LITTLE SEARCHING FOR SIGNALS

THE LITTLE BOOK OF DATA

SEARCHING FOR SIGNALS
The little book of data
As bytes of data multiply by the second, we are increasingly bombarded by poorly-presented data. This seems highly strange given we process visual information 60,000 times faster than text.

If we are to turn data into information and, crucially, information into insight, the visual depiction of data demands our attention. To this end, displaying information has been a neglected art form within finance for far too long. In this little book we aim to rectify matters, in however small a way. Part curation, part creation, we have drawn from experts in this field – the late Hans Rosling, LSE Cities and Our World in Data to name just a few.

The subject matter is not exhaustive; it can’t be. What we hope to do is to provide easy to comprehend and visually-arresting snapshots of some of the most important factors shaping the financial world around us. It is a collection of visual vignettes we hope will help you, as they have us, see the world more clearly – and perhaps even differently.

Bad data visualisation confuses and wastes time. Good visualisations save time, draw you in, and shine a light.

Euan Munro
CEO, Aviva Investors
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Big picture

Visual depictions of major macro trends to help investors gain perspective and distinguish the key trends taking place across the globe.
World health chart

INCOME LEVEL 1

INCOME LEVEL 2

(GDP PER CAPITA, $ PER YEAR, PRICE ADJUSTED)
The world as 100 people

EXTREME POVERTY

BASIC EDUCATION

LITERACY

LIVING IN EXTREME POVERTY
NOT LIVING IN EXTREME POVERTY

UNEDUCATED
EDUCATED

ILLITERATE
LITERATE
Global gross external debt breakdown (% of global total)

UNITED STATES
34.3%

JAPAN
17.9%
Global debt snowball

The higher the debt per capita, the closer to the centre of the map the country is.
Global debt is up almost US$150 trillion over 15 years
Trade wars
Evolution of recent tariffs (USD)

TARIFFS IMPOSED BY THE US ON IMPORTS

TARIFFS IMPOSED ON US GOODS
- CHINA
- CANADA
- EUROPEAN UNION
- MEXICO

**US:** Imposed tariffs of 20% on the first 1.2 million washing machines imported + 20% on all solar panels imports. Total value of goods subject to US tariffs ≈ $6 billion

**China:** Imposed tariffs on $3 billion of American pork, wine and pipes imports

**EU:** Imposed tariffs on $7.1 billion of various American goods
Canada: Imposed tariffs on $12.8 billion of American products.
Mexico: Imposed tariffs on $3 billion of American steel, pork, cheese, and whiskey imports.

China: In response to the new US tariffs, China retaliated with tariffs on $50 billion of additional American goods.
EU: Agreed to impose tariffs on an additional $3 billion of US goods in response to their previous steel and aluminium decision.

US: Threatened to impose tariffs on $200 billion of Chinese goods (which came into effect on September 24), and stated it is prepared to impose tariffs on an extra $267 billion in case China retaliates.
China: In September, threatened to add tariffs on $90 billion additional US goods.
China’s Belt and Road Initiative (BRI) encompasses two main trade routes: the ‘belt’, which loosely follows the ancient Silk Road through central Asia towards Europe, and the ‘road’, a string of maritime connections between Southeast Asia, South Asia and East Africa. BRI spans 65 countries, accounting for 29 per cent of global output and 63 per cent of the world’s population.

China says the idea is to promote “open and efficient international cooperation”. Critics suggest the real aim is to project Chinese political influence abroad.
BIG PICTURE

MARITIME SILK ROAD INITIATIVE

SILK ROAD ECONOMIC BELT
Brexit
From hard to soft

Scenario 1: Baseline assumption, representing business as usual if the UK remains within the Single Market and Customs Union.

Scenario 2: From 2021, after a two-year transition period, the UK would be part of the European Economic Area but not the Customs Union. This scenario is similar to the conditions currently faced by Norway: there would continue to be free movement of goods, services, people and capital within the EEA.

Scenario 3: From 2021, after a transition period, the UK would be part of the Customs Union, but not the EEA. This scenario is similar to the conditions currently faced by Turkey: there would be no tariffs on goods traded between the UK and EU; however, the UK could face barriers to trade in services. As the UK is no longer part of the EEA, it will be able to have control over migration, but EEA countries will also be able to restrict migration from the UK.

Scenario 4: From 2021, after a transition period, the UK would no longer be part of the EEA nor the Customs Union. The UK will be able to freely set economic policy and regulatory standards, and its trade with most of the rest of the world would be under WTO rules. There would be no free movement of people under WTO rules.

Scenario 5: This scenario is similar to Scenario 4, except it is assumed there will be no two-year transition period from 2019 onwards.
<table>
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<th>Region</th>
<th>Value</th>
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<td>EUROPEAN UNION MEMBERS</td>
<td>US$324.8bn</td>
</tr>
<tr>
<td>ASIA</td>
<td>US$157bn</td>
</tr>
<tr>
<td>NORTH AMERICA</td>
<td>US$58.3bn</td>
</tr>
<tr>
<td>NON-EUROPEAN UNION MEMBERS</td>
<td>US$37.8bn</td>
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<td>AFRICA</td>
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</table>

Brexit
UK Trade Flow based on OEC Data (2016)
EXPORT

US$175.6bn  EUROPEAN UNION MEMBERS

US$83.8bn  ASIA

US$61.8bn  NORTH AMERICA

US$28.5bn  NON-EUROPEAN UNION MEMBERS

AFRICA
Quantitative easing and the central bank white knights
Cumulative value of central bank purchases

- FEDERAL RESERVE
- EUROPEAN CENTRAL BANK
- BANK OF JAPAN
- BANK OF ENGLAND
- SWISS NATIONAL BANK

USD TRILLION

16
14
12
10
8
6
4
2
0

Flow of central bank asset purchases

USD TRILLION (ROLLING 12 MONTHS)

-1.0 -0.5 0.0 0.5 1.0 1.5 2.0 2.5


FORECAST

FEDERAL RESERVE
EUROPEAN CENTRAL BANK
BANK OF JAPAN
BANK OF ENGLAND
NET
Demographics

If demographics are destiny, as some assert, this section will help provide clarity on the shifting glacial trends taking place under our respective noses.
Global population

The growth of the global population over recent decades has prompted much hand-wringing over unsustainable resource use and other environmental costs. But as these maps show, the pace of growth is far from uniform.

The proportion of people who live in Africa and Southeast Asia will continue to rise sharply over this century, while the population share of Europe and the Americas will fall. Ageing populations in these regions are likely to cause big economic challenges, an issue we explore over the following pages.
Ageing populations

% OF POPULATION 65+
- > 30%
- 25-30%
- 20-25%
- 15-20%
- 10-15%
- 5-10%
- 0-5%

2015

DEMOGRAPHICS
Financing health and pensions
Life expectancy vs health expenditure
The pension gap will soon dwarf global GDP

- Australia: 9 (2015) 13 (2050), 5% (annual growth)
- Canada: 3 (2015) 11 (2050), 5% (annual growth)
- China: 11 (2015) 119 (2050), 7% (annual growth)
- India: 3 (2015) 85 (2050), 10% (annual growth)
- Japan: 11 (2015) 26 (2050), 2% (annual growth)
- Netherlands: 6 (2015) 4% (annual growth)
- UK: 3 (2015) 33 (2050), 4% (annual growth)
- US: 28 (2015) 137 (2050), 5% (annual growth)
- Total: 400 (2050)
## Migration

Perceptions are *not* reality

**WHAT PERCENTAGE OF THE POPULATION DO YOU THINK ARE IMMIGRANTS (I.E. NOT BORN IN THE COUNTRY)?**

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<th>Country</th>
<th>% Point Difference</th>
<th>Too Low</th>
<th>Too High</th>
<th>Avg. Guess</th>
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_N.B. THE RESULTS HAVE BEEN ROUNDED UP TO THE NEAREST WHOLE NUMBER_
The Ipsos Perils of Perception survey highlights how wrong the online public across 32 countries are about key global issues and features of the population in their country. On many subjects – murder rates, immigration, teenage pregnancy, etc. – things are not as they seem.

We focus here on the issue of immigration. Results show the majority of online respondents hugely overestimate the immigration percentage, with 22 of the 32 countries missing the actual number by a difference of more than 10 percentage points. Apart from Israel and Saudi Arabia, where the online public underestimated the percentage of immigrants, all countries inflated this number, highlighting the trend that migration issues are being overly exaggerated around the world. This is especially true in Latin America.
Migration
Migration flow evolution 1980 - 2015 (millions)
With the benefits of diversity all but indisputable now, the focus on gender equality is rightly taking centre stage. After all, why would you ignore 50 per cent of the potential working population?

Although crude and not representative of any gender pay gaps that exist, the map adjacent clearly highlights how much progress has been made to overall labour force participation and where the laggard countries reside. Books like Saadia Zahidi’s *Fifty Million Rising* are timely critiques of areas for improvement.
Innovation and technology

Highlighting the implications of the recent bilateral innovation race, as well as the impact online interactions, dematerialised businesses and increasing amounts of data have in shaping global markets.
Research and development spending by country

Investing in innovation can be risky; with no crystal ball it is hard to tell what is going to be a success, and sometimes the results aren’t seen for decades. Yet economic experts tend to agree on the importance of R&D investment to long-term economic growth.

The numbers comprised in this visualisation include government, private, academic and non-profit investments, painting a complete picture of R&D across the world.

The standout point here is how top-heavy R&D investment is; ten countries account for about 80 per cent of the entire world’s outlay. Judging by this visualisation, it is clear the US and China will continue to be locked in an ongoing race for innovation and economic control over the rest of the world.
Trend in unicorn creation
Number of new startups with $1bn+ valuations

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<td>20</td>
<td>62</td>
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- AIRBNB
- PINTEREST
- UBER
- WEWORK
- TRANSFERWISE
- GO-JEK
- ZOOM
- COMMUNICATIONS
- ROBINHOOD
- REDDIT
- DELIVEROO
- SPACEX
- MAGIC
- LEAP
- SLACK
- TECHNOLOGIES
- DIDI
- CHUXING
- BUZZFEED
- 23ANDME
The term unicorn was first used by investor Aileen Lee of Cowboy Ventures in 2013 to define a private company with a valuation of US$1 billion or more. The first unicorn appeared in 2003 and, since then, their number have steadily grown due to the proliferation of increasingly bigger rounds of funding. In fact, close to 50 per cent of total deal value in 2017-2018 were transactions worth US$50 million or more.

Today, we count 282 unicorns around the world, whose combined valuation is approaching US$900 billion. The US is clearly leading the charge with 121 unicorns, including Uber, the most valuable private company (US$68 billion), followed by China with 76, home to the second most valuable unicorn, Didi Chuxing (US$56 billion). In contrast, Europe only counts 31 unicorns.

In terms of industries, e-commerce/marketplaces and fintech are the most represented, mainly due to their usually low capital requirements, which make them an attractive investment for major venture capital firms.
Can Moore’s Law go on forever?
This graph is based on Moore’s Law, which states that the number of transistors in integrated circuits, now represented by the computing power of new technology (Y axis), is increasing exponentially with every new creation.

However, squeezing smaller and smaller circuits onto smaller and smaller silicon chips is not an activity that can go on forever. For many, quantum computing holds the answer.

Moore’s Law or no Moore’s Law, the role of technology in economic progress is unquestionable and much rests on our collective ability to turn innovations into productivity gains.
Internet users by region

- Europe & Central Asia
- East Asia & Pacific
- Latin America & Caribbean
- South Asia
- North America
- Middle East & North Africa
- Sub-Saharan Africa


User counts: 0, 500 Million, 1 Billion, 1.5 Billion, 2 Billion, 2.5 Billion, 3 Billion
Data deluge
Projected data produced by digital universe

FORECAST

ZETTABYTES

2013
2020
2025
1,000,000 TERABYTES = 1 ZETTABYTE
Urbanisation

Understanding that 70 per cent of the global population are set to reside in urban areas, as well as the nuances that lurk below the surface, will be key to effective policy and overall decision-making.
Urbanisation
The world’s urban population will have grown by 2.5 billion people in just 100 years

% of global population living in urban areas

- 1950: 30%
- 2018: 55%
- 2050: 68%
90% of the increase is taking place in Asia and Africa
<table>
<thead>
<tr>
<th>GOVERNANCE</th>
<th>PLANNING</th>
<th>TRANSPORT &amp; ENVIRONMENT</th>
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<tbody>
<tr>
<td>Voter turnout in the last local elections (%)</td>
<td>Built up area in the city (%)</td>
<td>Percentage of daily trips made by public transport (modal share)</td>
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<tr>
<td>Number of elected representatives in city council / assembly</td>
<td>Average density of built up area (people/km²)</td>
<td>Car ownership rate (per 1,000 people)</td>
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<tr>
<td>Term limit for mayor / city leader (years and mandates)</td>
<td>Green space in the city (m² person)</td>
<td>Cost of a bus ticket in the city (US$)</td>
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<td>Number of Twitter followers the mayor / city leader has</td>
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<td>Annual mean PM10 Levels (μg/m³)</td>
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Inspired by the work of the late US graphic designer and transit expert Peter Dovak, these maps show the rapid development of Chinese city metro systems since 1990.
Sustainability

There is no doubt climate change is happening, and the consequences of temperature rise are not only limited to environmental decay, but also economic. Corporates and financial institutions have a major role to play in mitigating these impacts.
Sustainable energy
Do we suffer from a lack of imagination?

1 MILLION TRILLION
KILOWATT-HOURS A YEAR

TOTAL GLOBAL ENERGY USAGE = 150 TRILLION KILOWATT-HOURS PER YEAR
In 1931, not long before his death, inventor and father of electricity Thomas Edison told his friend Henry Ford: “I’d put my money on the sun and solar energy. What a source of power! I hope we don’t have to wait until oil and coal run out before we tackle that.”

This visual challenges our collective imagination. It shows clearly the disparity between the total amount of energy delivered to the earth by the sun and the amount of energy we use each year.
Climate change
Global temperature change

PREDICTED INCREASE IN GLOBAL TEMPERATURE

1900 1940 1980 2020 2060 2100

AVERAGE PREDICTION
Losses will primarily occur in the latter half of the century.
Sea level rise
People in Asian cities will be worst affected

Climate change is transforming the environment in numerous ways. But the most dramatic consequence of a warmer planet will be the rise in global sea levels. Thermal expansion of seawater is one contributing factor; melting ice sheets and glaciers another.

If temperatures reach the higher end of current projections, the implications for coastal cities would be severe. The graphic below shows the cities most at risk on each continent. East Asia is especially vulnerable: at three degrees Celsius above pre-industrial temperatures, large swathes of Shanghai and Osaka would be deluged.
Markets

Visualisations of data designed to highlight both the opportunities and risks associated with equities, bonds and alternative assets.
### Where has all the diversification gone?
#### Pre-2008 (Jan 1998 - Dec 2007)

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<th>EUR IG</th>
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#### Correlations Spectrum
-1 = Perfectly negatively correlated
1 = Perfectly correlated

(1 = Perfectly Correlated)
(-1 = Perfectly Negatively Correlated)
### Post-2008 (Jan 2008 - Nov 2016)

<table>
<thead>
<tr>
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<th>US IG</th>
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<th>US HY</th>
<th>EMD USD</th>
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**Key:****
- **US IG:** US Investment Grade
- **EUR IG:** European Investment Grade
- **US HY:** US High Yield
- **EMD USD:** Emerging Market Debt (USD)
- **ABS/SEC:** Asset-Backed Securities/Securitised
- **CMBS:** Commercial Mortgage-Backed Securities
- **US EQ:** US Equities
- **EURO EQ:** European Equities
- **JAPAN EQ:** Japanese Equities
- **EM EQ:** Emerging Market Equities
Illiquidity premium
Revealing premia in select private markets transactions

- Infrastructure Debt Transactions
- Private Corporate Debt Transactions
- Real Estate Long Income Transactions

ILLIQUIDITY PREMIUM (BASIS POINTS)

Real assets indicative yield spreads above comparable government bonds (annual data, Q3 2018)
Fixed income - beware duration risk
What actually happened

For those who remember it, the bond massacre of 1994 still sends shivers down the spines of investors.

Low government bond yields and inflation make comparisons between then and now obvious. However, there is one major, and worrying, difference: duration. Simply defined, duration is a bond’s sensitivity to interest rates. And the persistently low yield environment means investors face significant risks as interest rates start to rise.

To help understand the true comparison, in the two charts provided here we show what actually happened to US Treasury yields in three significant market event periods (1994, 2000 and 2006) and what those events would have looked like given the level of duration risk currently embedded into fixed income markets.
What would have happened based on today’s market duration levels
A virtually new world
The rise of tech

2008

EXXON MOBIL  ENERGY
PETROCHINA  ENERGY
WAL-MART  CONSUMER
CHINA MOBILE  TELECOMS
PROCTER & GAMBLE  CONSUMER
ICBC  FINANCIALS
MICROSOFT  TECHNOLOGY
JOHNSON & JOHNSON  HEALTHCARE
GENERAL ELECTRIC  INDUSTRIALS
AT&T  TELECOMS

2018

APPLE  TECHNOLOGY
AMAZON  TECHNOLOGY
MICROSOFT  TECHNOLOGY
ALPHABET  TECHNOLOGY
BERKSHIRE HATHAWAY  FINANCIALS
FACEBOOK  TECHNOLOGY
ALIBABA GROUP  TECHNOLOGY
JPMORGAN CHASE  FINANCIALS
JOHNSON & JOHNSON  HEALTHCARE
TENCENT  TECHNOLOGY
Internet companies: China on the rise

- AMAZON  US
- MICROSOFT  US
- ALPHABET  US
- FACEBOOK  US
- ALIBABA  CHINA
- TENCENT  CHINA
- ANT FINANCIAL  CHINA
- NETFLIX  US
- EBAY/PAYPAL  US
- SALESFORCE HOLDINGS  US
- NASPERS  SA
- BOOKINGS HOLDINGS  US
- UBER  US
- BAIMU  CHINA
- DIDI CHUXING  CHINA
- MEITUAN DIANPING  CHINA
- XIAOMI  CHINA
- JD.COM  CHINA
- AIRBNB  US
- TOUTIAO  CHINA

MARKET CAP ($ TRILLIONS)

2013
2018
Risk is not ‘normal’
RISK
IS NORMAL UNTIL
IT ISN’T • MODELS BASED
ON GAUSSIAN BELL CURVES
NAIVELY REDUCE RISK TO UNIFORM
RULES • UNFORTUNATELY LIFE IS
INHERENTLY SKEWED AND MESSY;
NOT NEARLY AS NEAT AS THE LOGICIANS
WOULD LIKE • AND WHILE ‘RISK’ CAN BE MEASURED
PROBABILISTICALLY, UNCERTAINTY CANNOT • AN ELUSIVE
GAP EXISTS BETWEEN KNOWN UNKNOWNS AND UNKNOWN
UNKNOWN, LEAVING THE MATHS WANTING – UNABLE TO GRASP THE
FINER POINTS OF SURPRISE • BLACK SWANS, RANDOM WALKS AND FAT TAILS ALL
CONSPIRE TO DEVIATE IN THE MOST UN-STANDARD OF WAYS! SO BE HUMBLE ENOUGH TO
EMBRACE UNCERTAINTY FOR, ALAS, YOU CAN ONLY CONTROL WHAT YOU CAN AND MUST ACCEPT THAT WILDNESS LIES IN WAIT
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32 Financing health and pensions - Life expectancy vs health expenditure Health spending measures the consumption of healthcare goods and services, including personal healthcare (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration), but excluding spending on investments. Shown is total health expenditure (financed by public and private sources). Our World in Data, 2015. NB. Health financing is reported as the annual per capita health expenditure and is adjusted for inflation and price level differences between countries (measured in 2010 international dollars). (https://ourworldindata.org/financing-healthcare)
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Illiquidity premium - Revealing premia in select private markets transactions Aviva Investors, Q2 2018

Illiquidity premium - Real assets indicative yield spreads above comparable government bonds Aviva Investors, Q3 2018 "High quality: unlevered infrastructure with largely predictable cash flow. All data as at 30 September 2018. The future returns and opinions expressed are based on Aviva Investors internal forecasts and should not be relied upon as indicating any guarantee of return from an investment managed by Aviva Investors nor as advice of any nature.

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A virtually new world - The rise of tech Thomson Reuters/FT, 15 October 2018

A virtually new world - Internet companies: China on the rise Thomson Reuters/FT, 15 October 2018

Risk is not ‘normal’ Inspired by W. J. Youden and G. K. Chesterton
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For any feedback or question regarding this content, please contact James Whiteman at james.whiteman@avivainvestors.com

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