history (United Nations Department of Economic and Social Affairs Population Division, n.d.).

The distribution of working-age populations across countries and regions will become highly unequal. In the next 20 years, it is projected that the proportion of the working-age in South Asia, Latin America, the Middle East and North Africa will be above 65% (United States National Intelligence Council 2021). But without adequate skills training and job creation, these countries will experience demographic burdens, not dividends.

As a corollary, various countries and regions will experience a dramatic rise in their old-age dependency ratios—the population aged 65 and

above relative to the working-age population. This will be sharply felt in the developed world. In Europe and North America, it is projected to rise to 49 older persons per 100 working-age persons by 2050, up from the current 30 (United Nations Department of Economic and Social Affairs Population Division, n.d., 11). The old-age dependency ratio is projected to more than double in East and Southeast Asia, from 18 in 2019 to 43 in 2050 (United Nations Department of Economic and Social Affairs Population Division, n.d.).

Rising old-age dependency ratios could hamper economic growth. The pool of retirees will grow faster than the labour force. A greater share of national income will need to be devoted to healthcare and other social and economic support for seniors. Shifting age structures pose the risk of many developing countries in Asia becoming old before they become rich, making the middle-income trap more likely.

Fertility rates far below replacement pose particularly serious challenges. The decline in the labour force will be sharp rather than gradual and there will be a growing number of the very elderly who will require some kind of mobility assistance and personalised care.

In Singapore, the fertility rate is only about half the replacement rate. Paradoxically, the public discourse on demographics has focused on whether the population is too large or growing too fast or whether there are too many foreigners. But more significant than the size or composition of the population is the age of the population, in particular the implications on the economy of a shrinking labour force and on society of a growing care gap for the very elderly.

Shrinking Labour Force

Singapore's working-age citizen population has begun to shrink. By 2030, the proportion of citizens aged 20 to 64 is expected to decrease from 63 to 56% (National Population and Talent Division 2020, 9). A shrinking workforce means that productivity growth is the only source of economic growth. Increases in automation, female labour force participation, and retirement age will help but this will not be enough to offset the demographic impact on economic growth.

Immigration and intake of foreign workers are one of the more effective ways to stretch out the effects of sharp labour force decline. This cannot be a permanent solution because eventually, there will be physical limits to the size of population that Singapore can accommodate. But immigration can help to smoothen the transition and reduce adjustment costs on the economy and society.

The key is integration. Too rapid a rate of immigration can threaten a country's sense of identity and create anxieties of being overrun by foreigners. Countries that are able to successfully integrate immigrants into their societies have better prospects of overcoming their demographic constraints. Singapore has always been among such countries, and we must remain so.

Growing Care Gap

Singapore is one of the most rapidly ageing countries in the world. By 2030, one in four Singaporeans will be aged 65 years and above, a marked increase from the ratio of one in six in 2020 and one in eleven in 2010 (United Nations Department of Economic and Social Affairs Population Division, n.d., 33; Department of Statistics Singapore 2021).

There will likely be a growing gap in caregiving for the elderly. Generally, the elderly of tomorrow are likely to stay healthy much longer than those today. But while fewer are likely to have chronic or debilitating conditions, more may become prone to the ailments of the very elderly, such as dementia and Alzheimer's. Between 2000 and 2020, the number of residents aged 65 years and over who had mobility issues nearly doubled from around 25,500 to 50,000 (Ministry of Health 2021).

The second horseman: inequality

The second horseman—inequality—is the most prominent and talked about horseman. He poses one of the biggest social, economic, and political challenges of our time.

Dispersion in income growth is a global phenomenon. In the US, there has been a sharp divergence in wage growth between the two ends of the income distribution. According to a recent Brookings report, between 1979 and 2018, the average real hourly wage of the bottom 20% of the income distribution had more or less stagnated (Nunn and Shambaugh 2020). By contrast, the income of the top 1% in the US had risen sharply, by 160% in the same period (Mishel and Kandra 2020). Along with its spectacular growth, China has also seen the world's biggest and fastest rise in inequality. A study by the China Development Research Foundation suggests that China's Gini coefficient has surged from less than 0.3 in 1978 to more than 0.48 in 2012 ("Crony Tigers, Divided Dragons" 2012).

Technology and globalisation have been cited as the proximate drivers of the rise in income

inequality. Of the two, globalisation is blamed more often but many economists believe that skill-biased technological change is the main driver of income inequality. Technological change has dampened the demand for lower-skill workers. By expanding opportunities for offshoring production, globalisation has had strong displacement effects in localised settings but its impact on inequality has probably not been as pervasive as that of technology.

A certain degree of income inequality is inevitable and even desirable in a market economy. Differences in rewards are necessary to spur effort and enterprise, and unequal outcomes that reflect unequal abilities are generally accepted by most people. I would suggest that inequality becomes socially unacceptable and economically inefficient when it leads to increased poverty, middle class stagnation, a growing wealth gap, or reduced social mobility. These four outcomes imply a certain permanence and erode that critical ingredient for personal endeavour—that is, hope for the future.

Increased Poverty

The central economic challenge for a very large part of the world's population is poverty not inequality. As the late American economist Martin Feldstein puts it, the emphasis should be on eliminating poverty, and not on the overall distribution of income or the general extent of inequality (Feldstein 1999, 33).

Indeed, in many developing countries, alleviating poverty is a higher priority than reducing income inequality. And rightly so. In many of these countries, economic growth has been the single most powerful factor in alleviating poverty. Growth has lifted hundreds of millions of people out of poverty in the last 50 years, in China, India, Indonesia, and others.

In the developed countries, poverty is lower, more stable and not as responsive to economic growth. The US appears to be somewhat of an outlier, where the poverty rate rose significantly in the wake of the recession caused by the 2008 global financial crisis, and early research suggests that the poverty rate rose again during the COVID-19 pandemic (Han, Meyer, and Sullivan 2021). The US poverty rate seems particularly sensitive to recessions, with some research pointing to weak US social safety nets as a key factor (Gould and Wething 2021). European countries have had relatively more stable poverty rates through business cycles, with their stronger social safety nets.

Developed countries, including high-income ones like Singapore, should set ambitious targets for reducing poverty. There is probably very little absolute poverty in Singapore. Nonetheless, it is important that the wage gap between those at the lower deciles of the income distribution and the median wage earner is not unduly large.

Middle Class Stagnation

A thriving middle class is a necessary condition for the stability of society and durability of democracy. The gradual erosion of trust in the economic and political system that we see in many advanced economies is due not so much to the widening gap between the rich and the poor but to the stagnation of the middle class. Some estimates suggest that there has been hardly any increase in real median wages in the US since the mid-1970s (DeSilver 2018; Galka 2017; Gould 2020). In the UK there has been similar stagnation (Cominetti 2020; Blanchflower and Machin 2014, 20).

Focusing on the divergent demands for various mid-level skills is more insightful than merely looking at income deciles. There are important

differences within the mid-wage brackets that we should recognise. What has been declining in many advanced economies is the traditional middle of the job market, composed primarily of construction, production, and clerical jobs that do not require a high degree of skills. In the US, the secular decline in manufacturing employment due to technological change has been associated with wage stagnation in the middle class (Sandbu 2020). But demand for another set of mid-level skills is growing in areas such as healthcare, education, mechanical maintenance and repair, and some high-touch social, recreational, and community services.

Singapore's experience on median wages has not been bad. Real median wages increased by an average 2.6% per annum from 2011 to 2020, higher than the 1.2% annual growth between 2001 and 2010¹. Sustaining healthy growth in median wages through active labour market policies will be important to give the broad middle of society hope and confidence in the future.

Growing Wealth Gap

Wealth inequality has most likely worsened more than income inequality. According to the British economist Adair Turner, average wealth-to-income ratios have gone from around 300-400% in 1970 to about 600% in 2014; it must be even higher now (Turner 2014, 1). According to the Global Wealth Report, millionaires make up 1% of the global adult population but account for 43% of global net worth (Shorrocks, Davies, and Lluberas 2021, 25).

Wealth inequality is more pernicious than income inequality. If wealth were merely the accumulation of savings from income, then inequalities in wealth would largely reflect inequalities in income. The work of Thomas Piketty suggests there has been a

lot of wealth accumulation without any significant increase in saving (Piketty 2014, 219–20). This is because the prices of assets that form wealth have risen faster than the prices of current goods and services that enter income.

The key driver of wealth inequality in many countries is the rising price of urban land. According to Adair Turner, real estate has grown significantly as a source of wealth in the last 40 years, accounting for more than half of all national wealth in the UK and France. In both countries, the increase in the wealth-to-income ratio over the last 40 years has been significantly driven by the rise in real estate values or property prices (Turner 2014, 11).

Property price increases are driven by both consumption and investment demand. As their incomes rise, people devote an increasing percentage of their disposable income to purchases of property in so-called prime locations, which are limited in supply. Over time, this tends to lead to house prices rising faster than incomes. This in turn stimulates investment demand for housing in the pursuit of capital gains. Globally, property has become an investment asset class. Getting on the housing escalator to get rich has become a trend across the major urban centres of the world: London, Sydney, Vancouver, Los Angeles, Dubai, Hong Kong, Singapore, and many more.

In almost all societies, wealth is far more unequally distributed than income. As the ratio of wealth becomes more important relative to income, income inequality further increases. Market processes are allocating an increasing share of national income to income from property and other financial assets and a reducing share to income from work. This is a development that we should be deeply concerned about.

Reduced Social Mobility

Rising income inequality can lead to reduced social mobility. The evidence is rather mixed on whether income inequality has directly reduced social mobility. On the other hand, income inequality has very likely increased disparities in health, education, skills levels, and subsequent labour mobility—all of which have an impact on social mobility. A highly skewed income distribution could translate into less equality of opportunity for the next generation. This seems to be happening. Among the rich nations for which studies have been done, those with greater income inequality tend to have less mobility across generations (Corak 2013, 82).

We must avoid the risk of a hereditary meritocracy. The word “meritocracy” was coined in the 1950s by Michael Young, a British sociologist. Even then, Young had warned that the incipient meritocracy to which he had given a name could be as narrow and pernicious in its own way, as the aristocracies of old. The condition of one’s birth should not overly determine the outcome of one’s life.

The paradox at the heart of the new meritocracy is that how far one goes in education determines how far one goes in life. According to Claudia Goldin and Lawrence Katz from Harvard University, differences in educational attainment explain 60% of America’s widening wage inequality between 1973 and 2005 (Goldin and Katz 2009, 26–27). This was attributed to the rising wage premium to education and the soaring cost of college education in America. In short, income inequality is being driven by inequality in human capital.

As the importance of human capital grows, meritocracy itself is at risk of becoming heritable, where the elite reproduce themselves. People are

naturally good—some would say biologically programmed—at passing on their privileges to their children. According to Sean Reardon of Stanford University, recent decades have seen a growing correlation between parental income and children’s test scores (Kim 2018). Educated and successful men and women tend to marry one another. Such assortative mating increases inequality by 25% by one estimate (Greenwood et al. 2014, 351). Such couples typically enjoy two large incomes, provide stable homes for their children, and stimulate them relentlessly from birth with enrichment classes.

Public policies can play a key role in mitigating the adverse effects of income inequality. The key measures are well-documented in studies by the International Monetary Fund and Organisation for Economic Co-operation and Development: improving education and skills training; improving access to healthcare; higher infrastructure investment; expanding financial inclusion; increasing labour market flexibility and mobility; and encouraging participation in labour markets across genders and age. These are essentially what Singapore has been doing, with a fair degree of success. But with the acceleration of technological change, labour markets will need to be even more dynamic and flexible, characterised by a high degree of job destruction, creation, and mobility. This will probably require more protection and security for workers than we currently have in Singapore.

The choice is not between growth and distribution. Some people believe that rapid economic growth has been one of the causes of inequality. The reality is that lower economic growth will not improve inequality and will only make redistribution more difficult. Faster growth per se does not create inequality. It is the singular pursuit of growth unaccompanied by measures to facilitate a more

even distribution of its benefits that worsens inequality. Such growth will eventually prove unsustainable if a large segment of the society feels left behind. Likewise, carefully designed policies to reduce inequality will not necessarily reduce growth.

The third horseman: technology

The third horseman—technology—is the fastest. He is galloping way ahead of the others.

I think the four general-purpose technologies that could have the biggest impact are artificial intelligence (AI); robotics; the Internet of Things (IoT); and blockchain technology.

Probably the most impactful will be AI—algorithms that are designed to continuously learn from the data that they gather and be able to programme themselves to perform new tasks. AI is being used to process vast quantities of data and recognise patterns. Computers using AI are now trading financial assets and operating motor vehicles; they are even writing clean prose and composing music.

Robots are gaining the dexterity to do complex manual jobs. There are robots that are now able to stitch a sliced grape back together or de-bone a chicken wing; these technologies are already being used to perform delicate surgery.

IoT is already ubiquitous. We see it most commonly in the form of mobile phones. They are essentially devices embedded with sensors or software to connect with other systems and devices. Data from IoT devices is making possible the real-time tracking of goods along supply

chains and continuous management of risk in financial services. The potential of IoT devices will increase dramatically as 5G networks and edge computing capacity picks up over the next decade. As more industries become IoT-enabled, new business models will emerge.

Blockchain technology is still nascent but has transformative potential if it can be scaled. Public blockchain is already being used to coordinate inter-company processes. It may have the potential to enable digitised economic and financial transactions across the world, 24/7, in real time. Exchange of value can be as seamless as sending an email. Tokenisation—representing an asset through a smart contract on a blockchain—can make possible the monetisation of many assets whose economic value is currently unrealised, such as unused file storage, computing power, and energy credits. This can unlock latent capacity in the real economy.

A digital economy is emerging and data is its lifeblood. The application of these various technologies is bringing about digitalisation. Within the 2010s, the accumulated universe of data surged from about 1 trillion gigabytes to nearly 50 trillion. According to McKinsey Global Institute, data flows account for about 3.5% of the world's Gross Domestic Product (Bughin and Lund 2017). The growth in computational power and vast increase in the volume of data available have enabled data-driven decision-making, using granular, real-time data, including unstructured information, such as social media postings. Driven by consumer demand and innovative firms, digital connectivity seems likely to accelerate, further enhancing the centrality of data to social and economic life.

The COVID-19 pandemic has given a significant boost to digitalisation. Many more people are now comfortable with digital interactions, and

remote working models are proliferating. The pandemic has also provided an added reason for digitalisation—resilience. Having a digital backup in case human mobility or physical contact is restricted has become a key feature of business continuity planning.

Digitalisation has on balance been democratising. Yes, there is a digital divide—between those who have access to digital technology and those who do not. But on balance, digital technology has probably enabled more inclusion than it has created exclusion. The beauty of digital technology is its ease of access through the mobile phone, the internet, and broadband connectivity. There were 2.5 billion smartphone users in the world in 2016; as of 2020, that number has jumped to 3.8 billion (Bankmycell n.d.). Online digital platforms provide access to the smallest as well as the biggest players; they allow upstarts to build business models with global scale.

Notwithstanding the substantial benefits, the social license for continued digitalisation will depend on how countries address three issues relating to technology—the data dilemma, cyber threats, and the impact on jobs.

The Data Dilemma

The aggregation and extensive mining of data have promoted economic inclusion and opportunity. Firms are able to better understand their customers, deliver more customised services at lower costs, and reach out to previously underserved customers.

But this data revolution is being propelled by a handful of digital giants with monopoly powers. A small group of American and Chinese software companies, such as Alibaba, Amazon, Google, Facebook, and Tencent, have leveraged first-mover advantages and network effects to become the

monopoly facilitators of data flows. Their ability to gather huge amounts of data through their pervasive platforms and to control this data has created an entry barrier for potential competition. They have considerable influence on society through their control of the platforms on which people and firms interact with one another.

This then is the data dilemma: how do we harness the benefits of data aggregation while ensuring a competitive playing field and that individuals' personal data are not misused?

Countries that get their data policies right are better placed to grow the digital economy. This means implementing sensible data governance policies that protect personal data while not impeding innovation and inclusion. Data aggregators should adopt the principles of transparency, fairness, and accountability in the use of data. The growing Web 3.0 movement has already seen the private sector create platforms that enable more open and equitable access to data.

Control over data and digital platforms has also become a subject of contestation among nation states. Many developed countries are seeking to tax cross-border digital transactions; many developing countries are imposing data localisation requirements that prohibit the cross-border transfer of data. Excessively taxing digital transactions or prohibiting the sharing of data will increase business costs, reduce efficiency, and curtail firms' ability to serve their customers better.

What we need more is data connectivity not data localisation. In the digital economy of the future, data connectivity agreements among countries will become as important as today's free trade agreements. Singapore is off the starting block, initiating digital connectivity agreements with some like-minded jurisdictions. These

could become pathfinders for broader international data agreements.

The world needs a new Digital Bretton Woods. Just as the rules for international trade and finance were set by the Bretton Woods agreements following World War Two, we may need a new set of global rules to govern international data flows and exercise oversight of data monopolies. This will help to provide the foundation for a sound and vibrant global digital economy.

Cyber Threats

The incidence, scale, and complexity of cyber attacks have been on a growing trend. Recent attacks on major organisations globally such as Colonial Pipeline, SolarWinds, and Microsoft are powerful reminders that the fallout from a cyber attack can be far-reaching. Not content with corrupting a victim's data using crypto-ransomware, cyber attackers are now exfiltrating information from the victim. Cyber criminals are also targeting major third-party information technology vendors and attacking supply chains to infiltrate the systems of multiple entities.

Breaches in sensitive connected systems can lead to serious consequences. Large-scale cyber attacks that succeed in shutting down the electricity grid, telecommunications network or interbank payment system can have systemic consequences across the economy and society. Critical infrastructure systems are especially at risk from nation states and terrorist groups seeking to obtain classified information or disrupt vital operations.

Digital defence is already a sixth limb of total defence in Singapore. Singapore is in a better place than most countries with a national Cyber Security Agency overseeing a network of sectoral agencies with oversight of the critical

infrastructures within their respective sectors. But cyber defence is a work-in-progress. Businesses today are responsible for the security of their premises but they do not take measures to defend themselves against an airborne missile attack from abroad—that is the job of the armed forces. How different from a missile attack is a sophisticated, state-sponsored cyber attack? Should we explore a more integrated cyber defence architecture combining the civilian and the military?

A Digital Bretton Woods could include setting out protocols for behaviour in cyber space. It could also include frameworks for cyber defence, and maybe even rules of cyber engagement. It will not be easy, as nation states themselves engage in cyber espionage and cyber attacks. Is there potential for Singapore, as a trusted, competent, and progressive jurisdiction, to play a facilitative role in shaping such an international architecture?

Impact on Jobs

Technology has been changing the nature of work and skills for over 200 years. In the 1750s, the rise of industrial technology devalued the skills of artisans but benefitted millions of less-skilled workers who only had to focus on small portions of an extended process. In the 1980s, information technology began to take over medium-skilled work, such as back-office jobs. We are now witnessing the advance of technology across the skills spectrum: automation for routine work; robotics for manufacturing activities; blockchain for intermediation services; and AI for knowledge work.

The impact of technology on jobs will be uneven across industries. Robotic automation is proliferating in manufacturing, and e-commerce is transforming retail trade. Autonomous vehicles and drones will put at risk jobs linked to driving vehicles to move people or goods. But

will there be new jobs to complement or service the robot economy? Or will robots repair robots? We do not know.

With growing automation, we should think tasks not jobs, skills not occupations. Historically, what technology displaces are not jobs and occupations per se but tasks and skills. The introduction of the printing press reduced the value of scribing skills but increased the value of publishing and dissemination skills. The advent of the internal combustion engine eroded the value of horsemanship skills but created value for driving skills. Today, the emergence of search engines is shifting value from knowledge-gathering skills to knowledge application skills. Technology is unlikely to eliminate a large number of jobs; rather, it will affect portions of almost all jobs to a greater or lesser degree, depending on the type of tasks involved in these jobs.

There are sectors with skills requirements that are likely to be affected by technology in a positive way. Jobs where automation is more likely to be human augmenting rather than replacing include those in education and training, healthcare, and social work activities. Such jobs require significant cognitive and social intelligence and a knowledge of human heuristics.

Reducing the need for human labour is not entirely a bad thing, especially in labour-short Singapore. Can robots transform the construction and cleaning industries and reduce Singapore's dependence on foreign labour?

The key to a good outcome for jobs is to intertwine human and technological capabilities. This is of course easier said than done. But the competition from machines has brought to the fore two quintessentially human qualities: imagination and empathy. When machines can do more of what we do today, we will do in our jobs more of

what makes us essentially human: to think and create, to feel and connect.

Creative imagination is likely to remain the preserve of humans, for at least quite some time. Computers have started to display signs of creativity. IBM's AI cooking application, Chef Watson, for instance, reads thousands of existing recipes, and is trained to create combinations that people are likely to find delicious but do not know about (Brandt 2017; Kleeman 2016). But while computers can come up with novel answers that humans cannot, they still operate in a fixed domain, solving defined problems. In practice, problems change as we try to solve them. When it comes to asking new questions or regard old problems from a different angle, the human imagination still has a distinct advantage.

Humans are social creatures, capable of empathy. While robots are starting to understand human emotions through facial expressions, they cannot offer the deep interpersonal connections that we crave. There will still be a premium placed on hearing our diagnoses from a doctor, even if a computer supplied it, simply because we want to talk about it with another human. As mechanical tasks and even some cognitive tasks become commoditised, perhaps the scarcest resource will be relationship workers—those who excel in building bridges with others. Computers cannot weigh ethical dilemmas and grey areas. On such matters, humans have to remain at the centre of accountability.

Human imagination, empathy and accountability cannot be automated away. In an almost ironic way, technology may well help to make us more conscious of what it means to be human and make us better human beings.

When nothing is certain, everything is possible. Technology will disrupt our familiar ways. But

individuals and businesses, facilitated by sound public policies, need to face this challenge not with anxiety but a sense of adventure.

The fourth horseman: climate change

Of the four horsemen, climate is the one that poses an existential challenge. He is the most complex and his trajectory is highly uncertain and difficult to assess.

Climate change is already happening. Atmospheric concentrations of carbon dioxide have reached the highest levels in 800,000 years (Loria 2018). Over the last three decades, the number of climate-related disasters has tripled (OXFAM International n.d.). Global sea levels have risen 20 centimetres over the past century, with the rate of increase doubling in the past two decades (Lindsey 2021). The increase in global average temperatures has already reached 1 degree Celsius above pre-industrial levels (Met Office United Kingdom 2015). Extrapolating current trends in greenhouse gas emissions, global temperatures are expected to rise by over 3 degrees Celsius above pre-industrial levels by 2100 (Tollefson 2020; Climate Action Tracker n.d.). In fact, we may have already crossed some climate tipping points that could trigger self-perpetuating loops and unleash a domino effect.

If the current emissions trajectory continues, the world will most likely experience climate catastrophe. The damage to human and natural systems will be severe and likely irreversible. This includes rising sea levels, frequent natural disasters, extreme wet and dry seasons, higher incidence of vector-borne diseases, decline in food supplies, and reduction of biodiversity. According to the Network of Central Banks and

Supervisors for Greening the Financial System, global GDP could be 15-25% lower by 2100 due to these impacts (The Central Banks and Supervisors Network for Greening the Financial System 2020, 8).

How the world responds to the climate challenge will determine the future of generations to come. To avoid the most severe effects of climate change, global greenhouse gas emissions must come down 45% by 2030 and reach net zero around 2050 to keep global warming to within 1.5 degrees Celsius above pre-industrial levels (Rowling 2020; Chestney and Chung 2018). This is what 195 countries resolved to do as part of the Paris Agreement in 2016.

There is a renewed sense of urgency and commitment to the climate agenda. Despite the COVID-19 pandemic, 2020 witnessed an unprecedented number of commitments to carbon neutrality and net zero emissions—by governments, corporations, and other institutions (Holder 2020; United Nations 2020). Perhaps the pandemic has sensitised us to how closely our lives are intertwined with our environment and how fragile our natural ecosystem is.

Beyond commitments, concerted action is necessary for the world to make the transition to a sustainable future. Long-term ambitions need to be translated into tangible policies and early actions. To reach net zero by 2050, the world needs to start significantly reducing emissions now. The International Energy Authority has released the world's first comprehensive roadmap on how sectors can transition to a net zero energy system by 2050 while ensuring stable and affordable energy supplies and enabling economic growth (International Energy Agency 2021).

Singapore is firmly committed to doing its part in the global effort to reduce greenhouse gas

emissions. Earlier this year, the government launched the *Singapore Green Plan*, which sets out a road map towards sustainable development, a green economy, and net zero emissions. Singapore aims to peak carbon emissions around 2030 and to achieve net zero as soon as viable after 2050. We may need to raise our climate ambition in the coming years.

Climate change presents physical and transition risks to economies and societies. Physical risk arises from the impact of climate-related natural catastrophes and widespread environmental degradation. Transition risks arise from the process of adjustment to an environmentally sustainable economy, including changes in public policies, technological developments in renewable energy, and shifts in consumer and investor preferences. Increases in carbon prices and an energy reset towards renewables are likely to be among the more impactful developments.

Physical Impact

The physical impact of climate change is likely to be multi-directional and varied across regions. Wet places are likely to become wetter and dry places drier. Tropical countries are expected to experience the most severe impacts of climate change. At the same time, rising temperatures in the polar regions of the world could have potentially devastating consequences for sensitive ecosystems across the planet. The distribution of arable land, freshwater resources, and land and sea connectivity could potentially be altered.

The speed, scale, and impact of global warming are highly uncertain. This reflects the complexity of the climate system and its interactions with humanity. In fact, some scientists believe that global warming may well usher in a new ice age (Calvin 1998, 59). The melting of the polar glaciers will not only raise sea levels but also reduce the

salinity of the oceans that could in turn lead to changes in the patterns of ocean currents. If the Gulf Stream, which circulates warm waters across the North Atlantic Ocean, stops functioning, parts of western Europe and the east coast of the US and Canada could potentially experience Arctic conditions (Cho 2017).

As a low-lying tropical island, Singapore is at significant physical risk from climate change. With most of the country lying just 15 metres above sea level, the risk of coastal inundation and inland flooding is real. According to the Centre for Climate Research Singapore, by the end of the century, daily mean temperatures will increase by 1.4 to 4.6 degrees Celsius and mean sea levels will rise by 0.25 to 0.76 metres (National Climate Change Secretariat 2016, 4). To mitigate some of these impacts, we have begun to take measures such as using technology to reduce urban heat, diversifying our water supply in case of dry spells, and building polders to protect our coastline against sea level rise.

Carbon Prices

Carbon pricing is gaining momentum. There are 64 carbon-pricing initiatives in the world today, with 35 of them being carbon taxes and 29 emissions trading systems (The World Bank 2021). Today, most of the jurisdictions that have implemented carbon pricing have carbon prices below US\$50 per tonne of carbon dioxide equivalent, with the exception of the Scandinavian countries (The World Bank 2021).

However, to put the world on a trajectory towards achieving the Paris Agreement goals, carbon prices will need to be much higher. According to the High-Level Commission on Carbon Prices led by economists Joseph Stiglitz and Nicholas Stern and recent estimates by the Network for Greening the Financial System, carbon price

needs to increase to between US\$100 and US\$160 per tonne of carbon dioxide equivalent by 2030 (Carbon Pricing Leadership Coalition 2017, 3); The Central Banks and Supervisors Network for Greening the Financial System 2020, 15). Recently, IMF staff have proposed a three-tier carbon price floor among the largest emitters in the world, at US\$25, US\$50, and US\$75 per tonne (Parry, Black, and Roaf 2021, 11). If large emitters agree on a global minimum carbon price, there is likely to be a convergence globally towards that price. Carbon-intensive exports from countries with lower carbon prices may be subject to carbon border adjustments in importing countries with higher carbon prices.

Singapore is the first country in Southeast Asia to implement a carbon tax. But at S\$5 or US\$3.75 per tonne of greenhouse gas emissions, it is far below what is needed to catalyse carbon mitigation efforts.

Higher carbon prices will have a significant impact on many industries globally. Activities such as power generation from fossil fuels, production of steel and cement, and building and construction, will experience outsized impacts given their current reliance on emissions-intensive inputs and processes. In the electric utility sector, for instance, profits at risk could be as much as 90% of margins by 2030 (Cuff 2018). There will be knock-on impacts downstream, as these activities form the basis for a good part of the economy.

Energy Reset

The global transition from hydrocarbons to renewable energy is gaining momentum and is likely to accelerate. The cost of renewable energy has fallen dramatically over the past decade. While fossil fuels remain the dominant source of energy production, the amount of power generated

through wind and solar is rapidly catching up to that generated by coal (International Renewable Energy Agency 2021, 13, 20). Coal power plants are being phased out around the world. But oil and natural gas are likely to remain major sources of energy production until 2040 (U.S. Energy Information Administration 2020, 4).

The energy reset will be particularly challenging for Singapore because our natural endowments disadvantage the harnessing of renewable energy. We do not have the land space necessary to tap solar or wind energy, or fast-flowing rivers for hydro-electric power. Singapore needs to be highly innovative to overcome these disadvantages. Using our reservoirs, we are opening one of the world's largest floating solar energy systems. We are exploring transmission lines to neighbouring countries to tap on and trade in the renewable energy they produce. We will need many more of such innovations in the years ahead.

Transitioning to a net zero economy also opens up opportunity in the green economy of the future. Countries with the technological capabilities and fiscal resources will be able to seize opportunities brought about by transition. Singapore is well placed to thrive in a green economy, provided we make some bold, decisive moves. We will need a whole-of-nation effort to make the transition to a sustainable future.

The Singapore Synthesis

The four horsemen are riding through Singapore. Many of their adverse effects cannot be avoided. But if we set our minds to it, Singapore has what it takes to mitigate the downsides, seize the opportunities, and create a better world.

Singapore's remarkable development as an economy, as a society, and as a nation, was made possible by a synthesis of an eclectic mix of policies and approaches. As an economy, Singapore has judiciously combined the invisible hand of markets with the enabling hand of the government to deliver First World prosperity. As a society, it has enshrined meritocracy as the guiding principle while achieving considerable equality in educational and economic opportunity. As a nation, it has been one of the most international in orientation while assiduously building a distinct national identity and ethos.

There has been an overall coherence across policies, a synergy across the various parts: the Singapore Synthesis. Three attributes form the cornerstone of the Singapore Synthesis:

- Adaptation—an ability to adopt best practices from around the world
- Competition—an emphasis on letting the market determine outcomes
- Pragmatism—a focus on what works in practice rather than in principle

These attributes have been decisive in Singapore's success to date and will remain critical for Singapore's future in the face of the four horsemen. But they may not be enough. Adaptation without innovation descends into stagnation. Competition without inclusion degenerates into elitism. Pragmatism without inspiration deteriorates into expediency. We need a refreshed Singapore Synthesis, one that not replaces but enhances the old Synthesis.

The new Singapore Synthesis must pivot towards more innovation, inclusion, inspiration. In the face of the challenges posed by the four horsemen, we need to be more of an innovative economy, an inclusive society, and an inspiring nation. They are about how we make a living; how we build a community; how we find our purpose. □

About the Author



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Mr Menon was previously Permanent Secretary at the Ministry of Trade and Industry (2007–2011), where he implemented measures to support the economy during the Global Financial Crisis; and Deputy Secretary at the Ministry of Finance (2003–2007), where he reviewed how the government should invest and spend its foreign reserves.

A recipient of the Singapore Government's Meritorious Service Medal and Public Administration (Gold) Medal, Mr Menon has served on several boards in the public, private, and people sectors.

An active participant in international central banking and financial regulatory communities, Mr Menon is a member of the G20's Financial Stability Board (FSB) Steering Committee, and previously chaired the FSB's Standing Committee on Standards Implementation (2013–2017).

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Notes:

1. Nominal wage data is from Gross Monthly Income From Work (excluding employer Central Provident Fund contributions) of full-time employed resident workers, Comprehensive Labour Force Survey, Ministry of Manpower, Singapore. Real wage growth data are Monetary Authority of Singapore staff estimates, obtained from deflating nominal wage growth by All-Items Consumer Price Index.