

Artificial intelligence (AI) is a source of both huge excitement and apprehension. What are the real opportunities and threats for your business? Drawing on a detailed analysis of the business impact of AI, we at PwC identify the most valuable commercial opening in your market and how to take advantage of them.

Sizing the prize

What's the real value of AI for your business and how can you capitalise?

+14%

According to PwC research carried out for this report, global GDP could be up to 14% higher in 2030 as a result of AI – the equivalent of an additional \$15.7 trillion – making it the biggest commercial opportunity in today's fast changing economy

+26%

The greatest gains from AI are likely to be in China (boost of up to 26% GDP in 2030) and North America (potential 14% boost). The biggest sector gains will be in retail, financial services and healthcare as AI increases productivity, product quality and consumption.



Defining AI

In our broad definition, AI is a collective term for computer systems that can sense their environment, think, learn, and take action in response to what they're sensing and their objectives.

Forms of AI in use today include, among others, digital assistants, chatbots and machine learning. AI works in four ways:

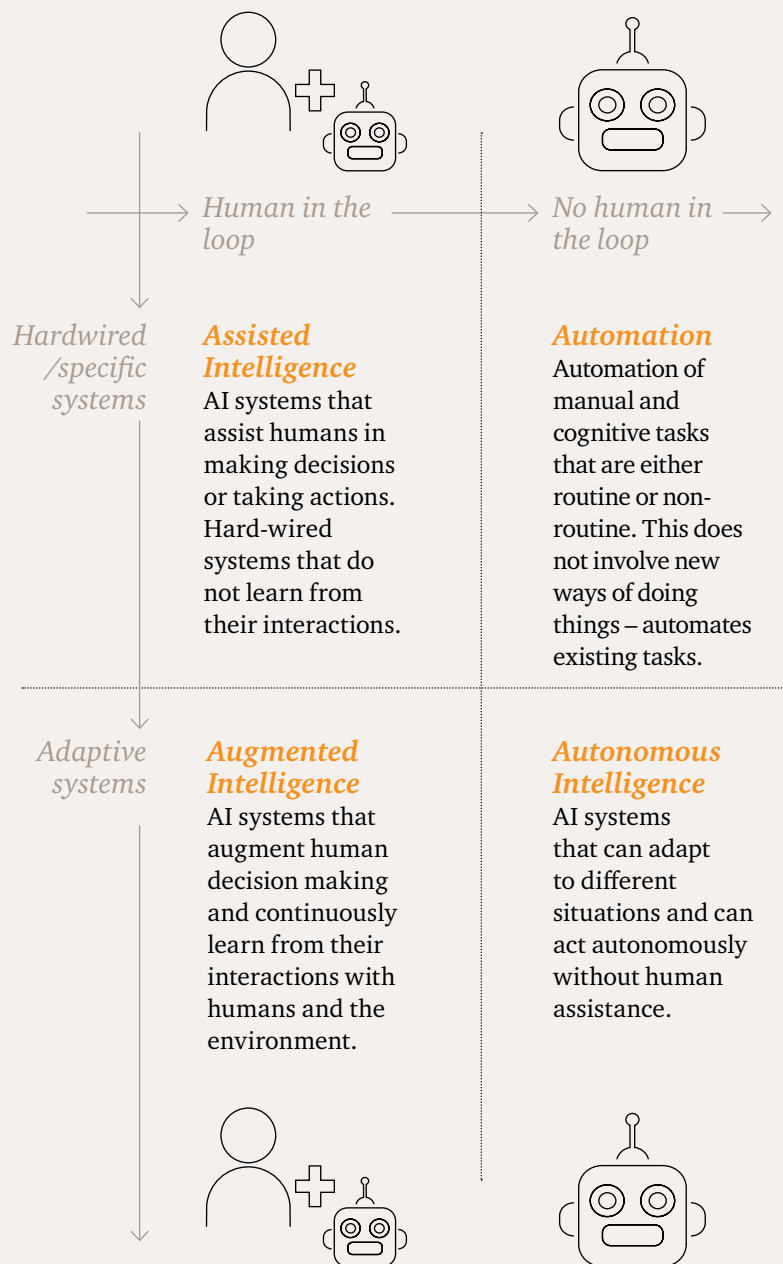
Automated intelligence: Automation of manual/cognitive and routine/non-routine tasks.

Assisted intelligence: Helping people to perform tasks faster and better.

Augmented intelligence: Helping people to make better decisions.

Autonomous intelligence: Automating decision making processes without human intervention.

As humans and machines collaborate more closely, and AI innovations come out of the research lab and into the mainstream, the transformational possibilities are staggering.



For a full glossary of AI techniques and their applications, please see page 26.

Contents

<i>Introduction</i>	4
<i>Big prize, big impact</i>	6
<i>AI Impact Index</i>	12
<i>Realising the potential</i>	22
<i>Conclusion</i>	24



Introduction: Getting down to what really counts

Business leaders are asking: What impact will AI have on my organisation, and is our business model threatened by AI disruption? And as these leaders look to capitalise on AI opportunities, they're asking: Where should we target investment, and what kind of capabilities would enable us to perform better? Cutting across all these considerations is how to build AI in the responsible and transparent way needed to maintain the confidence of customers and wider stakeholders.

These are the strategic questions we'll be addressing in a series of reports designed to help enterprises create a clear and compelling business case for AI investment and development. While there's been a lot of research on the impact of automation, it's only part of the story. In this new series of PwC reports, we want to highlight how AI can enhance and augment what enterprises can do, the value potential of which is as large, if not larger, than automation.

There's a lot of expectation surrounding artificial intelligence (AI). There's also a significant amount of wariness.

The analysis carried out for this report gauges the economic potential for AI between now and 2030, including for regional economies and eight commercial sectors worldwide. Through our AI Impact Index, we also look at how improvements to personalisation/customisation, quality and functionality could boost value, choice and demand across nearly 300 use cases of AI, along with how quickly transformation and disruption are likely to take hold. Other key elements of the research include in-depth sector-by-sector analyses.

In this opening report, we outline the regional economies that are set to gain the most and the three business areas with greatest AI potential in each of eight sectors. Future reports will focus on specific sectors, along with functional areas such as marketing, finance and talent management. We'll also be setting out the detailed economic projections and, in partnership with Forbes magazine, publishing interviews with some of the business leaders at the forefront of AI.

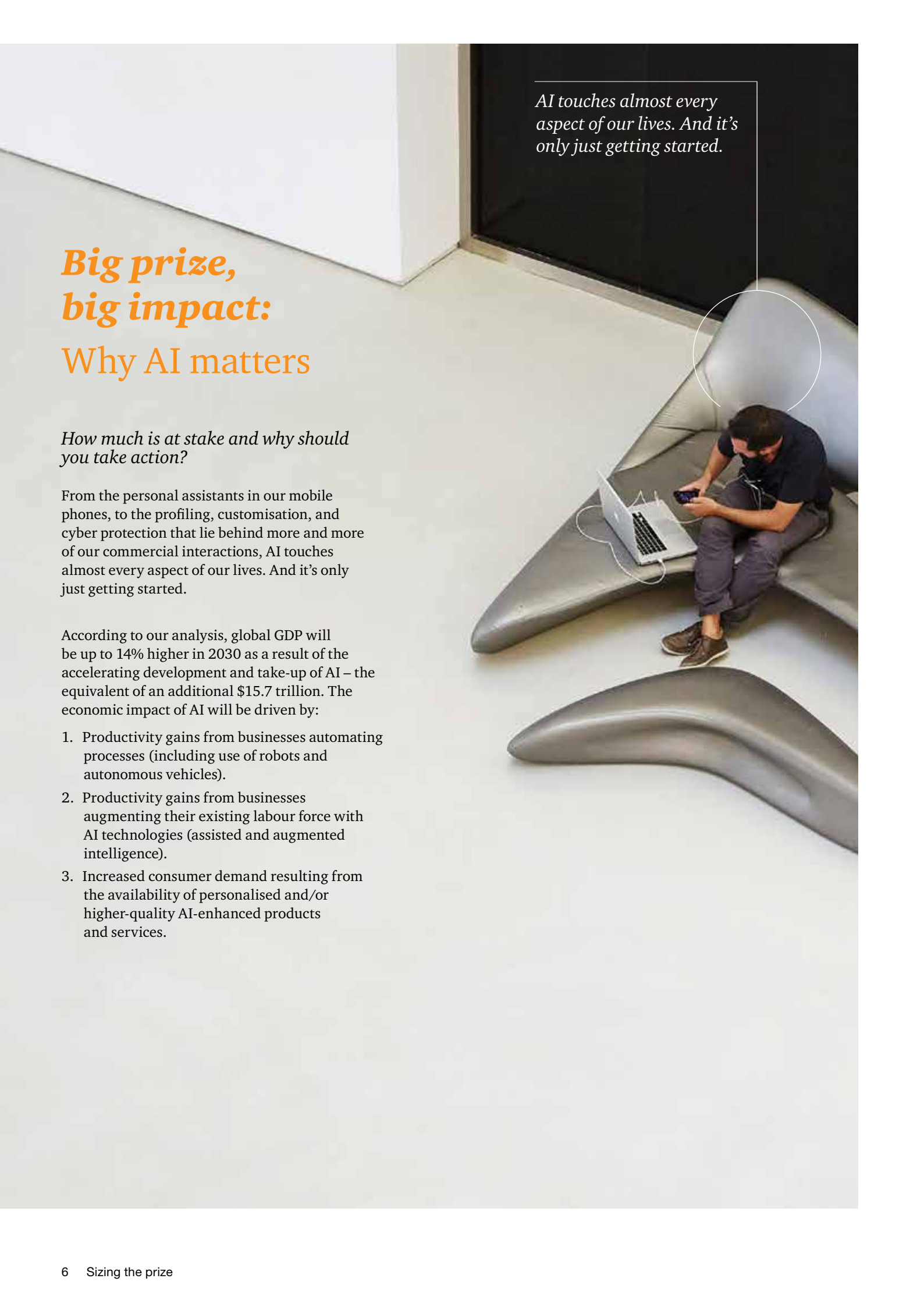
\$15.7 trillion

Game changer

What comes through strongly from all the analysis we've carried out for this report is just how big a game changer AI is likely to be, and how much value potential is up for grabs. AI could contribute up to \$15.7 trillion¹ to the global economy in 2030, more than the current output of China and India combined. Of this, \$6.6 trillion is likely to come from increased productivity and \$9.1 trillion is likely to come from consumption-side effects.

While some markets, sectors and individual businesses are more advanced than others, AI is still at a very early stage of development overall. From a macroeconomic point of view, there are therefore opportunities for emerging markets to leapfrog more developed counterparts. And within your business sector, one of today's start-ups or a business that hasn't even been founded yet could be the market leader in ten years' time.

¹ \$ denotes US dollars throughout, estimated values are expressed in real terms at 2016 prices (i.e. excluding the impact of general price inflation when looking ahead to 2030).



AI touches almost every aspect of our lives. And it's only just getting started.

Big prize, big impact: Why AI matters

How much is at stake and why should you take action?

From the personal assistants in our mobile phones, to the profiling, customisation, and cyber protection that lie behind more and more of our commercial interactions, AI touches almost every aspect of our lives. And it's only just getting started.

According to our analysis, global GDP will be up to 14% higher in 2030 as a result of the accelerating development and take-up of AI – the equivalent of an additional \$15.7 trillion. The economic impact of AI will be driven by:

1. Productivity gains from businesses automating processes (including use of robots and autonomous vehicles).
2. Productivity gains from businesses augmenting their existing labour force with AI technologies (assisted and augmented intelligence).
3. Increased consumer demand resulting from the availability of personalised and/or higher-quality AI-enhanced products and services.

How we gauged the impact and potential of AI

To estimate the impact and potential of AI, our team conducted an ambitious, dual-phased top-down and bottom-up analysis. In addition to drawing on input from our extensive network of clients, and sector and functional advisors within PwC, we've been working with our partners at Forbes and Fraunhofer, a global leader in emerging technology research and development. Together, we set out to identify the most compelling examples of potential AI applications across each sector's value chain, and designed a framework to assess the degree and pace of impact of each. In total, we identified and rated nearly 300 use cases, which are captured in our AI Impact Index.

Our Econometrics unit then used this bottom-up input as part of their top-down analysis assessing AI's impact on, and the interactions between, key elements of the economy including labour, productivity, business and government. The models were informed by global economic datasets, extensive academic literature, and existing PwC work on automation. The analysis looked at the total economic impact of AI, accounting for increased productivity (which may involve the displacement of some existing jobs), the creation of new jobs, new products, and other effects. We'll be publishing an extended technical read out of these results later in the year.

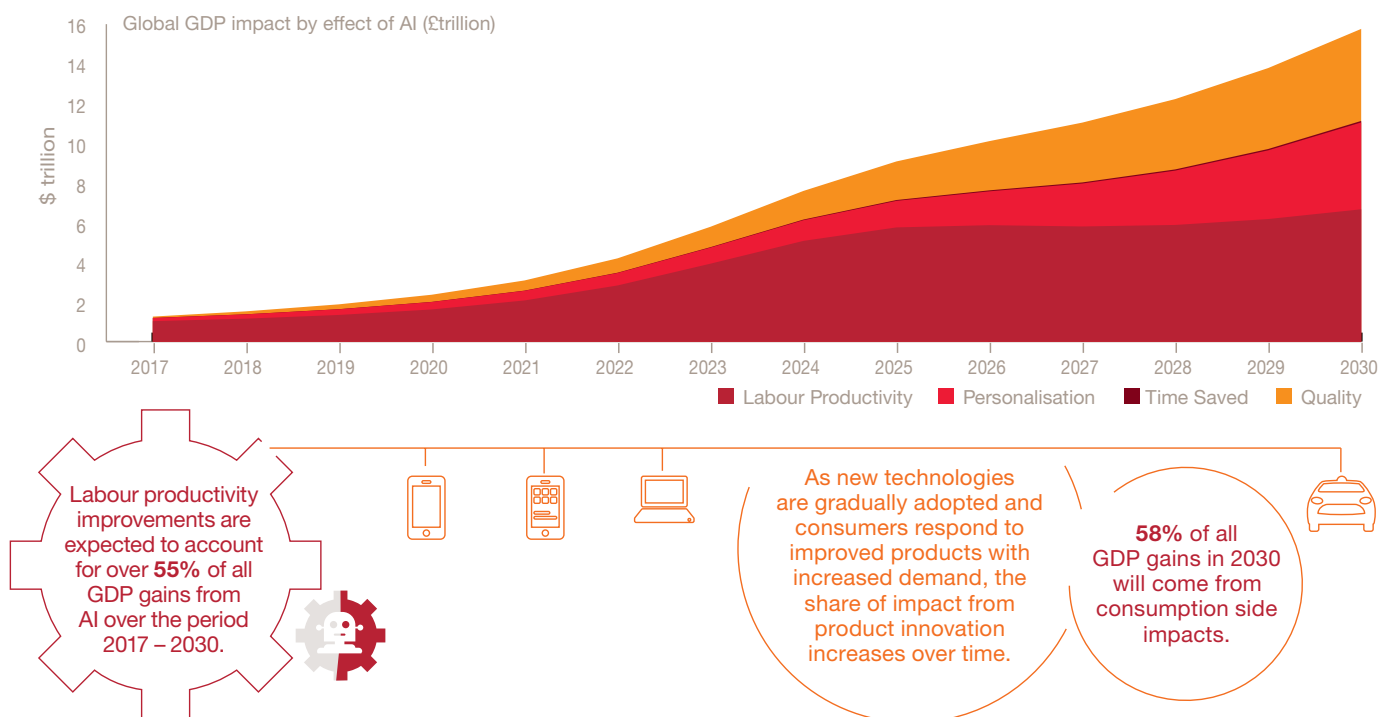
For a more detailed methodology see page 27.

Over the past decade, almost all aspects of how we work and how we live – from retail to manufacturing to healthcare – have become increasingly digitised. The internet and mobile technologies drove the first wave of digital, known as the Internet of People. However, analysis carried out by PwC's AI specialists anticipates that the data generated from the Internet of Things (IoT) will outstrip the data generated by the Internet of People many times over. This increased data is already resulting in standardisation, which naturally leads to automation, and the personalisation of products and services, which is setting off the next wave of digital. AI will exploit the digital data from people and things to automate and assist in what we do today, as well as find new ways of doing things that we've not imagined before.

Productivity gains

In the near-term, the biggest potential economic uplift from AI is likely to come from improved productivity (see Figure 1). This includes automation of routine tasks, augmenting employees' capabilities and freeing them up to focus on more stimulating and higher value-adding work. Capital-intensive sectors such as manufacturing and transport are likely to see the largest productivity gains from AI, given that many of their operational processes are highly susceptible to automation.

Figure 1: Where will the value gains come from with AI?



Source: PwC analysis

The impact on productivity could be competitively transformative – businesses that fail to adapt and adopt could quickly find themselves undercut on turnaround times as well as costs. They stand to lose a significant amount of their market share as a result. However, the potential of this initial phase of AI application mainly centres on enhancing what's already being done, rather than creating too much that's new.

Increased consumer demand

Eventually, the GDP uplift from product enhancements and subsequent shifts in consumer demand, behaviour and consumption emanating from AI will overtake the productivity gains, potentially delivering more than \$9 trillion of additional GDP in 2030. Consumers will be mostly attracted to higher quality and more personalised products and services, but will also have the chance to make better use of their time – think of what you could do if you no longer had to drive yourself to work, for example. In turn, increased consumption creates a virtuous cycle of more data touchpoints and hence more data, better insights, better products and hence more consumption.

The consumer revolution set off by AI opens the way for massive disruption as both established businesses and new entrants drive innovation and develop new business models. A key part of the impact of AI will come from its ability to make the most of parallel developments such as IoT connectivity².

AI front-runners will have the advantage of superior customer insight. The immediate competitive benefits include an improved ability to tap into consumer preferences, tailor their output to match these individual demands and, in doing so, capture an ever bigger slice of the market. And the front-runners' ability to shape product developments around this rich supply of customer data will make it harder and harder for slower moving competitors to keep pace and could eventually make their advantage unassailable. We can already see this data-driven innovation and differentiation in the way books, music, video and entertainment are produced, distributed and consumed, resulting in new business models, new market leaders and the elimination of traditional players that fail to adapt quickly enough.

Healthcare, automotive and financial services are the sectors with the greatest potential for product enhancement and disruption due to AI according to our analysis. However, there is also significant potential for competitive advantage in particular areas of other sectors, ranging from on-demand manufacturing to sharper content targeting within entertainment (we set out the business areas with most AI potential in each sector in the next section).

Some job displacement – but also new employment opportunities

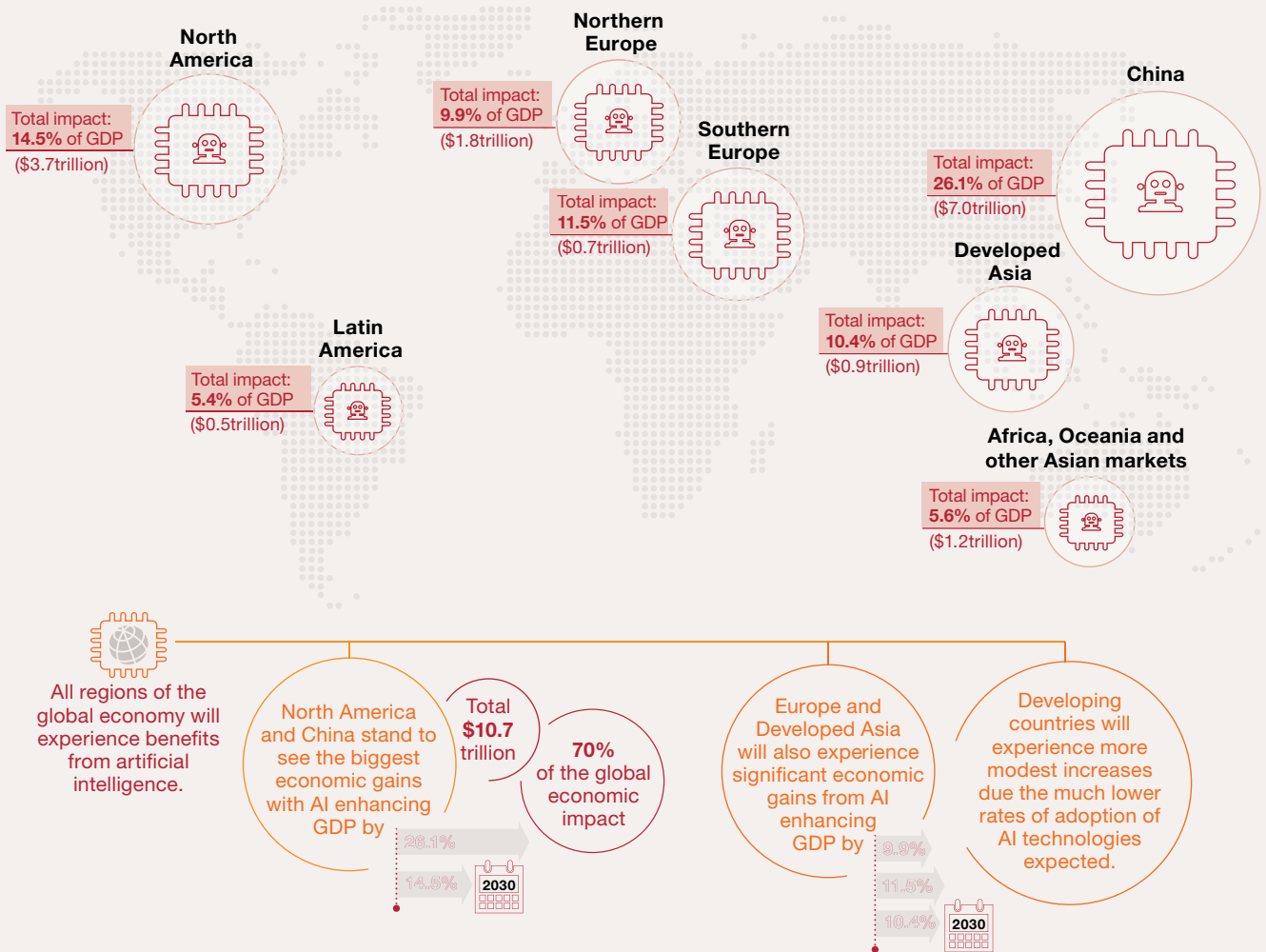
The adoption of 'no-human-in-the-loop' technologies will mean that some posts will inevitably become redundant, but others will be created by the shifts in productivity and consumer demand emanating from AI, and through the value chain of AI itself. In addition to new types of workers who will focus on thinking creatively about how AI can be developed and applied, a new set of personnel will be required to build, maintain, operate, and regulate these emerging technologies. For example, we will need the equivalent of air traffic controllers to control the autonomous vehicles on the road. Same day delivery and robotic packaging and warehousing are also resulting in more jobs for robots and for humans. All of this will facilitate the creation of new jobs that would not have existed in a world without AI.

Impact on different regions

As Figure 2 highlights, some economies have the potential to gain more than others in both absolute and relative terms. China and North America are likely to see the biggest impact, though all economies should benefit.

² AI is the key to realising the promise of IoT as AI becomes an indispensable element of IoT solutions and the convergence of AI and IoT spur the development of 'smart' machines. We explore this further in 'Leveraging the upcoming disruptions from AI and IoT' (<https://www.pwc.com/gx/en/industries/communications/assets/pwc-ai-and-iot.pdf>)

Figure 2: Which regions will gain the most from AI?



All GDP figures are reported in market exchange rate terms
 All GDP figures are reported in real 2016 prices, GDP baseline based on Market Exchange Rate Basis

Source: PwC analysis

Net effect of AI, not growth prediction

Our results are generated using a large scale dynamic economic model of the global economy. The model is built on the Global Trade Analysis Project (GTAP) database. GTAP provides detail on the size of different economic sectors (57 in total) and how they trade with each other through their supply chains. It gives this detail on a consistent basis for 140 different countries.

When considering the results, there are two important factors that you should take into account:

1. Our results show the economic impact of AI only – our results may not show up directly into future economic growth figures, as there will be many positive or negative forces that either amplify or cancel out the potential effects of AI (e.g. shifts in global trade policy, financial booms and busts, major commodity price changes, geopolitical shocks etc.).

2. Our economic model results are compared to a baseline of long-term steady state economic growth. The baseline is constructed from three key elements: population growth, growth in the capital stock and technological change. The assumed baseline rate of technological change is based on average historical trends. It's very difficult to separate out how far AI will just help economies to achieve long-term average growth rates (implying the contribution from existing technologies phase out over time) or simply be additional to historical average growth rates (given that these will have factored in major technological advances of earlier periods).

These two factors mean that our results should be interpreted as the potential 'size of the economic prize' associated with AI, as opposed to direct estimates of future economic growth.

North America

In North America, the potential uplift to GDP from AI will be amplified by the huge opportunities to introduce more productive technologies, many of which are ready to be applied. And the gains will be accelerated by the advanced technological and consumer readiness for AI, along with the impact of rapid accumulation of assets – not just technology, but data touchpoints and the flows of information and customer insight that come with them.

North America is likely to see the fastest boost in the next few years. While the impact will still be strong from the middle of the 2020s, it probably won't be quite as high as in the earlier years. One of the main reasons is that as productivity in China begins to catch up with North America, this will stimulate exports of AI-enabled products from China to North America.

China

The high proportion of Chinese GDP that comes from manufacturing heightens the potential uplift from introducing more productive technologies. It is likely to take some time to build up the technology and expertise needed to implement these capabilities and therefore the GDP boost won't be as rapid as the US. But in around ten years' time, the productivity gains in China could begin to pull ahead.

A key part of the value potential comes from the higher rate of capital re-investment within the Chinese economy compared to Europe and North America, as profits from Chinese businesses are fed into increasing AI capabilities and returns. AI will also play an important part in the shift to a more consumer-oriented economy on the one hand and the move up the value chain into more sophisticated and high tech-driven manufacturing and commerce on the other. The focus and investment are amply demonstrated by the surge in AI patents filed in China³. An acceleration in talent development in areas such as analytics will be crucial in realising the potential gains from AI within the Chinese economy.

North America is likely to see the fastest boost in the next few years.

Critical assumptions

Our estimates reflect certain assumptions, which we will stress-test in our forthcoming detailed economic assessment. What happens if the pace of AI adoption is faster/slower in particular countries, for example? How does that affect the distribution of global growth? What happens if estimated changes in product quality do not materialise? A slowdown in the pace of AI uptake would delay the benefits that feed through to labour productivity. We see this as a key driver to both the timing and the overall impact of AI on GDP.

We're currently exploring the quantitative effect of several key scenarios. This includes examining alternate combinations of input parameters, as well as the timing of AI uptake. These sensitivity tests are designed to help better understand the risks around our results, while providing more insight into the parameters that drive the relationship between AI and economic growth. We plan to present the results of several scenarios in our detailed economic assessment.

³ China is now second behind the US in AI patent filings, a key indicator of long-term trends in technology. Source: 'The Global Race for Artificial Intelligence – Comparison of Patenting Trends', Wilson Center, 1 March 2017 (<https://www.wilsoncenter.org/blog-post/the-global-race-for-artificial-intelligence-comparison-patenting-trends>)

Figure 3: How quickly will AI impact productivity?

North America and China are expected to witness the greatest GDP gains from AI increasing productivity, but the trajectory over impact for the two countries differs.



How to respond?

If your business is operating in one of the sectors or economies that is gearing up for fast adoption of AI, you'll have to move quickly if you want to capitalise on the openings, and ensure your business doesn't lose out to faster-moving and more cost-efficient competitors.

If you're in one of the sectors or economies where the disruptive potential is lower and adoption likely to be slower, there is still a significant challenge ahead – no sector or business is in any way immune from the impact of AI. In fact, the potential for innovation and differentiation could be all the greater because fewer market players are currently focusing on AI. The big question is how to secure the talent, technology and access to data to make the most of this opportunity.

Doing nothing is not a feasible option. It's easy to dismiss a lot of what's said about AI as hype. Yet as our analysis underlines, without decisive response, many well established enterprises and even whole business models are at risk of being rendered obsolete.

In the short-term, many of the opportunities and threats are likely to focus on productivity, efficiency and cost – the transformative phase. If you're the CEO of a transport and logistics company, for example, you're already seeing the impact of robots within packing and fulfilment operations. The bigger disruption will emerge when the sector switches to autonomous trucking. Are you in a position to move ahead of your competitors? What are the openings for vehicle manufacturers, technology companies and other potential new entrants to make inroads in your market? Could your business be at risk of becoming obsolete if you don't move quickly enough?

Automation in action

An online insurer has leveraged an AI bot to automate the claims process from beginning to end. Instead of the days or even months it traditionally took to settle a claim, the bot is able to complete the entire pipeline from claims receipt, policy reference, fraud detection, payout and notification to customers in just three seconds. When rolled out at scale, this solution is poised to have a huge impact on the insurance industry.

Source: PwC AI specialists



AI Impact Index: Targeting and timing your investment









AI is set to be the key source of transformation, disruption and competitive advantage in today's fast changing economy. Drawing on the findings of our AI Impact Index, we look at how quickly change is coming and where your business can expect the greatest return.

In the research carried out for this report, we've drilled down to the sector-by-sector and product-by-product impact of AI to enable your business to target the opportunities, pinpoint the threats and judge how to address them.

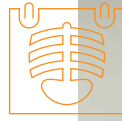
The unique analysis within PwC's AI Impact Index includes a rating for the potential to free up time and enhance quality and personalisation. We've used this analysis to create nearly 300 use cases setting out the openings for innovation; the drivers, timings and current feasibility of market adoption; what could hold this up and how these barriers could be overcome.

The areas with the biggest potential and associated timelines we outline here are designed to help your business target investment in the short – to medium-term. Some aspects of change, such as robotic doctors, could be even more revolutionary, but are further off.

Figure 4: What's the potential value for your sector?

		<i>Potential AI Consumption Impact</i>	<i>Personalisation</i>	<i>Time Saved</i>	<i>Utility</i>	<i>Data Availability</i>
Sector	Subsector					
Healthcare		3.7	3.8	2.7	3.9	4.4
	Providers/Health Services	3.9	4.1	3.0	3.9	4.7
	Pharma/Life Sciences	3.8	3.9	2.8	4.2	4.1
	Insurance	3.6	3.6	2.6	3.8	4.2
	Consumer Health	3.5	3.4	2.3	3.4	4.8
Automotive		3.7	3.9	2.9	3.8	3.9
	Aftermarket & Repair	3.9	4.2	2.8	3.6	4.6
	Component suppliers	3.9	4.0	2.0	3.5	5.0
	Personal Mobility as a Service	3.8	4.0	3.7	4.0	3.7
	OEM	3.6	4.0	3.0	4.0	3.5
	Financing	3.3	3.3	3.0	3.7	3.0
Financial Services		3.3	2.8	2.6	3.2	4.6
	Asset Wealth Management	3.4	2.9	2.2	3.7	4.3
	Banking and Capital	3.3	2.5	2.9	3.0	5.0
	Insurance	3.2	3.1	2.4	3.1	4.4
Transportation and Logistics		3.2	3.5	2.6	3.3	3.7
	Transportation	3.5	3.0	2.8	3.5	5.0
	Logistics	3.1	3.9	2.5	3.1	3.0
Technology, Communications and Entertainment		3.1	2.5	2.1	3.3	4.3
	Technology	3.3	2.7	2.4	3.6	4.1
	Entertainment, Media and Communication	3.0	2.5	2.0	3.3	4.4
Retail		3.0	2.8	2.1	3.3	3.8
	Consumer Products	3.1	3.0	2.3	3.3	3.8
	Retail	3.0	2.6	2.0	3.3	3.7
Energy		2.2	3.2	2.1	3.1	3.1
	Oil & Gas	2.3	4.0	2.1	2.9	3.0
	Power & Utilities	2.1	2.0	2.1	3.3	3.2
Manufacturing		2.2	2.0	1.2	3.7	3.8
	Industrial manufacturing	2.2	2.0	1.4	3.7	3.9
	Industrial Products/Raw Materials	2.1	NA	1.0	3.6	3.7
Grand Total		3.1	3.1	2.3	3.5	4.1

Supporting diagnosis in one of the areas in healthcare with the biggest potential



Healthcare

Three areas with the biggest AI potential

Supporting diagnosis in areas such as detecting small variations from the baseline in patients' health data or comparison with similar patients.

Early identification of potential pandemics and tracking incidence of the disease to help prevent and contain its spread.

Imaging diagnostics (radiology, pathology).

Consumer benefits

Faster and more accurate diagnoses and more personalised treatment in the short and medium-term, which would pave the way for longer-term breakthroughs in areas such as intelligent implants. Ultimate benefits are improved health and lives saved.

Time saved

More effective prevention helps reduce the risk of illness and hospitalisation. In turn, faster detection and diagnosis would allow for earlier intervention.

Timing

Ready to go: Medical insurance and smarter scheduling (e.g. appointments and operations).

Medium-term potential: Data-driven diagnostics and virtual drug development.

Longer-term potential: Robot doctors carrying out diagnosis and treatment.

Barriers to overcome

It would be necessary to address concerns over the privacy and protection of sensitive health data. The complexity of human biology and the need for further technological development also mean that some of the more advanced applications may take time to reach their potential and gain acceptance from patients, healthcare providers and regulators.

High potential use case: Data-based diagnostic support

AI-powered diagnostics use the patient's unique history as a baseline against which small deviations flag a possible health condition in need of further investigation and treatment. AI is initially likely to be adopted as an aid, rather than replacement, for human physicians. It will augment physicians' diagnoses, but in the process also provide valuable insights for the AI to learn continuously and improve. This continuous interaction between human physicians and the AI-powered diagnostics will enhance the accuracy of the systems and, over time, provide enough confidence for humans to delegate the task entirely to the AI system to operate autonomously.

Automotive

Three areas with the biggest AI potential

Autonomous fleets for ride sharing.

Semi-autonomous features such as driver assist.

Engine monitoring and predictive, autonomous maintenance.

Consumer benefit

A machine to drive you around and 'on-demand' flexibility – for example a small model to get you through a city or a bigger and more powerful vehicle to go away in for the weekend.

Time saved

The average American spends nearly 300 hours a year driving⁴ – think what you could with that time if you didn't have to spend it behind the wheel.

Timing

Ready to go: Automated driver assistance systems (e.g. parking assist, lane centring, adaptive cruise control etc.).

Medium-term potential: On-demand parts manufacturing and maintenance.

Longer-term potential: Engine monitoring and predictive, autonomous maintenance.

Barriers to overcome

Technology still needs development – having an autonomous vehicle perform safely under extreme weather conditions might prove more challenging. Even if the technology is in place, it would need to gain consumer trust and regulatory acceptance.

High potential use case: Autonomous fleets for ride sharing

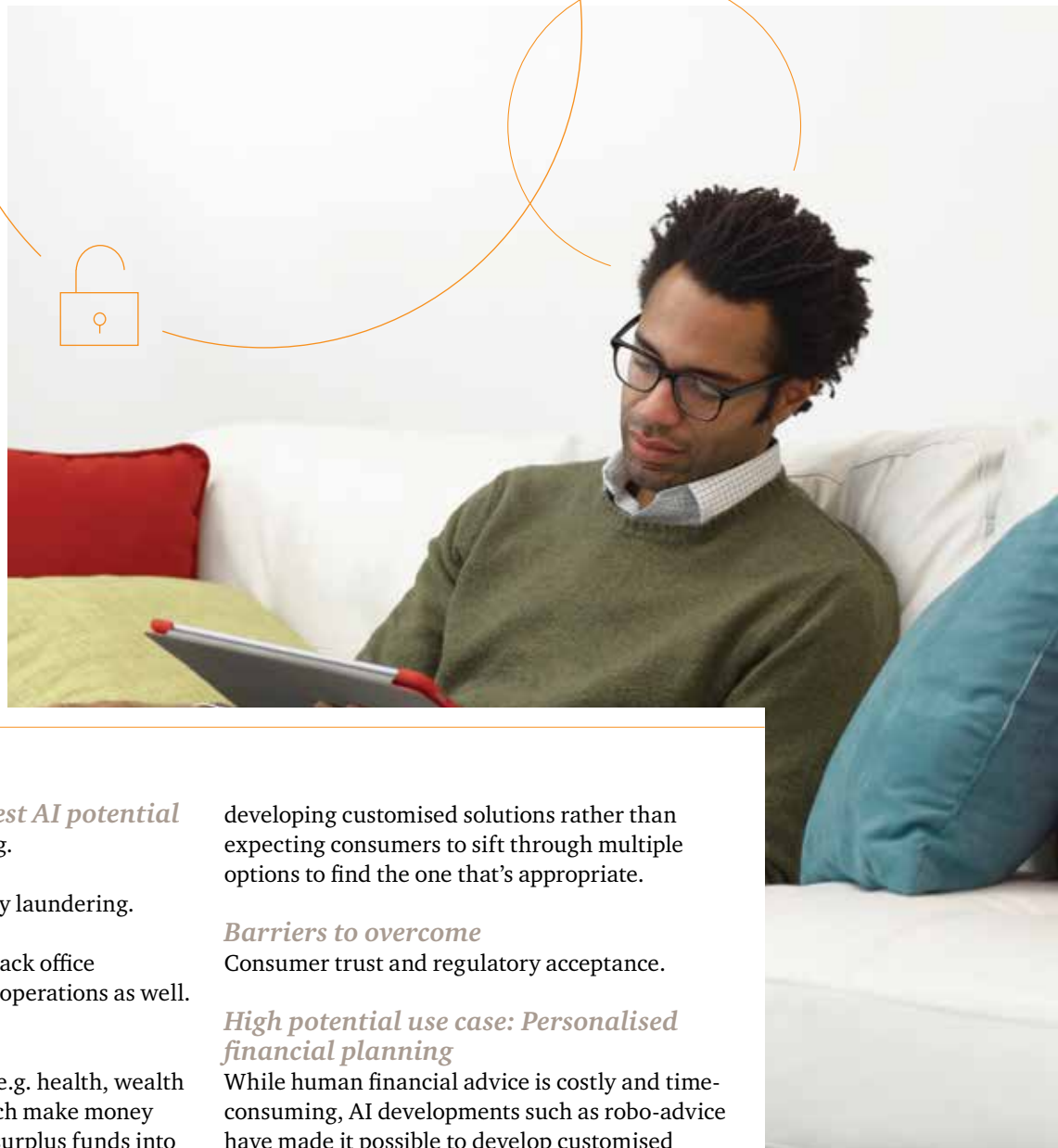
Autonomous fleets would enable travellers to access the vehicle they need at that point, rather than having to make do with what they have or pay for insurance and maintenance on a car that sits in the drive for much of the time. Most of the necessary data is available and technology is advancing. However, businesses still need to win consumer trust.



Predictive engine monitoring and maintenance technology is advancing.

⁴ American Automobile Association media release 8 September 2016 (<http://newsroom.aaa.com/2016/09/americans-spend-average-17600-minutes-driving-year/>)

Businesses can develop customised solutions rather than expecting consumers to sift through multiple options to find the one that's appropriate.



Financial services

Three areas with the biggest AI potential Personalised financial planning.

Fraud detection and anti-money laundering.

Process automation – not just back office functions, but customer facing operations as well.

Consumer benefit

More customised and holistic (e.g. health, wealth and retirement) solutions, which make money work harder (e.g. channelling surplus funds into investment plans) and adapt as consumer needs change (e.g. change in income or new baby).

Timing

Ready to go: Robo-advice, automated insurance underwriting and robotic process automation in areas such as finance and compliance.

Medium-term potential: Optimised product design based on consumer sentiment and preferences.

Longer-term potential: Moving from anticipating what will happen and when in areas such as an insurable loss (predictive analytics) to proactively shaping the outcome (prescriptive analytics) in areas such as reduced accident rates or improved consumer outcomes.

Time saved

The information customers need to fully understand financial position and plan for the future is at their fingertips and adapts to changing circumstances. Businesses can support this by

developing customised solutions rather than expecting consumers to sift through multiple options to find the one that's appropriate.

Barriers to overcome

Consumer trust and regulatory acceptance.

High potential use case: Personalised financial planning

While human financial advice is costly and time-consuming, AI developments such as robo-advice have made it possible to develop customised investment solutions for mass market consumers in ways that would, until recently, only have been available to high net worth (HNW) clients. Finances are managed dynamically to match goals (e.g. saving for a mortgage) and optimise client's available funds, as asset managers become augmented and, in some cases, replaced by AI. The technology and data is in place, though customer acceptance would still need to increase to realise the full potential.

Assisted intelligence in action

A financial services organisation used machine learning to develop time-series clusters of their policyholder transactions. The machine learning solution helped the company to identify common customer transaction patterns and better understand the key triggers driving variances. Combining policyholder data with external data on customer preferences, financial literacy, and other behavioural dimensions allowed the firm to better predict which patterns would occur for each customer persona. The organisation designed interventions around these insights, which opened the way for improved outcomes for both the customer and the company.

Source: PwC AI specialists

Retail

Three areas with the biggest AI potential

Personalised design and production.

Anticipating customer demand – for example, retailers are beginning to use deep learning to predict customers' orders in advance.

Inventory and delivery management.

Consumer benefit

On-demand customisation as the norm and greater availability of what you want, when and how you want it.

Timing

Ready to go: Product recommendation base on preferences.

Medium-term potential: Fully customised products.

Longer-term potential: Products that anticipate demand from market signals.

Time saved

Less time exploring shelves, catalogues and websites to find the product that you want.

Barriers to overcome

Adapting design and production to this more agile and tailored approach. Businesses also need to strengthen trust over data usage and protection.

High potential use case: Personalised design and production

Instead of being produced uniformly, apparels and consumables can be tailored on demand. If we look at fashion and clothing as an example, we could eventually move to fully interactive and customised design and supply in which AI created mock-ups of garments are sold online, made in small batches using automated production, and subsequent changes are made to design based on user feedback.



Retailers are beginning to use deep learning to predict customers' orders in advance.



Technology, communications and entertainment

Three areas with the biggest AI potential

Media archiving and search – bringing together diffuse content for recommendation.

Customised content creation (marketing, film, music, etc.).

Personalised marketing and advertising.

Consumer benefit

Increasingly personalised content generation, recommendation and supply.

Timing

Ready to go: Content recommendation for consumers.

Medium-term potential: Automated telemarketing capable of holding a real conversation with the customer.

Longer-term potential: Use-case specific and individualised AI-created content.

Time saved

Quicker and easier for consumers to choose what they want, reflecting their preferences and mood at the time.

Barriers to overcome

Cutting through the noise when there is so much data, much of it unstructured.

High potential use case: Media archiving and search

We already have personalised content recommendation within the entertainment sector. Yet there is now so much existing and newly generated (e.g. online video) content that it can be difficult to tag, recommend and monetise. AI offers more efficient options for classification and archiving of this huge vault of assets, paving the way for more precise targeting and increased revenue generation.

Manufacturing

Three areas with the biggest AI potential

Enhanced monitoring and auto-correction of manufacturing processes.

Supply chain and production optimisation.

On-demand production.

Consumer benefit

Indirect benefits from more flexible, responsive and custom-made manufacturing of goods, with fewer delays, fewer defects and faster delivery.

Timing

Ready to go: Greater automation of a large number of production processes.

Medium-term potential: Intelligent automation in areas ranging from supply chain optimisation to more predictive scheduling.

Longer-term potential: Using prescriptive analytics in product design – solving problems and shaping outcomes, rather than simply predicting and responding to demand in product design.

Time saved

Faster response and fewer delays.

Barriers to overcome

Making the most of supply chain and production opportunities requires all parties to have the necessary technology and be ready to collaborate. Only the biggest and best-resourced suppliers and manufacturers are up to speed at present.

High potential use case: Enhanced monitoring and auto-correction

Self-learning monitoring makes the manufacturing process more predictable and controllable, reducing costly delays, defects or deviation from product specifications. There is huge amount of data available right through the manufacturing process, which allows for intelligent monitoring.



AI will facilitate more seamless integration of supply chain data, enabling anticipatory production and more efficient delivery of products to customers.



Energy

Three areas with the biggest AI potential

Smart metering – real-time information on energy usage, helping to reduce bills.

More efficient grid operation and storage.

Predictive infrastructure maintenance.

Consumer benefit

More efficient and cost-effective supply and usage of energy.

Timing

Ready to go: Smart metering.

Medium-term potential: Optimised power management.

Longer-term potential: More efficient and consistent renewable energy supply in areas such as improved prediction and optimisation of wind power.

Time saved

More secure supply and fewer outages.

Barriers to overcome

Technological development and high investment requirements in some of the more advanced areas.

High potential use case: Smart meters

Smart meters help customers tailor their energy consumption and reduce costs. Greater usage would also open up a massive source of data, which could pave the way for more customised tariffs and more efficient supply.

Transport and logistics

Three areas with the biggest AI potential
Autonomous trucking and delivery.

Traffic control and reduced congestion.

Enhanced security.

Consumer benefit

Greater flexibility, customisation and choice in how goods and people move around and the ability to get from A to B faster and more reliably.

Timing

Ready to go: Automated picking in warehouses.

Medium-term potential: Traffic control.

Longer-term potential: Autonomous trucking and delivery.

Time saved

Smart scheduling, fewer traffic jams and real-time route adjustment to speed up transport.

Barriers to overcome

Technology for autonomous fleets is still in development.

High potential use case: Traffic control and reduced congestion

Autonomous trucking reduces costs by allowing for increased asset utilisation as 24/7 runtimes are possible. Moreover, the whole business model of transport & logistics (T&L) might be disrupted by new market entrants such as truck manufacturers offering T&L and large online retailers vertically integrating their T&L.

Augmented intelligence in action

An automotive company developed a dynamic agent-based model to simulate thousands of strategic scenarios for entering the ridesharing market. The model allowed key decision makers to test a variety of policy configurations in a virtual, risk-free simulated environment to help them understand the ultimate impact on market share and revenue over time, before actually making any decisions. Flight simulators allow pilots to test the impact of their decisions in a virtual environment to better prepare them for making decisions in flight, so why shouldn't business executives do the same?

Source: PwC AI specialists



Realising the potential



What do you want from AI? Where do you begin?
How do you keep pace with change?

1/Work out what AI means for your business

The starting point for strategic evaluation is a scan of the technological developments and competitive pressures coming up within your sector, how quickly they will arrive, and how you will respond. You can then identify the operational pain points that automation and other AI techniques could address, what disruptive opportunities are opened up by the AI that's available now, and what's coming up on the horizon.

2/Prioritise your response

In determining your strategic response, key questions include how can different AI options help you to deliver your business goals and what is your appetite and readiness for change. Do you want to be an early adopter, fast follower or follower? Is your strategic objective for AI to transform your business or to disrupt your sector?

AI provides the potential to enhance quality, personalisation, consistency and time saved, but it's also important to consider the technological feasibility of the AI and the availability of the data needed to support AI. How are you planning to overcome barriers and accelerate innovation?

To prioritise your response, it's important to map the key process flows to be automated and decision flows to be augmented. What functions contain high potential processes that could drive near-term savings, for example? As data becomes the primary asset and source of intellectual property, what investments and changes would enable you to capture more data and use it more productively? With this map in place, you can then develop the cost-benefit analysis for automation and augmentation.

AI is applicable across all elements of the value chain, which can lead to multiple silos of initiatives or confusion in finding a good starting point. Developing the insight, governance and organisational collaboration to pick your spot and drive initiatives forward are therefore critical.

To prioritise your response, it's important to map the key process flows to be automated and decision flows to be augmented.

3/Make sure you have the right talent and culture, as well as technology

While investment in AI may seem expensive now, PwC subject matter specialists anticipate that the costs will decline over the next ten years as the software becomes more commoditised. Eventually, we'll move towards a free (or 'freemium' model) for simple activities, and a premium model for business-differentiating services. While the enabling technology is likely to be increasingly commoditised, the supply of data and how it's used are set to become the primary asset.

To make the most effective use of this technology, it's important to instil a data-driven culture that blends intuition and analytical insights with a focus on practical and actionable decisions across all levels.

Demand for data scientists, robotics engineers and other tech specialists is clearly growing. These are in short supply, especially in less developed markets according to the interviews we carried out with PwC's data and analytics' regional leaders, so it will be important to gear long-term training and development to these emerging needs. As adoption of AI gathers pace, the value of skills that can't be replicated by machines is also increasing. These include creativity, leadership and emotional intelligence⁵.

It's important to prepare for a hybrid workforce in which AI and human beings work side-by-side. The challenge for your business isn't just ensuring you have the right systems in place, but judging what role your people will play in this new model. People will need to be responsible for determining the strategic application of AI and providing challenge and oversight to decisions.

4/Build in appropriate governance and control

Trust and transparency are critical. In relation to autonomous vehicles, for example, AI requires people to trust their lives to a machine – that's a huge leap of faith for both passengers and public policymakers. Anything that goes wrong, be it a malfunction or a crash, is headline news. And this reputational risk applies to all forms of AI, not just autonomous vehicles. Customer engagement robots have been known to acquire biases through training or even manipulation, for example.

AI should therefore be managed with the same discipline as any other technology enabled transformation. Key questions to ask while building AI include:

Have you considered the societal and ethical implications?

How can you build stakeholder trust in the solution?

How can you build AI that can explain its logic so that a lay person can understand?

How can you build AI that is unbiased and transparent?

It's important to put in place mechanisms to source, cleanse and control key data inputs and ensure data and AI management are integrated.

Transparency is not only important in guarding against biases within the AI, but also helping to increase human understanding of what the AI can do and how to use it most effectively.

We further explore business strategies for an AI world in 'A strategist's guide to artificial intelligence' (<https://www.strategy-business.com/article/A-Strategists-Guide-to-Artificial-Intelligence?gko=0abb5>).

It's important to prepare for a hybrid workforce in which AI and human beings work side-by-side.

Autonomous intelligence in action

Entertainment industry consumers now have an unprecedented choice of movies, television, music and games. While this provides consumers with more opportunity to enjoy content specific to their unique tastes, they can experience 'choice overload' during their search. And worse, sometimes they make no choice at all! Video and music streaming companies have begun using autonomous recommendation engines that combine segment trends, ratings and content similarity to personalise suggestions and engage customers. Engaging customers not only increases retention, but also allows companies to collect more data on individuals and improve the personalisation of offerings – creating a virtuous feedback loop that provides a significant competitive advantage.

Source: PwC AI specialists

⁵ We explore AI's role in this creative process in 'AI is already entertaining you', strategy+business, 1 May 2017 (<https://www.strategy-business.com/article/AI-Is-Already-Entertaining-You?gko=dc252>)

Conclusion:

The options for
survival and success



Picture your market in five years' time. How can you create the capabilities to compete?

As our analysis underlines, AI has the potential to fundamentally disrupt your market through the creation of innovative new services and entirely new business models. We've already seen the creative destruction of the first wave of digitisation. With the eruption of AI, some of the market leaders in ten, even five years' time may be companies you've never heard of. In turn, some of today's biggest commercial names could be struggling to sustain relevance or have even disappeared altogether, if their response has been too little or too late.

Tomorrow's market leaders are likely to be exploring the possibilities and setting their strategies today. We believe there are four key questions your business should address if it wants to keep pace and capitalise on the opportunities:

How vulnerable is your business model to AI disruption? How soon will the change arrive?

Are there game-changing openings within your market and, if so, how can you take advantage?

Do you have the right talent, data and technology to help you understand and execute on the AI opportunities?

How can you build trust and transparency into your AI platforms and applications?

Get this right and creativity, collaboration and decision making within your organisation can all be empowered. You'll have the potential to understand customer behaviour and anticipate and respond to their individual needs with a precision and foresight that have never been possible before.

The ultimate commercial potential of AI is doing things that have never been done before, rather than simply automating or accelerating existing capabilities. Some of the strategic options that emerge won't match past experience or gut feelings. As a business leader, you may therefore have to take a leap of faith. The prize is being far more capable, in a far more relevant way, than your business could ever be without the infinite possibilities of AI.

The prize is being far more capable, in a far more relevant way, than your business could ever be without the infinite possibilities of AI.

Helping your business to make the most of AI

PwC is already working with companies across each of the different sectors to help them plan for and take advantage of AI to support their business strategy and improve performance.

If you would be interested in a consultation about the potential within your business, please feel free to get in touch.

Gerard Verweij

Global Data and Analytics Leader

E: gerard.verweij@pwc.com

Dr. Anand S. Rao

Global Leader of Artificial Intelligence

E: anand.s.rao@pwc.com

Twitter: [@AnandSRao](https://twitter.com/AnandSRao)

Jim Woods

Global and Hong Kong/China Risk Assurance Leader

E: jim.woods@hk.pwc.com

Twitter: [@jimwoods001](https://twitter.com/jimwoods001)

Glossary

AI consists of a number of areas, including but not limited to those below:

Main AI areas	Description
Large-scale Machine Learning	Design of learning algorithms, as well as scaling existing algorithms, to work with extremely large data sets.
Deep Learning	Model composed of inputs such as image or audio and several hidden layers of sub-models that serve as input for the next layer and ultimately an output or activation function.
Natural Language Processing (NLP)	Algorithms that process human language input and convert it into understandable representations.
Collaborative Systems	Models and algorithms to help develop autonomous systems that can work collaboratively with other systems and with humans.
Computer Vision (Image Analytics)	The process of pulling relevant information from an image or sets of images for advanced classification and analysis.
Algorithmic Game Theory and Computational Social Choice	Systems that address the economic and social computing dimensions of AI, such as how systems can handle potentially misaligned incentives, including self-interested human participants or firms and the automated AI-based agents representing them.
Soft Robotics (Robotic Process Automation)	Automation of repetitive tasks and common processes such as IT, customer servicing and sales without the need to transform existing IT system maps.

www.pwc.com/AI

At PwC, our purpose is to build trust in society and solve important problems. We're a network of firms in 157 countries with more than 223,000 people who are committed to delivering quality in assurance, advisory and tax services. Find out more and tell us what matters to you by visiting us at www.pwc.com.

This publication has been prepared for general guidance on matters of interest only, and does not constitute professional advice. You should not act upon the information contained in this publication without obtaining specific professional advice. No representation or warranty (express or implied) is given as to the accuracy or completeness of the information contained in this publication, and, to the extent permitted by law, PwC does not accept or assume any liability, responsibility or duty of care for any consequences of you or anyone else acting, or refraining to act, in reliance on the information contained in this publication or for any decision based on it.

© 2017 PwC. All rights reserved. "PwC" refers to the PwC network and/or one or more of its member firms, each of which is a separate legal entity. Please see www.pwc.com/structure for further details.

170621-091011-KK-OS