THE LITTLE BOOK OF DATA
JOINING THE DOTS
AVIVA INVESTORS
Igor Stravinsky once said: “To listen is an effort, and just to hear is no merit. A duck hears also.” It is the same with seeing. We can observe at a superficial level, but not necessarily understand.

This is the second edition of our Little Book of Data. We are indebted to the permissions granted throughout; Alexander Radtke’s Warning Stripes and Craig Taylor’s Coral Cities stand out as particular gems.

This book comes with two large caveats. The first is that we don’t have room to include or cover all the important issues of the day. We have done our best to collate and curate, but it is an impossible task. Second is the data we don’t see. What counts cannot always be counted, so to understand the world we often have to look beyond the data that is easily rendered. Important trends will lie submerged from our view. The ability to think critically – to question assumptions, methodologies and gut reactions – is going to be crucial in the years ahead.

We cannot remove the effort involved with seeing and understanding, but by paying more attention to visual representations of data we can reduce some of the burden – particularly as the information age continues to drown us all. Enjoy.

Euan Munro
CEO, Aviva Investors
<table>
<thead>
<tr>
<th>Topic</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIG PICTURE</td>
<td>7</td>
</tr>
<tr>
<td>CONNECTED THINKING</td>
<td>23</td>
</tr>
<tr>
<td>URBANISATION</td>
<td>37</td>
</tr>
<tr>
<td>RETIREMENT</td>
<td>47</td>
</tr>
<tr>
<td>SUSTAINABILITY</td>
<td>57</td>
</tr>
<tr>
<td>MARKETS</td>
<td>73</td>
</tr>
<tr>
<td>APPENDIX</td>
<td>89</td>
</tr>
</tbody>
</table>
Big picture

Visual depictions of major macro trends to help investors gain perspective and distinguish the key developments taking place across the globe.
A whole new world
The world divided into four regions with equal populations
The 31 countries (worth) of China

GDP (PPP) INTERNATIONAL DOLLARS, 2018 (BILLIONS)

- Qatar
- Uzbekistan
- Kazakhstan
- Austria
- Peru
- UAE
- Netherlands
- South Africa
- Sweden
- South Korea
- Mexico
- Bangladesh
- Argentina
- Algeria
- Iran
- Spain
- France
- Italy
- Greece
- India
- Indonesia
- Japan
- Korea, Republic of
- Malaysia
- Philippines
- Netherlands
- Norway
- Pakistan
- Thailand
- Vietnam
- Chile
- Venezuela
- Mongolia
- Russia
- Turkey
- Egypt
- Australia
- Canada
Warning stripes (1900-2100)

| SSP5-8.5 | Focus on **Growth** and rapid progress | Emissions growth accelerates further |
| SSP3-7.0 | Focus on **Rivalry** and national security | Emissions growth steady for the whole century |
| SSP2-4.5 | Focus on **Continuity** and slow progress | Emissions peak in 2040-2050, net zero early next century |
| SSP1-1.9 | Focus on **Sustainability** and well-being | Emissions peak in 2020, net zero between 2050-2060 |

Stylised global mean temperatures 1900-2100.
Design by Alexander Radtke.
Stylised global mean temperatures 1900-2100.

Focus on rapid progress and national security

Focus on slow progress and well-being

Emissions growth accelerates further

Emissions growth steady for the whole century

Emissions peak in 2040-2050, net zero early next century

Emissions peak in 2020, net zero between 2050-2060
On borrowed time
Unsustainable resource consumption by country

Earth Overshoot Day
1-Aug
There are some races you want to win, and others you don’t.

Earth Overshoot Day is the calendar date on which humanity’s resource consumption for the year exceeds Earth’s capacity to regenerate those resources that year. In 2018, it was August 1. The date for 2019 was July 29.

A country’s Overshoot Day is the date on which Earth Overshoot Day would fall if all of humanity consumed like the people in that country. In other words, and as illustrated in this visualisation, countries closer to December 2018 have a far better ecological footprint than those closer to the beginning of the year.
“Tariffed”: Trading blows

“Trade wars are good, and easy to win,” boasted US President Donald Trump in March 2018. As his trade spat with China continues, it is clear they are anything but.

In total, over 50 per cent of US imports from China became subject to special US trade protection by the end of 2018.

It is not just the size of the tariffs imposed by the US that matters, but also the amount of imports impacted. Special protection has been imposed on imports from China for decades. However, the full historical context shows the sheer scale of this trade spat.

Share of US goods imports from China covered by special forms of tariff and non-tariff protection

- 100%
- 90%
- 80%
- 70%
- 60%
- 50%
- 40%
- 30%
- 20%
- 10%
- 0%

- 1980
- 1983
- 1986
- 1989
- 1992
- 1995
- 1998
- 2001
- 2004
- 2007
- 2010
- 2013
- 2016
- 2019

- 39.1%
- 50.6%
- 8.1%
- 96.7%

Section 301 on nearly all remaining US imports from China
China’s carefully calibrated retaliation

The charts below reveal a clear strategy on China’s part to target the US Rust Belt, as measured by the distribution of share of county level export-trade volumes affected by retaliation measures by the EU and China.
If you want something doing…

Declining productivity rates present one of the most perplexing puzzles of economics over the last decade or so. As technology improves, innovation and efficiency gains should bolster the production of goods and services per hour worked. But the opposite appears to be happening.

The reasons are contentious, but getting to the root causes is essential for progress. Productivity affects a range of important measures such as national competitiveness, living standards, trade performance and economic growth. As economist Paul Krugman says: “Productivity isn’t everything, but in the long run it is almost everything.”

Labour productivity growth in the OECD

% (ANNUAL)
2.5
Labour productivity growth in the OECD

% (ANNUAL)
3
2.5
2
1.5
1
0.5
0
-0.5

CANADA  FRANCE  GERMANY  ITALY  JAPAN  UNITED KINGDOM  UNITED STATES

OECD countries with lowest labour productivity levels

% (ANNUAL)
8
6
4
2
0
-2

CHILE  ESTONIA  GREECE  HUNGARY  KOREA  LATVIA  MEXICO  POLAND  PORTUGAL
Content providers – Google, Facebook, Amazon and Microsoft – have invested in fibre-optic undersea cables at an unprecedented scale. Between 2013 and 2017, they added capacity at a compound annual rate of at least 75 per cent. In 2018, Google became the first non-telecom company to privately own an intercontinental cable.
The implications are far-reaching. Big Tech already controls a vast amount of data underpinning the global economy. What happens when these companies also control the infrastructure to carry that data?
AI: The real deal or a Mechanical Turk?
The evolution of AI: Deep learning

Artificial intelligence has been around for more than 60 years. However, machine-learning techniques have enabled programs to learn through training instead of programming only, giving us the tools to solve real-world challenges more accurately.

More recently, deep learning has delivered breakthrough results in various fields. Networks of artificial neurons process data in order to extract features and optimise variables relevant to a given problem. Most importantly, results improve through training – just as they would if handled by a real brain!

Although the current political climate might predict some brain drain in the UK, the country is still by far the European powerhouse for AI and deep learning entrepreneurship. However, in the ‘gold rush’ to profit from all things AI, there are question marks around what is merely purported, as opposed to genuinely authentic AI.
The UK is the heart of European AI entrepreneurship.

Number of registered AI companies:
- **UK**: 479
- **Germany**: 196
- **France**: 217
- **Spain**: 166
- **Netherlands**: 103
- **Sweden**: 73
- **Ireland**: 75
- **Italy**: 66
- **Finland**: 49
- **Denmark**: 36
- **Portugal**: 45
- **Austria**: 43
- **Norway**: 32

The chart visualizes the number of registered AI companies across various European countries, highlighting the UK's leading position in AI entrepreneurship.
Connected thinking

As the challenges facing individuals and society become ever more complex, understanding relationships and deep connections will be key.
Financial centres: Competitive and connected

Finance is often described as the piping infrastructure for economic growth. Understanding the linkages between different hubs is therefore of critical importance.

The charts here are taken from ‘The Global Financial Centres Index’, which is now in its 26th edition.

The top five centres: GFCI ratings over time
Climate modelling is beyond complex
In the last four decades, the models used by climate scientists have developed enormously. “In a typical forecast there are about a billion discrete equations,” according to leading climate mathematician Professor Chris Budd.

Complex. Interrelated. Margin for error. There’s plenty to grapple with.
Rare earths

Niobium – which is typically used in superalloys – is the most concentrated resource sector with 91.5% of global production coming from Brazil.

Resources sectors with a score of 1500 or below are considered to have healthy competition with more market participants. Silver and nickel fall into this category. As does gold, which is produced in 90+ countries.

China dominates the market for the production of rare earth elements with 84% of the market. Only four other countries produce rare earth elements in any notable quantity; Australia, Russia, Brazil and Malaysia.
Rare earth elements are vital components in the electronic gadgets we use every day – but these resources are not evenly distributed across the globe.

This graphic uses the Herfindahl-Hirschman Index, a measurement of market concentration, to show which mineral sectors are competitive and which are monopolistic. Minerals closer to the centre of the circle are more competitive markets; those on the outer rim are monopolies. The market for rare earths is dominated by a single country: China.

**EXAMPLE:**

The market for petroleum is extremely competitive, with an HHI score of 686. There are many companies extracting petroleum all over the world.

**EXAMPLE:**

In contrast, major oil sands reserves are limited to just two countries: Canada and Venezuela. As such, the oil sands market operates closer to a monopoly, with an HHI score of 6871.
5G: An anatomy of an equity investment idea
An example of connected thinking in action from our equity team

Components for 5G handsets require truly innovative technology
New product cycle requiring new components, software and services
5G global capital expenditures expected to reach $26 billion in 2022, up from $528 million in 2018*

KEY QUESTIONS

Who will supply the enabling technology?
Who benefits from telecom companies' (telcos) capex bill?
New capex cycle changing pricing/margin profiles, impacting market shares
Can telcos profit from higher pricing or new services if they invest in 5G?

Can 5G lead to faster replacement cycle in smartphones?

INDUSTRY DRIVERS

- Internet of Things (IoT)
- Virtual/augmented reality
- Automation
- Mobile broadband
- Cybersecurity

CONSENSUS

5G could be a repeat of 3G and 4G, when some telcos struggled to benefit from pricing advantages
Weaker sales in smartphones hurt those providing the components for them
Smartphone unit sales tapering because users are not replacing them as frequently
Challenging environment partly due to US-China trade tensions, cyclical downturn and security concerns surrounding Huawei
**Investment Team Views**

A faster smartphone replacement cycle will help those providing components for the handsets.

**Equity Portfolio Construction**

Verizon’s superior network and financial strength support dividend growth, making it suitable for a global income strategy.

- **Real Assets**
  - Internet of Things (IoT)
  - Virtual/augmented reality
  - Automation
  - Mobile broadband
  - Cybersecurity

**Credit**

Focus on telco equipment providers with higher likelihood of increasing market share shares during 5G’s rollout.

**Multi-Asset**

- **Smartphones/Wearables**
  - Smartphone manufacturers will probably advance if users replace handsets faster, because existing phones are not compatible with 5G.
  - Samsung’s dominant position in making smartphones and potentially bigger role as a 5G equipment supplier may be attractive in a global emerging market strategy.
  - Skyworks could fit a global unconstrained strategy due to its growth potential in providing components for 5G smartphones, no matter which handset makers dominate.

- **Semiconductors**
  - Companies benefitting will include those with first-mover advantages and/or the ability to monetise the exponential growth in data and content.

- **Telecom Equipment**
  - Ericsson and Nokia may benefit from restrictions on Huawei, creating future opportunities in a European strategy.

**Size = Importance in Decision**
A question of trust: What’s behind blockchain technology?
Tech-enabled trends such as social networking, the sharing economy and crowdfunding all rest on three basic levels of trust: trust in the idea; trust in the platform; and trust in other users. Blockchain – the world’s first distributed trustless consensus algorithm behind cryptocurrencies – reduces that convention of building and managing trust a step further.

Users still need to trust the idea and the platform, but they no longer need to trust other users. The process making this possible is far too complex to detail here, but essentially connects existing and new concepts in both technical and social disciplines, as shown in the Venn diagram.

Whether society is ready for such a change remains to be seen. If you believe the anarchists, decentralising trust is the answer. However, the battle over where we place our trust is intensely political, as indicated by the global attempts to regulate – and even co-opt – cryptocurrency exchanges, chipping away at one of Blockchain’s main advantages around decentralisation. Don’t give up on our innate reliance on institutions and norms to create our trust frameworks just yet.
“Everyone is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid.”

Albert Einstein
In his landmark book *Frames of Mind: The Theory of Multiple Intelligences*, Howard Gardner proposed eight (later revised to nine) abilities related to intelligence. His theory represented a significant leap forward in how we judge people's intelligence, demanding we look beyond the simple IQ test that focuses heavily on logical and verbal strengths.

The importance of harnessing neurodiversity is becoming increasingly critical for companies and organisations.
Urbanisation

Understanding that 70 per cent of the global population are set to reside in urban areas by 2050, as well as the nuances that lurk below the surface, will be key to effective policy and overall decision-making.
Coral cities

“The varying patterns of urban forms are inherently dictated by their road network; a complex, seemingly organic connection of links moving people across their city. Like branches of coral they have a pattern and a function.” – Craig Taylor, Ito World

Taylor calculated how far you can travel (by car) from each city centre in 30 minutes. The resulting ‘coral formations’ show transport data in a new way. Each strand effectively shows the veins and arteries of a city, representing a possible route from the centre.

Coral cities provide a unique perspective on how we move around some of the world’s greatest metropoles.

LONDON
The role of a city is vastly different to 50 years ago. Many of Europe’s great cities grew up in an era of industrialisation, when competition was heavily driven by input costs. Locations benefited from qualities such as a natural harbour, access to a navigable river, proximity to sources of fuel (usually coal) and access to labour, suppliers and consumers.

Today, a city’s success is driven by its ability to facilitate information sharing to nurture idea creation. Competitive advantage no longer rests on access to inputs but on making more productive use of them. This requires continuous innovation.

Cities set to thrive, particularly in an era of knowledge capitalism, are those that manage to attract talent, establish or maintain clusters of value-add economic activity, and leverage the agglomeration effects that occur when firms and people locate in close proximity.
Total number of students by city

- COPENHAGEN: 450,000
- LONDON: 400,000
- LYON: 350,000
- PARIS: 300,000
- BERLIN: 250,000
- FRANKFURT: 200,000
- HAMBURG: 150,000
- STOCKHOLM: 100,000
- DUBLIN: 50,000
- AMSTERDAM: 50,000
- STUTTGART: 50,000
European cities: Talent, clusters and scale
Europe’s megacities

Europe’s two megacities, Paris and London, have a significantly higher Future City score than other cities in the region. Both act as magnets for global talent and their scale gives them a major competitive advantage. They have the right credentials to drive growth in an era of knowledge capitalism and both have office markets characterised by significant constraints to new development, signalling scope for sustained rental growth over the long run.

Population by metropolitan area (2018, thousands)
London's world-leading clusters

- Bloomsbury
- Holborn
- St. Luke's
- Clerkenwell
- City River
- Euston
- Angel
- Spitalfields
- Aldgate and Brick Lane
- St Paul's and Fleet Street

Dendrochronology
A new way of seeing two centuries of American immigration
The US has more immigrants than any other country. About 44 million people living there were born in another country, accounting for one in five of the global migrant population in 2017.

As indicated in this dendrochronology diagram, which treats each decade of immigration history in the US as a tree ring, the numbers swelled in the decades following the 1965 Immigration Act. (Previous policies were based on a national quota system.)

Not only did the rings become wider, but also more colourful, as immigrants arrived from a broader variety of countries in Asia, the Middle East and Latin America. They also favoured settling in the west and south over the north and northeast, with California and Texas receiving the highest immigrant population and New York a close third.

With the Trump administration’s immigration policies, though, the next decade could look very different.
Retirement

The challenges facing retirees are multi-dimensional. While understanding the numbers is important, the quest for purpose and meaning in retirement should also shape our thinking.
Have we reached peak retirement?
Average years spent in retirement

The idea that in one's sixties it might be time to step out of work and retire into a life of leisure is relatively recent. Just over a century ago, people in the UK died on average 23 years before the official retirement age.
Retiring at 60 is therefore a relatively new concept, and possibly a short-lived one. Looking at labour-force participation, the idea there is a single age at which everyone should retire is already outdated.
Multi-stage lives

If the notion of a multi-stage life is right, we should question the whole concept of a pension because of our need for assets at different times of our lives.

There is a whole covariance of assets we must look at: health, relationships and education, as well as work. This requires us to think differently about when we shuffle money from one period to another. That process is also going to be much more individualistic.
Evolution of Retirement Income Solutions

From three to many stages of life

- **Pre-retirement**
  - Cash
  - Variable annuity/drawdown
  - Part-time work
  - Pension or self-invested personal pension
  - Investments/savings
  - Property

- **Full retirement**
  - Conversion to conventional annuity
  - Bonds
  - Home-equity release/reverse mortgage
  - Long-term care
  - Inheritance planning

Evolving toward a flexible and fluid model of retirement income
Sequence of returns risk

How to best convert assets into income from long-term savings? Nobel Prize winner Professor William Sharpe described this as “the nastiest, hardest problem in finance”.

The problem for investors is that future ‘unknowns’ – like the pattern of returns – can lead to radically different outcomes. Drawing down on an illustrative portfolio invested in the S&P 500 (shown in yellow) or on a portfolio with returns stated in reverse order (in blue) can lead to materially different results. The order of returns matter as early losses can be hard to recover from.

S&P annual returns

Past performance is not an indicator of future performance, the value of investments can fall as well as rise.
Investor outcome at 6% drawdown rate

S&P 500 (1973-2008)
Ikigai: A reason for being

In Japan, the world’s most aged society, a whole concept has emerged that tries to set out ‘a reason for being’. Ikigai is an approach based on staying active, which is proving popular for the older generation, as well as those suffering from inertia or depression.

Ikigai suggests staying involved for as long as possible in different spheres of life, including work, leisure and vocational interests. The concept aligns with an old Japanese proverb: ‘Only staying active will make you want to live a hundred years’.

What is important about Ikigai is the way it encourages the elderly – and others – to search for balance and be actively engaged.
Sustainability

There is no doubt climate change is happening, and the consequences of temperature increases are not only limited to environmental decay, but also economic. Companies and financial institutions have a major role to play in mitigating these impacts.
Atmospheric carbon dioxide peaked at 414.7 parts per million (ppm) in May 2019, the highest level in human history.
Just what you need – another acronym. Although there is no clear definition of what constitutes a DAI, it is pretty clear we achieved it. It is widely accepted that DAIs apply to events dramatic enough to cause the destruction of entire ecosystems, mass extinction or disrupt the world’s food supply.

Take a look at the chart and make your own conclusions about our impact as humans.

The amount of carbon dioxide (CO2) in the atmosphere varies, tending to cycle between 180 and 300 parts per million. CO2 levels have risen dramatically since the industrial revolution. Humans’ disruption of the carbon cycle means higher average temperatures and greater extremes.
Melting ice caps

Sea ice volume is an important and telling climate indicator as it depends on both ice thickness and extent.

Although it is expected for sea ice volume to follow a certain cycle of increase and decrease during any given year, its continuous decline over the last 40 years has been extraordinary, losing close to two thirds of its 1979 volume.

The geopolitical implications are huge as overwater shipping routes have slowly replaced icebreaker shipping routes.
Arctic shipping routes are opening up.
Do you really need that business trip?

Passenger jets pump billions of tonnes of carbon dioxide into the atmosphere every year. The main polluters are travellers from rich countries.

This graphic compares per-passenger emissions on different routes with the annual carbon footprint of individuals in developing nations. A passenger on a return flight from London to Rome generates 234kg of CO2 – more than the average citizen in 17 countries emits in a whole year.
average citizen emits less CO2 in a year
Carbon: A taxing issue

Most countries that have introduced carbon taxes have set them way below the “severe mitigation” scenario set out in the Paris Agreement, which intends to cap the increase in temperature below two degrees Celsius above the pre-industrial era.

The “severe mitigation” scenario gives a 50 per cent chance of meeting that two-degree cap.

Minimum price range needed by 2020 to be consistent with achieving the Paris Agreement temperature target.
EU ETS 25
Denmark carbon tax (F-gases) 23
Slovenia carbon tax 19
Québec CaT, California CaT 16
Portugal carbon tax 14
Beijing pilot ETS 11
Argentina carbon tax (most liquid fuels), Saitama ETS, Tokyo CaT 6
Shanghai pilot ETS, Hubei pilot ETS, Singapore carbon tax 4
Estonia carbon tax, Tianjin pilot ETS, Fujian pilot ETS 2
Mexico carbon tax (lower), Ukraine carbon tax, Poland carbon tax <1

UK carbon price floor
Alberta CCIR, Alberta carbon tax
Ireland carbon tax
Korea ETS
New Zealand ETS, Spain carbon tax
Newfoundland and Labrador carbon tax, Canada federal fuel charge, Prince Edward Island carbon tax
Switzerland ETS, Colombia carbon tax, Latvia carbon tax, Chile carbon tax, RGGI
Norway carbon tax (lower), Mexico carbon tax (upper), Guangdong pilot ETS, Japan carbon tax
Argentina carbon tax (fuel oil, mineral coal and petroleum coke), Shenzhen pilot ETS, Chongqing pilot ETS

Minimum price range needed by 2020 to be consistent with achieving the Paris Agreement temperature target.
Costing the earth: Renewable costs plummet

Average unsubsidised levelised cost of energy (mean LCOE $/MWh)


GAS PEAKER
NUCLEAR
SOLAR THERMAL TOWER
COAL
GEOTHERMAL
GAS—COMBINED CYCLE
SOLAR PV—CRYSTALLINE
WIND
We have reached a turning point, where in some cases it is more cost effective to build and operate renewable energy projects than it is to maintain conventional generation facilities. Spot the steep decline in costs for large-scale solar and wind – although progress is still needed in energy-storage technologies.
Fighting thirst
Number of water-related conflicts

- INTRASTATE
- INTERSTATE
A drop in the ocean

With water-related conflicts on the rise, universal access to H2O demands our attention. After all, it should be considered a basic human right.

Estimates from the World Bank claim that to “achieve universal and equitable access to safe and affordable drinking water for all” and “achieve access to adequate and equitable sanitation for all and end open defecation” would cost $114bn a year, with 69 per cent of it focused on sanitation.

The $114bn figure would amount to just 0.39 per cent of the GDPs of the 140 countries the World Bank studied.

In other words, to provide access to drinking water for everyone would cost around $30bn a year.

However, The Economist points out this still amounts to a huge reallocation of resources, and that “for it to be realised three issues need to be tackled: ownership; price; and political priorities”.

$114bn

0.39%
All eyes on you...

Number of CCTV cameras in select cities

- **BEIJING, CHINA**: 470,000
- **LONDON, UK**: 420,000
- **WASHINGTON, DC**: 30,000
- **CHICAGO, ILLINOIS**: 17,000
- **HOUSTON, TEXAS**: 17,000

PER 1,000 INHABITANTS

- **BEIJING, CHINA**: 22
- **LONDON, UK**: 48
- **WASHINGTON, DC**: 45
- **CHICAGO, ILLINOIS**: 6
- **HOUSTON, TEXAS**: 8
For facial-recognition technology to work in the public sphere, you need two things: good software and lots of cameras. Much has been made of China’s use – and export – of facial-recognition technology for security and policing purposes, but when it comes to Big Brother-style surveillance of public spaces, plenty of European and American cities have a huge number of eyes in the sky too.

As these cities deploy facial-recognition software with increasing frequency, the ethical and legal battles are only just beginning.
Markets

Visualisations of data to highlight the opportunities and risks associated with equities, bonds and alternative assets.
The future of the US economy

There has been fevered discussion about the 'inverted yield curve' and what it tells us about the likelihood of a US recession. But this chart may be a better indicator of the long-term direction of travel for the US economy.

The breakdown of the correlation between unemployment and the fiscal deficit points to a political willingness to sustain spending even when the economy is purring. This dynamic could lead to mounting pressure on US public finances over the coming years.
US bookkeeping: fiscal year 2019

Receipts by source

- Individual income taxes: $1,718 Billion
- Social insurance and retirement: $1,243 Billion
- Corporation income taxes: $230 Billion
- Excise taxes: $99 Billion
- Miscellaneous: $85 Billion
- Customs duties: $71 Billion
- Estate and gift taxes: $17 Billion

Total receipts: $3,462 Billion

Outlays by function

- Social security: $1,044 Billion
- National defense: $688 Billion
- Medicare: $651 Billion
- Health: $585 Billion
- Income security: $515 Billion
- Net interest: $376 Billion
- Veterans' benefits and services: $200 Billion
- Education: $135 Billion
- Transportation: $96 Billion
- Other: $157 Billion

Total outlays: $4,447 Billion

Deficit: $984 Billion
Yields: Travelling towards zero

In 2019, renewed monetary support saw global risk-free rates fall sharply, with many 10-year sovereign-bond yields reaching new lows.

Negative-yielding bonds – sovereign and corporate – have flooded the market since 2016, reaching unprecedented volumes.

We are about to find out that travelling towards zero is a markedly different experience than living in a zero-yield world indefinitely.
German yield curve

BUND YIELD
1.0%
0.5%
0.0%
-0.5%
-1.0%

RESIDUAL MATURITY
0Y 2Y 4Y 6Y 8Y 10Y 12Y 14Y 16Y 18Y 20Y 22Y 24Y 26Y 28Y 30Y

25 OCT 2019
1M PRIOR
6M PRIOR

Negative territory: Governments and corporates

NEGATIVE-YIELDING GOVERNMENT BONDS (LH AXIS)
NEGATIVE-YIELDING CORPORATE BONDS (RH AXIS)
In August 2019, the renminbi (RMB) crossed the psychological threshold of US$7, rattling markets. This shows the renminbi’s increasing global significance, a goal China has long been working towards.

It is a larger trading partner than the US in east and southeast Asia, and could use its influence to supplant the dollar where it has not yet done so. With Hong Kong a ready-made financial hub, this could happen in a flash.
Share of global trade in value added to east and southeast Asia ex-China (%)
Corporate intangible investments are on the rise.

Differences in the accounting treatment of tangible and intangible investments affects the size of companies’ balance sheets, but can also have a meaningful impact on reported earnings. Efforts to compare companies merely on the basis of price-to-earnings ratios have therefore become more complicated.

Standard deviation in annual log changes over past ten years
US Aggregate: Intangibles and goodwill on the balance sheet
The European property cycle is hotting up
But lower-for-longer interest rates are likely to extend the cycle further
Illiquidity premium
Revealing premia in select private markets transactions

- ILLIQUIDITY PREMIA INFRASTRUCTURE DEBT
- ILLIQUIDITY PREMIA PRIVATE CORPORATE DEBT
- ILLIQUIDITY PREMIA REAL ESTATE FINANCE
- INFRASTRUCTURE DEBT TRENDLINE
- PRIVATE CORPORATE DEBT TRENDLINE
- REAL ESTATE FINANCE TRENDLINE
- REAL ESTATE EQUITY 3M ILLIQUIDITY PREMIA

ILLIQUIDITY PREMIUM (BPS)

- 300
- 250
- 200
- 150
- 100
- 50
- 0

Investing in private assets has historically been capable of higher returns than from publicly traded ones of broadly similar credit quality and maturity. This is often called the illiquidity premium and reflects the fact that private assets are not available to trade on an exchange.

The data highlights the range and diversity of off-market assets. Premia have narrowed since the end of 2018 when public spreads widened, but opportunities still exist to add value through these specialist transactions.
One planet problem
1.7 Earths.
We are living well beyond our resources. Ecosystems are being destroyed. Biodiversity is collapsing. Wildfires raging. Glaciers melting. Sea levels rising. Carbon dioxide and greenhouses gases stored in our earth’s core for millennia are flowing out at a rate of knots: a key threshold – 415 parts per million – has been breached for the first time in human history. Natural equilibria are being irreparably distorted: tipping points, butterfly effects and feedback loops loom, with unpredictable and non-linear effects. Extreme weather threatens to displace communities and stoke social unrest. We were warned. Four decades ago, Nasa’s James Hansen spoke of these dangers – and the scientific evidence of human-driven climate change dates back even further. Now we are belatedly starting to recognise the scale of the problem. But global markets and institutions are proving inadequate to the task, and are in desperate need of fixing. The rallying cry from the generation most exposed to our failings cannot fall on deaf ears. We are losing a zero-sum game with the highest of stakes. It’s a Greek tragedy of the commons: one where free-riding bystanders leave their heads buried. As the clock keeps ticking, life remains circular: after all, what goes around WILL come around.
Appendix
Sources

8  A whole new world  Minas Giannakis, MapChart.net.
9  A whole new world  GZERO Media / Eurasia Group.
   Note: Shared Socioeconomic Pathways (SSPs): Exploring different ways the world might evolve in the absence of climate policy and how
   different levels of climate change mitigation could be achieved when the mitigation targets of RCPs are combined with the SSPs.
   Note: The United States considerably increased its special protection toward China in 2018, albeit not through the laws it used to apply
   most of the protection between 2001 and 2017. The share of bilateral imports covered by US special tariffs increased from 7.5 per cent
   in 2017 to over 50 per cent in 2018, involving the imposition of new types of special tariffs, under mostly different laws, in 2018. The first
   two laws involved the United States applying trade restrictions on a relatively non-discriminatory basis and thus were not limited to
   imports from China. In January 2018, under Section 201 of the Trade Act of 1974, the United States announced restrictions on imports
   of solar panels and washing machines. In March 2018, under Section 232 of the Trade Expansion Act of 1962, the United States imposed
   trade restrictions on steel and aluminium, arguing imports of each were a threat to national security. The third law was Section 301 of the
   Trade Act of 1974, under which the United States imposed tariffs on roughly $250 billion of imports from China. Collectively, special tariffs
   applied under these laws—as well as the antidumping and countervailing duty laws described earlier—covered more than 50 per cent of US
   imports from China. This estimate accounts for the redundancies inherent in some products being hit with multiple special protection policies.
   Policy Research.
16-17 If you want something doing… OECD (2019), OECD Compendium of Productivity Indicators 2019, OECD Publishing, Paris,
   doi.org/10.1787/b2774f97-en.
   Note: A country’s labour productivity is measured by GDP per hour worked.
18-19 Data that lies beneath TeleGeography; www.telegeography.com.
   (Aviary Creative).
   Global Financial Centres (September 2019), Produced by Z/Yen in Partnership with CDI.
26  Climate modelling is beyond complex Moss et al. 2010, cited by Professor Chris Budd in “The Mathematics of Climate Change”.
32  A question of trust: What’s behind blockchain technology? @unchainedcap.
35  Multiple intelligences: The power of neurodiversity Based on Howard Gardner, “Frames of Mind: the Theory of Multiple Intelligences.”
38-39 Coral cities Craig Taylor, Ito World.
41  European cities: Talent, clusters and scale QS, April 2019.
<table>
<thead>
<tr>
<th>Page</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td><strong>Dendrochronology</strong> Pedro Cruz, John Wihbey, Avni Ghael and Felipe Shibuya. Co-Lab for Data Impact, College of Arts, Media, and Design (CAMD), Northeastern University.</td>
</tr>
<tr>
<td>48</td>
<td><strong>Have we reached peak retirement?</strong> NB Official state retirement age and years of anticipated pension payout based on cohort life expectancy at birth. Source: Old Age Pensions Act 1908, Commons Library Briefing, House of Commons Library. Cohort life expectancy at birth, Office for National Statistics, 1 January 2016.</td>
</tr>
<tr>
<td>50-51</td>
<td><strong>Multi-stage lives</strong> Lynda Gratton and Andrew Scott, “The Corporate Implications of Longer Lives.”</td>
</tr>
<tr>
<td>55</td>
<td><strong>Ikigai: A reason for being</strong> N/A.</td>
</tr>
<tr>
<td>60</td>
<td><strong>Melting ice caps</strong> Zachary M. Labe, Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS, Zhang and Rothrock, 2003).</td>
</tr>
<tr>
<td>61</td>
<td><strong>Melting ice caps</strong> NGA, NSIDC, NOAA.</td>
</tr>
<tr>
<td>63</td>
<td><strong>Do you really need that business trip?</strong> Atmosfair, The Guardian, July 2019.</td>
</tr>
<tr>
<td>70</td>
<td><strong>All eyes on you...</strong> GZERO Media / Eurasia Group.</td>
</tr>
<tr>
<td>74</td>
<td><strong>The future of the US economy</strong> Department of Labor, Office Management and Budget.</td>
</tr>
<tr>
<td>76-77</td>
<td><strong>Yields: Travelling towards zero</strong> Bloomberg.</td>
</tr>
<tr>
<td>78</td>
<td><strong>Renminbi: Value vs. influence</strong> Bloomberg, 31 October 2019.</td>
</tr>
<tr>
<td>80</td>
<td><strong>Equities: The trouble with styles</strong> Andrew Smithers, Productivity and the Bonus Culture. <a href="http://www.smithers.co.uk">www.smithers.co.uk</a>. Note: NIPA = National Income and Product Accounts.</td>
</tr>
<tr>
<td>81</td>
<td><strong>Equities: The trouble with styles</strong> “Non-GAAP EPS—Intangible Amortization: To Expense or Not to Expense?”, Credit Suisse: HOLT® Accounting &amp; Tax, August 14, 2019.</td>
</tr>
<tr>
<td>82-83</td>
<td><strong>The European property cycle is hotting up</strong> Aviva Investors, (Q2 data) July 2019.</td>
</tr>
<tr>
<td>84</td>
<td><strong>Iliquidity update</strong> Aviva Investors, 31 October 2019.</td>
</tr>
<tr>
<td>87</td>
<td><strong>One planet problem</strong> Aviva Investors.</td>
</tr>
</tbody>
</table>
**Important information**

For any feedback or questions regarding this content, please contact James Whiteman at james.whiteman@avivainvestors.com

This document is for professional clients and advisers only. Not to be viewed by or used with retail clients.

Except where stated as otherwise, the source of all information is Aviva Investors Global Services Limited (AIGSL) as at November 2019. Unless stated otherwise any views and opinions are those of Aviva Investors. They should not be viewed as indicating any guarantee of return from an investment managed by Aviva Investors nor as advice of any nature. Information contained herein has been obtained from sources believed to be reliable, but has not been independently verified by Aviva Investors and is not guaranteed to be accurate. Past performance is not a guide to the future. The value of an investment and any income from it may go down as well as up and the investor may not get back the original amount invested. Nothing in this material, including any references to specific securities, assets classes and financial markets is intended to or should be construed as advice or recommendations of any nature. This material is not a recommendation to sell or purchase any investment.

In the UK & Europe this material has been prepared and issued by AIGSL, registered in England No.1151805. Registered Office: St. Helen’s, 1 Undershaft, London, EC3P 3DQ. Authorised and regulated in the UK by the Financial Conduct Authority. In Singapore, this material is being circulated by way of an arrangement with Aviva Investors Asia Pte. Limited (AIAPL) for distribution to institutional investors only. Please note that AIAPL does not provide any independent research or analysis in the substance or preparation of this material. Recipients of this material are to contact AIAPL in respect of any matters arising from, or in connection with, this material. AIAPL, a company incorporated under the laws of Singapore with registration number 200813519W, holds a valid Capital Markets Services Licence to carry out fund management activities issued under the Securities and Futures Act (Singapore Statute Cap. 289) and Asian Exempt Financial Adviser for the purposes of the Financial Advisers Act (Singapore Statute Cap.110). Registered Office: 1Raffles Quay, #27- 13 South Tower, Singapore 048583. In Australia, this material is being circulated by way of an arrangement with for distribution to wholesale investors only. Please note that Aviva Investors Pacific Pty Ltd (AIPPL) does not provide any independent research or analysis in the substance or preparation of this material. Recipients of this material are to contact AIPPL in respect of any matters arising from, or in connection with, this material. AIPPL, a company incorporated under the laws of Australia with Australian Business No. 87 153 200 278 and Australian Company No. 153 200 278, holds an Australian Financial Services License (AFSL 411458) issued by the Australian Securities and Investments Commission. Business Address: Level 30, Collins Place, 35 Collins Street, Melbourne, Vic 3000, Australia.

The name “Aviva Investors” as used in this material refers to the global organization of affiliated asset management businesses operating under the Aviva Investors name. Each Aviva investors’ affiliate is a subsidiary of Aviva plc, a publicly- traded multi-national financial services company headquartered in the United Kingdom. Aviva Investors Canada, Inc. (“AIC”) is located in Toronto and is registered with the Ontario Securities Commission (“OSC”) as a Portfolio Manager, an Exempt Market Dealer, and a Commodity Trading Manager. Aviva Investors Americas LLC is a federally registered investment advisor with the U.S. Securities and Exchange Commission. Aviva Investors Americas is also a commodity trading advisor (“CTA”) and commodity pool operator (“CPO”) registered with the Commodity Futures Trading Commission (“CFTC”), and is a member of the National Futures Association (“NFA”). AIA’s Form ADV Part 2A, which provides background information about the firm and its business practices, is available upon written request to: Compliance Department, 225 West Wacker Drive, Suite 2250, Chicago, IL 60606.

RA19/1456/08112020