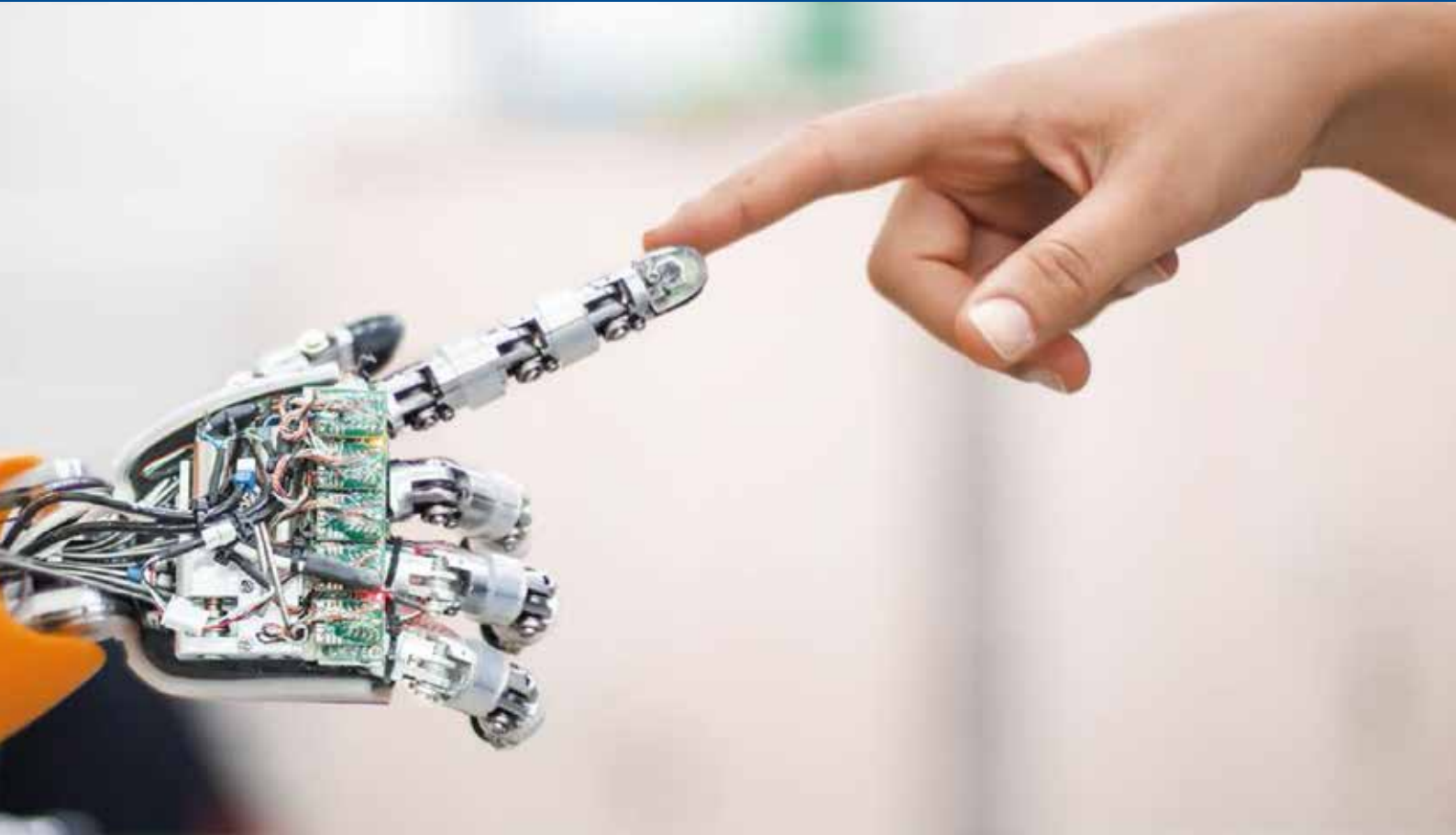# AI – Artificial Intelligence

Part of everyday life,
driving our future.

Allianz (ll)
Global Investors

Understand. Act.

Content

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AI – Artificial Intelligence

Part of everyday life, driving our future

Artificial intelligence is all around us. It is part of everyday life, and gaining ground all the time. The investment opportunities are many and varied. The "creative power of destruction" is unstoppable. On the contrary. And it's only just beginning.

Understand. Act.

- **Artificial intelligence (AI)** is all around us. It is part of everyday life, and gaining ground all the time.
- **Machines' ability to learn** comes from their virtually unlimited ability to process data, thanks to cheap storage capacities, cloud solutions and ever increasing processor speeds.
- **Data and computing power** allow structures to be recognized in what could previously not be structured, and enable new applications, for example in the healthcare sector, the "smart home", or the self-driving car.
- AI also lies behind the development of **"Industry 4.0"**, also known as the **"Fourth Industrial Revolution"**.

We have got used to computers being able to checkmate world chess champions. Victory over the world Go champion was another milestone. Shortly afterwards, the world's best poker player also lost to a computer (or rather, the underlying algorithm).

Progress has been astonishingly swift: while chess moves are relatively straightforward – at least for a computer brain – in the Chinese board game of Go there are more moves than there are atoms in the universe. Interestingly, the machine won not by working out these moves in advance, but by a ruse. This is reminiscent of artificial intelligence, or "AI" for short. Poker presents a similarly difficult challenge: how do electronic circuits recognize a bluff – in other words, an attempt to deceive?

What is artificial intelligence?

So what exactly is artificial intelligence (AI)? One definition of AI is "the branch of computer science that is concerned with the automation of intelligent behavior." Generally it is about "replicating human-like intelligence, that is to say, building or programming a computer in such a way that it can solve problems on its own."[1] The origins of AI go back around 70 years and started with researchers such as Alan Turing, Marvin Minsky and John McCarthy.

"The branch of computer science that is concerned with the automation of intelligent behavior."

[1] See Wikipedia on AI, last reviewed on 19 April 2017.

AI has already arrived in our everyday lives

The programs and algorithms behind artificial intelligence are already part of our lives. They are called "Siri" (Apple), "Cortana" (Microsoft), "Echo" (Amazon) or "Google Translate" and are there to make our lives easier. They rely on circuits whose computing power – unlike the human brain – can be expanded indefinitely, and which are fed with data.

Apart from "Siri" and its friends, AI[2] has long been part of many everyday applications: social media platforms which filter information, video analysis for security monitoring, applications in the healthcare sector (an Indian company already performs up to 100,000 diagnoses per day with AI), algorithms that write sports reports or business analyses … even legal opinions are produced using AI, with databases working in the background which it would take humans an eternity to comb through.
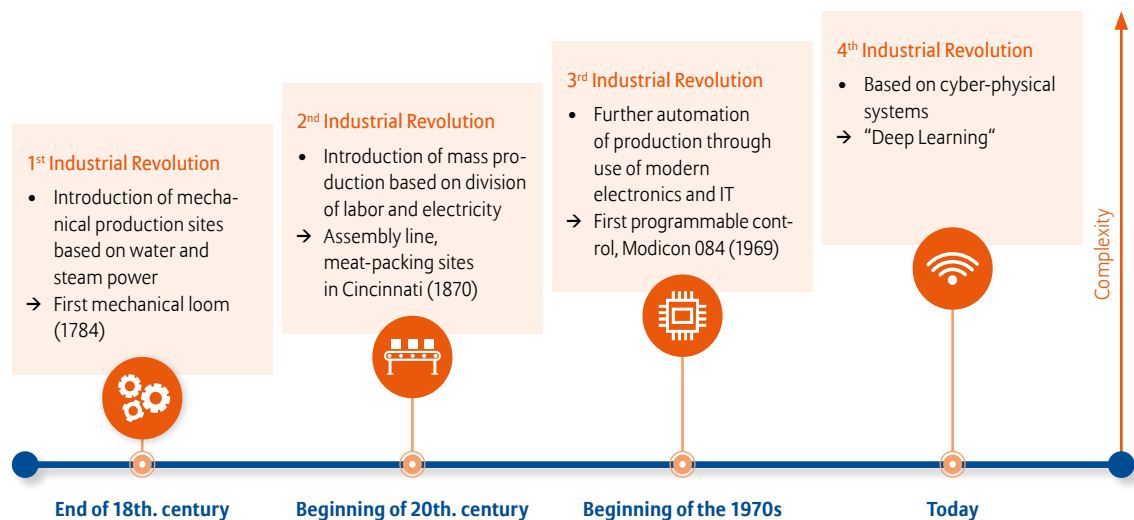
AI is part of everyday life. AI is our future. As many as 50 billion objects, all generating continuously analyzable data, will be connected to the "Internet of Things" by 2020. The "smart home" in which your fridge orders new supplies when food is running low, or the self-driving car, are keywords that are becoming part of everyday usage. But that is not only where you find AI: AI also lies behind the development of "Industry 4.0" or what has been called the "Fourth Industrial Revolution". The Industrial Revolution, which began with mechanization, can be broken down into several stages that reflect the development of production technology. It started with mechanization (looms), moved on to mass production with conveyor belts, then the introduction of IT and finally the world of AI and connected machines.

[2] In this analysis, "artificial intelligence" and "AI" are used interchangeably.

Chart 1: The four stages of the Industrial Revolution

1st Industrial Revolution
- Introduction of mechanical production sites based on water and steam power
→ First mechanical loom (1784)

2nd Industrial Revolution
- Introduction of mass production based on division of labor and electricity
→ Assembly line, meat-packing sites in Cincinnati (1870)

3rd Industrial Revolution
- Further automation of production through use of modern electronics and IT
→ First programmable control, Modicon 084 (1969)

4th Industrial Revolution
- Based on cyber-physical systems
→ "Deep Learning"

Complexity

End of 18th. century   **Beginning of 20th. century**   **Beginning of the 1970s**   **Today**

Source: Bitcom.

Technological infrastructure

Artificial intelligence is more than just a few clever algorithms that can solve problems independently. It involves a whole universe of technologies and machines – and thus investment opportunities – which work together. It starts with processor speeds, which increase exponentially. But speed is not everything. There is more to it than that – above all, data. The more data, the better, because storage capacity costs virtually nothing and can be connected at will via computer networks in the "cloud". Capacity problems do not arise, except where data availability is an

issue. When it comes to results, correlation is more important than causality, turning the mantra of statistics and econometrics on its head. The conventional wisdom is: when a statistical correlation is observed, this does not necessarily imply a true connection, i. e. causality.[3] The more data there is, the more links – and very specific links at that – can be identified. Data and computing power make it possible to recognize structures in what could previously not be structured. Even in the case of illnesses that progress very differently from one individual to another, patterns can be
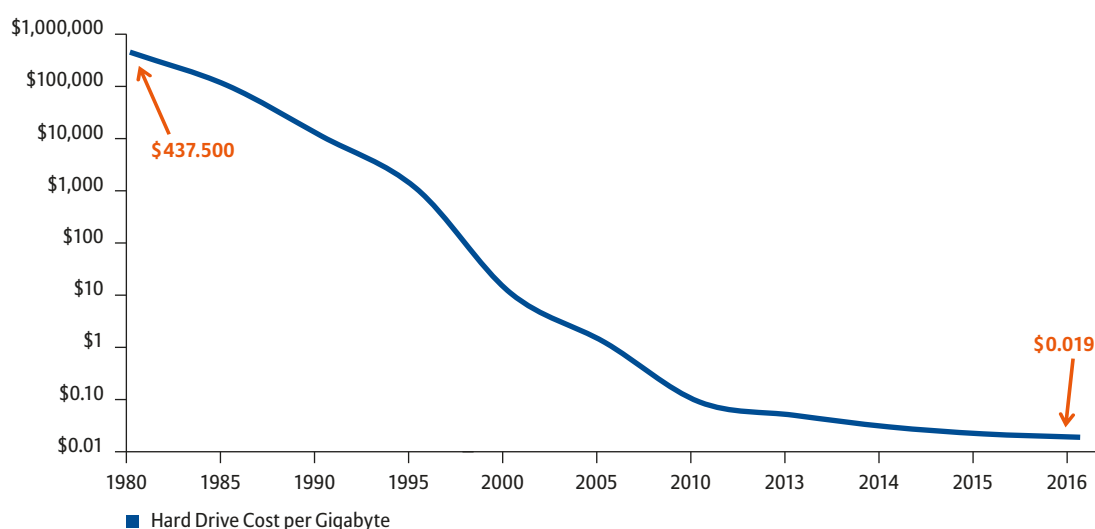
[3] In other words: the arrival of storks has nothing to do with an increase in the birth rate, despite what statistical analyses might seem to suggest.

recognized that allow targeted, individual treatment, provided sufficient data is available. Partly for this reason, the British National Health Service gave Google's "Deep Mind" artificial intelligence unit access to the data of 1.6 million patients. Not only will this increase the speed and accuracy of diagnosis, algorithms should also predict the future course of diseases.[4]

It also involves mobile applications that allow local data collection and analysis.

The big difference between AI and the human brain is that, while the latter's capacity is limited, computing capacity can be expanded almost infinitely. "Big data" can therefore be used to identify patterns that remain hidden to human brains working on their own. Given the volume of data, causality – that is to say, the relationship between cause and effect – is no longer decisive for recognizing and predicting trends. Instead, it is necessary to consider correlations – purely statistically identified connections that allow new solutions.[5]
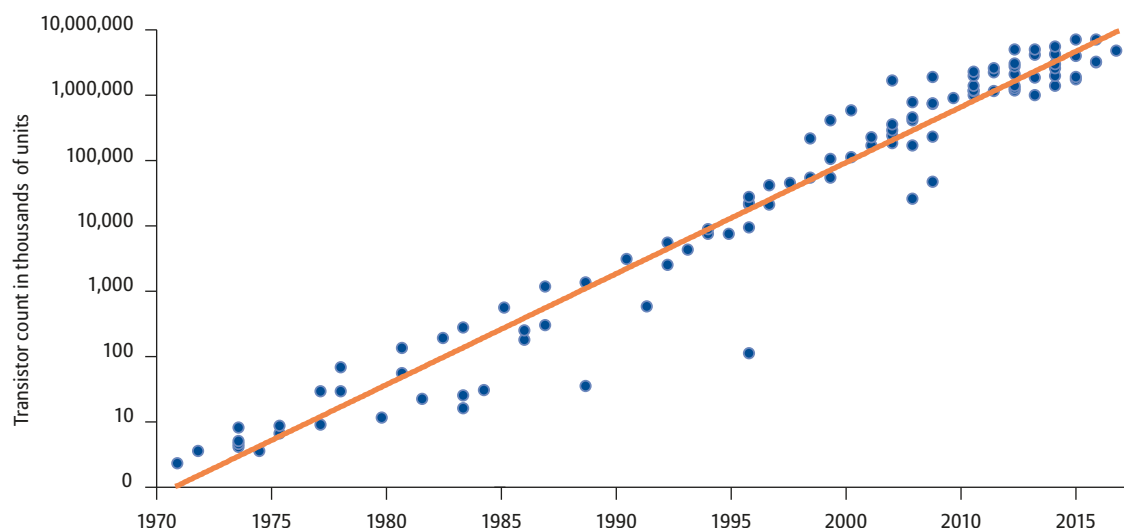
Chart 2: Cost of storage capacity

Source: Statistic Brain Research Institute, as at June 2017.

Chart 3: Moore's Law

Transistor count doubling nearly every two years

Source: AllianzGI Global Capital Markets & Thematic Research; Wikipedia.org, as at 21 April 2017.

[4] This document has been distributed for informational purposes only, and any reference to a particular investment or security is not a recommendation to buy, sell or hold such an investment or security, and should not be considered investment advice. Some or all the securities identified and described may represent securities purchased in client accounts. The reader should not assume that an investment in the securities identified was or will be profitable. The securities or companies identified do not represent all of the securities purchased, sold, or recommended for advisory clients. Actual holdings will vary for each client. Amazon, Apple, Microsoft and Google are referenced on this page because they represent the most competitive companies within the digital assistant market as at May 2017.

[5] See Steinbrecher, Michael and Schumann, Rolf; "Update: Why the data revolution affects us all"; Campus; 2015 (in German)

[6] The Wall Street Journal; "How Artificial Intelligence Will Change Everything"; updated on 6 March 2017.

[7] CNNMoney; "Google uses AI to help diagnose breast cancer"; 3 March 2017.

Memory and processing speed have long ceased to be limiting factors. On the contrary: computing speed has increased exponentially, while the cost of memory has virtually collapsed. And not only that: memory as well as computing power can be connected across the world via the cloud.
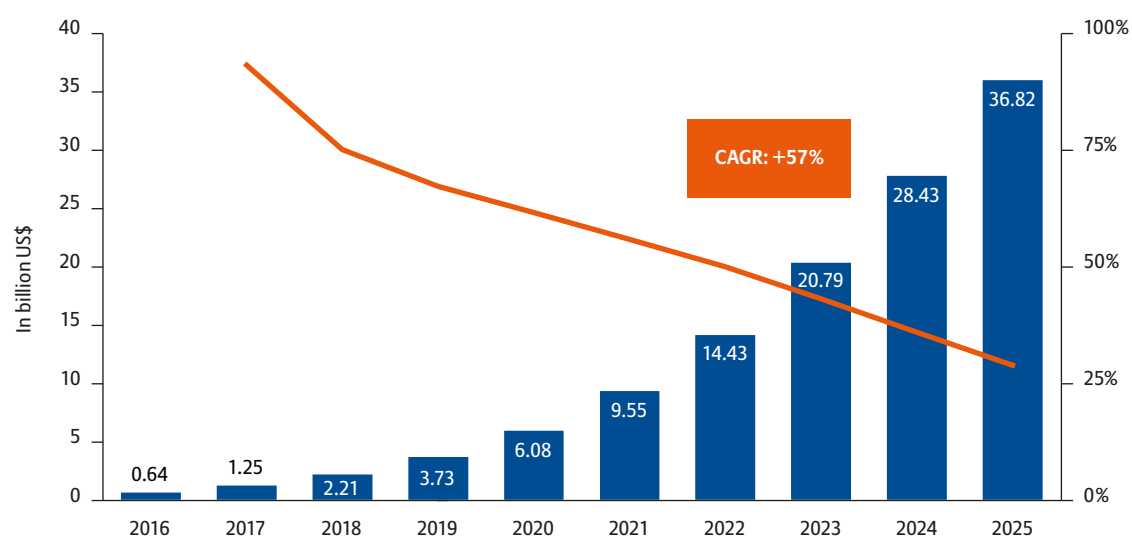
Against this background, one can understand how a team at Imperial College, London, developed an artificial intelligence-based solution that can diagnose pulmonary hypertension with 80% accuracy.[6]

Human cardiologists can only achieve 60% accuracy. It is a similar story with Google. The data giant now produces state-of-the-art results in the diagnosis of breast cancer.[7]

Both the demand for investment and the investment opportunities are immense. According to data provider Tractica, worldwide revenues from artificial intelligence are still below one billion US dollars. They are forecast to grow to nearly 37 billion US dollars by 2025, which would mean a growth rate of 57% p. a.

Chart 4: Artificial Intelligence: revenue forecast worldwide

Forecast revenues in billion US$

CAGR: +57%

CAGR: "compound annual growth rate". Source: Tractica, CB Insights, Venture Scanner., as at June 2017.

"Disruption" is everywhere –
AI and the bigger picture

What Joseph Schumpeter called "creative disruption" through technology – in this case driven by artificial intelligence – is everywhere. It will extend across all companies and sectors, and, besides identifying investment themes relating to artificial intelligence, when it comes to selecting individual stocks it will generally be more important than ever to separate the wheat from the chaff in terms of future viability. Here are a few statistics to show how fast things are changing: In 1960, the average lifespan of a typical company listed on the S&P 500 – the most important stock market index for US shares – was 60 years. By 1990 it had fallen to 20 years. Today it is probably around 12 years.[8] This clearly signals the need for actively managed solutions. It has never been so important to appreciate that passive investment products reflect yesterday's world.[9]
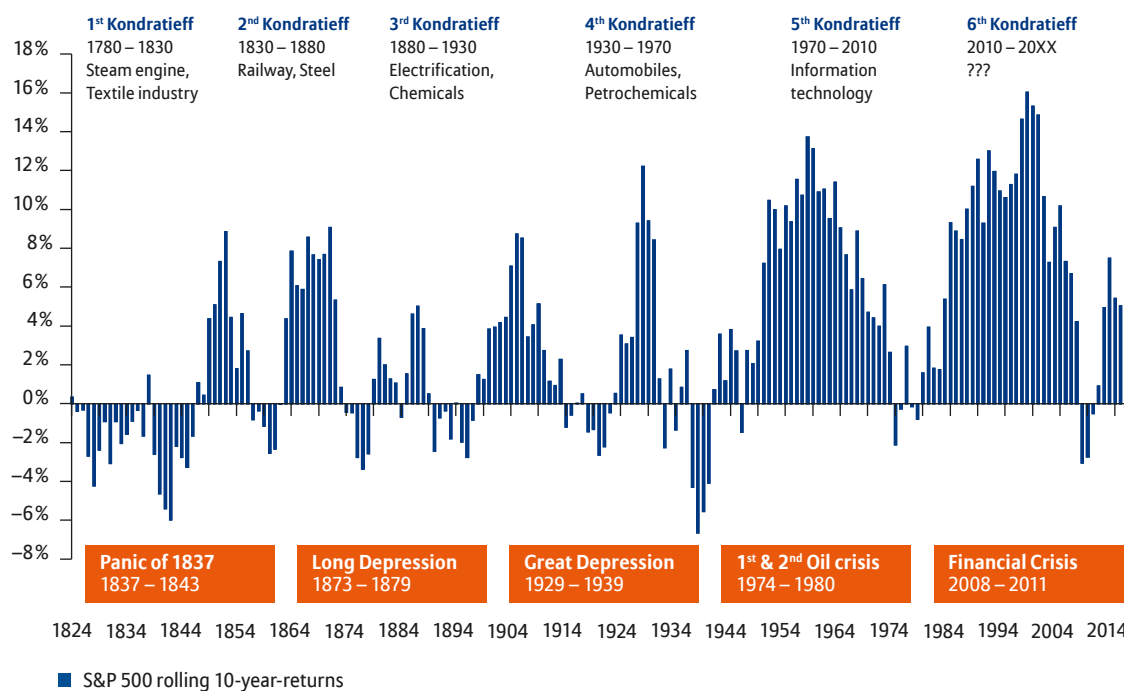
Impact of artificial intelligence

"Technological disruption" – the destruction of old technologies by new ones – is not a recent phenomenon. The Russian economist Nikolai Kondratieff discovered during the Stalin era that technological progress develops over very long periods of time and causes economic and social changes in the process. In the Kondratieff cycles named after him, he described what Joseph Schumpeter later termed "creative destruction".[10] Perhaps what is new this time around is that machines not only increase the productivity of human labor, but through artificial intelligence can be equipped to go on improving themselves and advance into areas of work previously reserved for humans.

[8] See Miller, Gunnar; "Active Management in Times of Disruption"; Allianz Global Investors; 2016.

[9] See Scheurer, Stefan; "Active Management"; Allianz Global Investors; 2016.

[10] See Naumer, Hans-Jörg; "The "green" Kondratieff – or why crises can be a good thing"; Allianz Global Investors; June 2012.

Chart 5: "The Creative Power of Destruction"

1st Kondratieff 1780 – 1830 Steam engine, Textile industry	**2nd Kondratieff** 1830 – 1880 Railway, Steel	**3rd Kondratieff** 1880 – 1930 Electrification, Chemicals	**4th Kondratieff** 1930 – 1970 Automobiles, Petrochemicals	**5th Kondratieff** 1970 – 2010 Information technology	**6th Kondratieff** 2010 – 20XX ???

Panic of 1837 1837 – 1843   **Long Depression** 1873 – 1879   **Great Depression** 1929 – 1939   **1st & 2nd Oil crisis** 1974 – 1980   **Financial Crisis** 2008 – 2011

■ S&P 500 rolling 10-year-returns

Source: AllianzGI Global Capital Markets & Thematic Research, as at January 2017.
Past performance is no reliable indicator for future results.

This might be – and forever remain – a dream of the future, but two things should be borne in mind:

1. Knowledge, innovation and technology have a habit of developing exponentially rather than in a linear fashion. Admittedly, over the first few millennia of human history, progress developed in a slow and linear manner. But over the last 200 years or so – since the start of the Industrial Revolution – technology has progressed by leaps and bounds. There is no reason to expect this exponential trend to stop. On the contrary. So it will be as well for us if we can adjust to it equally quickly (see Chart 6).

2. The story of the industrial revolution is a story of unprecedented prosperity growth for wide sections of the population and across borders. This is clear from the rapid growth of per capita income, despite a simultaneously exploding world population (the world's population did not exceed one billion until the beginning of the 19th

Century; see Chart 7). This also demonstrates what the Kondratieff cycles have already taught us: the creative power of destruction cannot prevent crises, but it can overcome them and create something new – a market economy and an "open society" (Karl Popper), provided that such changes are allowed.

The former president of the United States, Barack Obama, could well be right when he says: "My successor will govern a country being transformed by AI.[11]

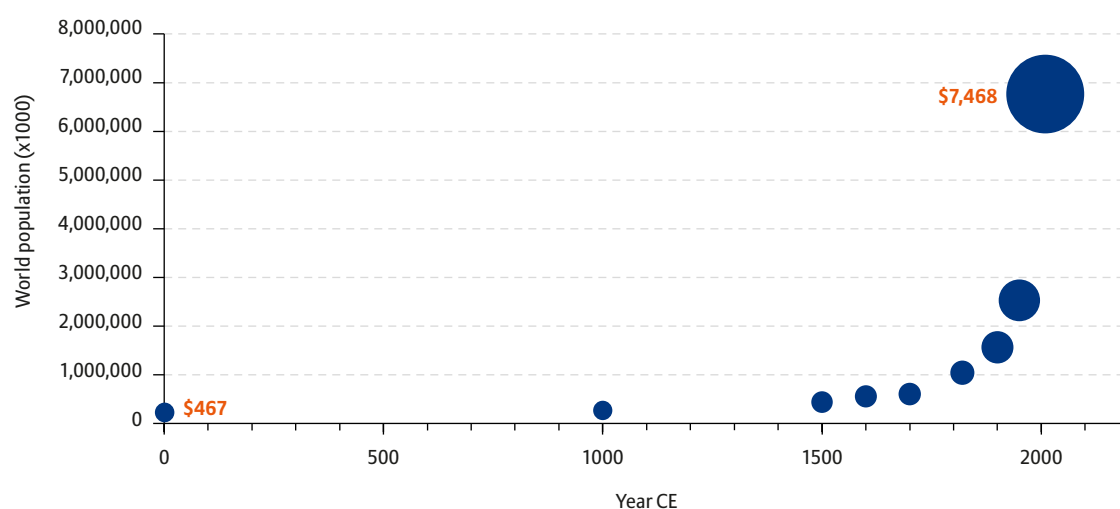AI is part of everyday life and will drive our future.

Chart 6: Knowledge & technology: exponential growth!
Turning point: population relative to inventions

Source: R. Fogek, D. Costa „A Theory of Technophysio Evolution, With Some Implications for Forecasting Population, Health Costs, and Pension Costs" (2004).

Chart 7: Growing world population – growing prosperity
GDP per capita relative to world population

World population (x1000) (y-axis): 0 to 8,000,000

Data points annotated: $467 (at Year 0), $7,468 (near Year 2000)

X-axis: Year CE — 0, 500, 1000, 1500, 2000

Source: Allianz Asset Management International Pensions, as at February 2016.

"My successor will govern a country being transformed by AI."

(Barack Obama,
former president of the United States)