The macro impact of Generative AI: Learning from previous tech revolutions

Can the impact of previous tech revolutions guide the impact of AI?

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Key points

- The emergence of generative AI has accelerated opinion on how quickly it will impact the global economy. AI promises a material productivity boost and looks likely to mark the next great wave of technological revolution
- There have been five previous technological revolutions since the 18th century's Industrial Revolution. Each has followed a similar pattern and broadly lasted 50 years
- AI might be implemented over a shorter timescale, but previous waves were slowed, not by technical feasibility, but the pace of change in broader societies and institutions, something that looks similarly challenging today
- The economic impact of such a new technology should boost productivity, growth and lower inflation. However, history teaches us to beware of considering such developments in isolation. The threat of job losses and the role of government and regulation will have a bearing on eventual economic outcomes

"No fate but what we make for ourselves"

The launch of ChatGPT and the introduction of other generative artificial intelligence (AI) interfaces has led to a reappraisal of how long it could take AI to markedly impact the global economy. Jia Xiaodong, the chief executive of Gala Technology – a mobile game developer – recently told Bloomberg News: "The impact of AI on the game industry in the past three to four months may be as dramatic as the changes in the past thirty or forty years"[1]. In a report earlier this year[2] – in the advent of generative AI – McKinsey brought forward its estimate of the feasibility of technical automation of 70% of all current human tasks from between 2029-2049 (estimated in 2017) to between 2025-2028.

Such a dramatic reappraisal of the emergence of AI technology creates a significant set of opportunities and challenges for every economy on the planet – large and small, global and local. In this paper, we examine the advent of AI in the context of previous general purpose technological revolutions, drawing out the stylised characteristics of such events that shaped the global economy broadly over periods of 50 years. We also analyse the potential similarities and differences for AI.

We also consider the themes which are likely to emerge with this new technology, to assess the possible macroeconomic impact. Productivity gains appear to be the key driver, delivering the potential for a significant, positive supply shock.

[1] "AI is Rewriting the Rules of $200bn Games industry", Bloomberg News, 25 July 2023.

[2] "The economic potential of generative AI", McKInsey & Co, June 2023.

This has positive implications for growth and reducing inflation. However, it also raises material questions about job losses, education and the role of governments, in terms of taxation – and regulation – while also threatening serious shocks to our political systems. These are rich themes, and this paper provides only an introduction to each.

The global economy is a complex system – a system that emerges organically because of the behaviour of the components within it. Accordingly, the impact of AI will depend on the interactions of all these factors and hence the choices we make over the coming months and years. We suggest that the cultural reference "There is no fate but what we make for ourselves"[3] is apt for the economic outlook. The ultimate impact on international economies, in terms of growth, inflation, unemployment and so on will in part reflect not just the large uncertainties surrounding AI technology itself, but also the choices that accompany its implementation, including how it is actually implemented, regulated and taxed. This makes any strong predictions about any outlook difficult at this stage.

"Productivity isn't everything, but in the long run it's almost everything"[4]

Certainty it seems that AI can provide a material boost to productivity. Different studies report significant productivity gains from combining AI with current human roles. A study that considered two groups undertaking independently graded writing tasks reported a significant improvement in speed of task completion and overall group writing grades from the group using AI in its second attempt, compared to a controlled group which did not.

A separate study, monitoring outcomes in a customer services call centre noted a 14% increase in calls per hour from teams using an AI tool – rising to 25% for those who reported that they followed all the AI's instructions.

Scaling up these micro studies into a view for the broader economic outlook is far from straightforward. Recent research from Goldman Sachs[5] estimated a productivity boost that could reach one percentage point (ppt) per annum. McKinsey estimated total AI providing a 0.2-3.3ppt boost, with generative AI accounting for 0.1-0.6ppt of that. However, these estimates rely on significant assumptions about the speed and broader ramifications of AI implementation.

While qualitatively, theory and evidence point to significant productivity enhancements from AI, two caveats are worth bearing in mind. McKinsey explicitly assumes the introduction of AI augments human work rather than replaces it – adding that alternatively workers find similarly productive work if displaced. It is not obvious either assumption will hold. For example, a team of 10 seeing a material boost in productivity may require fewer than that in the future. Productivity-enhancing AI is likely to go hand-in-hand with falling headcount in certain roles.

Where job losses do occur, it is not obvious those workers will be able to find similarly productive roles. Historically, manufacturing has been a beneficiary of significant automation and enjoyed strong productivity growth as a result. Workers switching from manufacturing to less productive services roles may form part of the reason for an overall deceleration in productivity growth in recent decades. This is especially true for AI; previous automation encouraged a switch from muscle-based to intelligence-based roles, in many instances lifting productivity. But AI suggests a further shift from "intelligence", a change that may not offer such productivity enhancement. We examine this further below.

Another caveat surrounds the specifics of how AI improves productivity. The two cited studies both reported material gains in *group* productivity. Yet closer inspection shows group productivity was raised through significant improvement of the worst-in-class, bringing them closer to best practice. Neither saw an improvement in best practice – neither in the writing task's grade scores, nor the proportion of successful customer resolutions in the customer sales example. In both, the original best-in-class provided the envelope to overall group performance. It is unclear whether AI will ultimately improve the best-in-class – something that might emerge with longer exposure to the tool – or whether increased reliance on AI could have a detrimental impact on the level of best-in-class.

Previous technological revolutions

Generative AI promises to be the next in a wave of general-purpose technologies – technologies with a wide range of applications across different sectors and industries. In broad terms there have been five great waves of general-purpose technologies or five technological revolutions. These are listed below with their approximate starting dates and countries of origin:

- The industrial revolution (1770; UK)
- Steam and railways (1830; UK/US)
- Steel, electricity and heavy engineering (1875; US/Germany)
- Oil, cars and mass production (1910; US/Europe)
- Information Technology (IT) (1970; US/Europe/Japan)

[3] Terminator 2: Judgement Day, 1991.

[4] Paul Krugman, "The Age of Diminished Expectations", 1990.

[5] "The Magnitude and Timing of the AI Investment Cycle", Goldman Sachs, 20 July 2023.

Each wave resulted in significant and distinct impacts on economies, societies and culture, echoing in such cultural reference points as the 18th century population predictions by Thomas Robert Malthus; the novels of Jules Verne and HG Wells; and more recently science fiction films like the Terminator and The Matrix.

Common to each wave was a prolonged implementation phase. The Victorian boom of the mid-19th century in Britain occurred two decades after the Rocket pulled its first railway train from Liverpool to Manchester. *'La belle époque'* period occurred around two decades after the start of the age of steel, while the *'Roaring Twenties'* came a few decades after the US oil booms, and 15 years after the advent of mass production.

In each, the long implementation phase was driven by the requirement of a broader network of technological/economic and social institutions which had to adapt before the new technology could be fully effective. For railways that included a rail network, but also new institutions to order national markets (including national time synchronisation), in banking and finance, as well as steam-powered factories and the growth of industrial cities.

Before *la belle époque* emerged, international markets needed order and worldwide regulation. That included the gold standard, international measures, patents, global insurance and shipping practice, as well as broader reforms including education and social legislation.

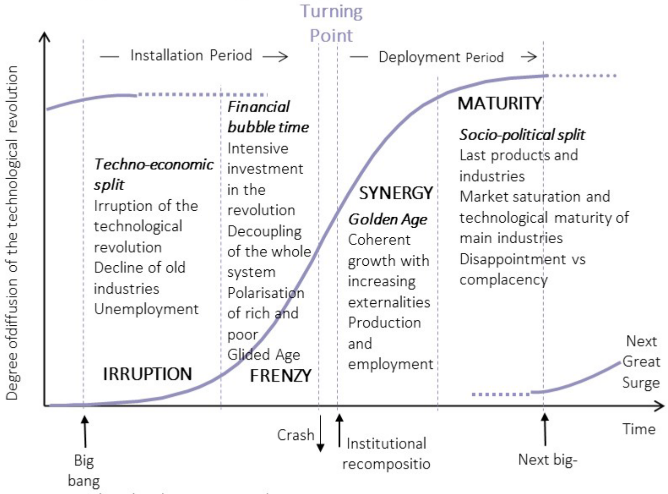
The five previous cycles occurred over a 50 to 60-year period, a timeline stretched not by the pace of technical innovation, but by the difference in rhythms between the technical, economic and social institutions that need to adapt to take full advantage of a new technology. This long-term pattern of technological implementation is like the economic theory observations of Kondratiev waves or supercycles, i.e., speculative cycle-like economic phenomena connected to the technology lifecycle.

More specifically, Carlota Perez[6] presents a stylised pattern followed by each of the previous technological waves (Exhibit 1). In broad terms, each cycle has delivered rapid technological diffusion and a fast-changing economy. This has generated social tensions, has typically been followed by financial collapse and then results in a period of adapted institutions and regulation which has culminated in full implementation.

Perez identifies five phases of each technological revolution, each with its own similar characteristic.

Exhibit 1: Stylised overview of technological revolution

Recurring phases of each great surge in the core countries



Source: Perez (2002) and AXA IM Research

1. **Irruption** of a new technology: new products backed by financial capital suggest new potential growth after a period of stagnation. Tensions are created between old and new technologies
2. **Frenzy** phase: Financial capital backs an intense build-up of new technology and ancillary infrastructure. This phase installs the potential of the new paradigm. But it increases social tensions and creates a divergence between real and financial assets
3. **Turning point**: Typically, a financial collapse resulting in recession or even depression. This galvanises the introduction of new social guardrails
4. **Synergy** phase: An alignment across the technological, economic, financial, regulatory and social spaces, which results in full deployment of the new technology. Typically, a 'golden age'
5. **Maturity**: The twilight of the 'golden age', future gains from now mature technologies fade, productivity growth slows, and markets stagnate. Labour and union pressure is typically high during this period

The relationship observed with financial capital is key. The irruption phase typically follows the maturity of a previous technology. As the prospects for returns fade in the old technology, financial capital seeks new ideas and sources of financial returns. This facilitates the spread of the new technology. In turn, this fast spread of new technology creates strong returns, but it becomes difficult to attract funds without super-normal return[7] potential and this can lead to notions of 'real value' getting lost. A convergence of real and financial values is typically seen after financial manias in panics and eventually crashes, which typically result in recessions and usher in a period of regulatory catch-up. During the synergy

[6] Perez, C., "Technological Revolutions and Financial Capital", 2002.

[7] Technically, profits in excess of that which should be expected in conditions of perfect competition

phase, the deployment of production capital is more clearly recognised as the wealth creator, with financial capital the facilitator. Eventually the maturity phase sees the exhaustion of profitable endeavour and while financial capital remains committed, returns slow, creating incentives for financial capital to seek the next opportunity. Exhibit 2 presents Perez's estimates of dates for each phase.

Exhibit 2: Estimated dates of each phase

Approximate dates of the insallation and deployment periods of each great surge of development

GREAT SURGE	Tecnological revolution / Core country		INSTALLATION: Irruption	INSTALLATION: Frenzy	Turning Point	DEPLOYMENT: Synergy	DEPLOYMENT: Maturity
1st	**The Industrial Revolution** *Britain*	1771	1770s and early 1980s	late 1780s and early 1790s	1793-1797	1798-1812	1813-1829
2nd	**Age of Steam and Railways** *Britain (spreading to continent and USA)*	1829	1830s	1840s	1848-1850	1850-1857	1857-1873
3rd	**Age of Steel, Electricity and Heavy Engineering** *USA and Germany overtaking Britain*	1875	1875-1884	1884-1893	1893-1895	1895-1907	1908-1918*
4th	**Age of Oil, Automobiles and Mass Production** *USA (spreading to Europe)*	1908	1908-1920*	1920-1929	*Europe:* 1929-1933 *USA:* 1929-1943	1943-1959	1960-1974*
5th	**Age of Information and Telecommunications** *USA (spreading to Europe and Asia)*	1971	1871-1987*	1987-2001	2001-??	20??	
		Big bang		Crash	Institutional recomposition		

Source: Perez (2002) and AXA IM Research

* Observe phase overlaps between successive surges

Finally, Perez also considers the geographic impact. In the main the above dynamic focuses on the geographic epicentre(s) of the technological revolution: The first two in Britain; the second also including the US; the third broadening to include Germany; with subsequent revolutions less country-specific as capital and information flow accelerated. Perez argues that the IT revolution, with its inception in the 1970s, is likely to be worldwide in character. Historically, there has been a distinct first mover advantage, although other countries have also been able to implement the technology and affect some degree of catch-up thereafter, with this happening in prime economies during the frenzy stage of the core countries development.

Will an AI cycle fit the same pattern?

Previously referenced technical feasibility estimates suggest AI is now more than capable of taking its first steps forward. While it is difficult to exactly pinpoint AI's equivalent of the Rocket on its maiden voyage, ChatGPT is probably a manifestation several years after that point. Investment into AI has also been increasing. Deutsche Bank estimates[8] that total investment (including private investment, mergers and acquisitions, initial public offerings) in AI has risen 150% since 2019 and 30-fold since 2013, estimating total investment of around $170bn in 2021. Goldman Sachs[9] forecast direct investment rising to $100bn in the US alone by 2025 and $200bn globally. These conditions appear consistent with being some way into the irruption phase.

There is a broader question as to how much technological infrastructure will be required to facilitate the implementation of AI compared with previous technologies. The physical nature of the technology appears small by comparison of the creation of industrialised cities, rail networks and steel works. However, the production and advancement of semiconductor technology, data centres and (clean) energy production required to drive AI still comes with a large cost, albeit that efficiency gains may increasingly be driven by AI. The level of these costs will further dictate the degree of recursive learning that AI can undertake, which in turn could govern the pace of the growth of intelligence.

Implementation could also be faster than previous technologies, which substituted for muscle – initially beasts of burden and then manual labour. These were typically low cost/low wage replacements and so the technology had to be delivered at competitive prices to make implementation cost effective. McKinsey[10] analysed US Bureau of Labor Statistics data that examined 850 occupations in the US, decomposing them into around 2,100 different work activities and then scored these against 18 different capabilities that have the potential for AI-driven automation. It estimated that five key industries faced the most scope for automation: Sales, marketing, software engineering, customer operations as well as product research and design. It also assessed that roles with the greatest potential for AI automation were those currently requiring the highest education: For those with higher degrees (Masters, PhDs or higher) AI automation potential rose to 57% of jobs from 28%, compared to smaller increases for those without high school diplomas (to 63% from 54%) and with high school diplomas (64% from 51%). Similarly, McKinsey estimated the roles most affected would come in the top wage quintiles in a key sample of economies, both developed (US, Japan, Germany and France) and emerging (China, India, Mexico and South Africa).

This suggests AI will allow increasing automation of high-wage, rather than low-wage roles and provides greater economic incentive for speedier implementation. As well as shortening the estimated time before the feasibility of technical automation for human tasks, McKinsey also shortened its estimates for the implementation of such technology to automate 50% of human tasks to between 2031-2059, from 2034-2069, an 8-year shift in the mid-point to 2044.

[8] "AI and the Five Ws: Why, What, Who, When, Where?", Deutsche Bank, March 2023.

[9] Briggs, J. and Kodnani, D., "The Magnitude and Timing of the AI Investment Cycle", Goldman Sachs, July 2023.

[10] McKinsey, Op. cit.

Technically and economically, generative AI could well be implemented more quickly than previous technological revolutions, a process that could be further aided by recursive learning and AI itself providing insights for a more efficient roll-out across the economy.

What remains more difficult to judge is how potentially quicker techno-economic developments will phase with socio-institutional spheres, which have historically slowed implementation the most. This will at least in part depend on the regulatory, governmental and societal reactions to the initial stages of AI.

Preliminary economic consequences

Given the economic impact of previous technological revolutions, a generative AI revolution could be highly significant. A truly comprehensive assessment of the potential impacts on macroeconomic variables like growth, inflation, unemployment and interest rates is beyond the scope of this paper. It is made more difficult by the uncertainty of what AI will finally look like, how quickly it could develop and the institutional framework around it. We set out some basic building blocks to help consider what an AI-driven future might look like in the short to long term. And in keeping with our "no fate but what we make" theme, we highlight some of the key decisions that will help shape the economic outcomes.

Unemployment – no room for complacency

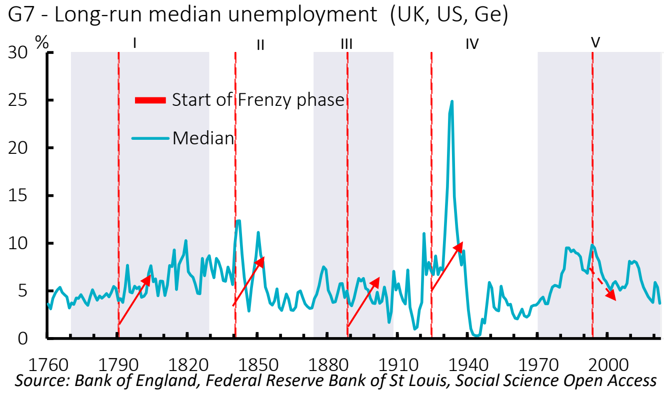
History teaches us that technological advances have boosted productivity, reducing the need for labour in certain sectors, but created jobs, often in new sectors, elsewhere. The movement from agriculture to manufacturing is the textbook example (a process still underway in some economies centuries later). More recently, shifts have occurred from manufacturing to services, including education, finance, technology and other business support functions which could not have been envisioned centuries, and perhaps even decades ago. This broad economic axiom is reflected in a recent publication by Deutsche Bank entitled: "History suggests that AI will ultimately create not destroy jobs".[11]

This view of long-run dynamics in labour overlooks potentially destabilising shorter run factors. Exhibit 3 presents an estimated long-run construction of G7 unemployment – aggregating G7 unemployment rates as available - to illustrate that unemployment has not risen materially over time. However, we add in the estimated starting point of the frenzy phase of each historic technological revolution – a phase associated with increased social tensions, not least through material job displacement. This shows that each technological wave has seen an increase in unemployment that lasted around 10 years from the start of the frenzy phase.

This attempts to capture a global impact, but disruption is likely to be larger looking at individual economies or local levels. Historic shifts saw large sections of the population move from abject poverty on the land to penury in newly industrialised cities and led to material changes in the structures of society. More recently, technological gains have led to deindustrialisation leaving heavily concentrated impacts in some areas.

Beyond local and temporal transitional concerns, we reserve some caution even over the longer term. A quirky perspective involves horses. By the start of the 20th century horses had seen several technological waves that had shifted their primary uses from transport, to military, to agriculture, to mining and other industries. Horses may have considered the advent of oil and the petrol engine as just another technological wave that could further displace their employment. Yet the petrol engine proved more terminal. As engines spread, impacting both transport and agriculture, the horse population shrank. Data from France shows the equine population shrank from 3m in the 1930s to around 0.4m by 1995, of which draft horses accounted for a move from 2.5m to below 0.1m[12], a trend echoed around the world. For horses, technology permanently substituted for their labour.

Exhibit 3: A long-run illustration of the tech impact on jobs



Source: Bank of England, Federal Reserve Bank of St Louis, Social Science Open Access Repository (SSOAR) & AXA IM Research, September 2023

For humans, where earlier technologies broadly replaced muscle – the fate of the horse population a subset of that – IT and AI will increasingly replace intelligence. As such, where previous jobs were replaced by those where intelligence (and dexterity) could perform better (or more cheaply), the future may see humans outcompeted both in strength and intelligence, significantly reducing the scope for possible future job creation to meet future demand.

[11] Reid, J. and Allen, H., "History suggests that AI will ultimately create not destroy jobs", May 2023.

[12] Rzekec, A., Vial, C. and Bigot, G., "Green Assets of Equines in the European Context of the Ecological Transition of Agriculture", Jan 2020.

Inflation – a function of institutions

Insofar as we consider AI to be a material positive supply-side boost, economic theory suggests it should create disinflationary pressure – the opposite of recent, negative supply side shocks. Indeed, in the relatively unfettered markets of the late 19th century, several economies suffered deflation at the inception of the new waves of technology. The actual impact, however, is likely to reflect institutional frameworks. Productivity gains mean producers can produce more for less. But whether these gains are passed on to consumers through lower prices (disinflationary), or retained as profits, will depend on the scale of competition that producers face.

This is not easy to gauge. Recent tech giants – and key developers of AI – are IT companies benefitting from economies of scale; networks are exponentially valuable the more people are connected to them. This has led to large mega-tech companies. If AI is embedded in these network-driven companies, there might be a tendency towards concentration that might limit disinflationary advantages. This is particularly true given current incumbents' ability to invest, but also the vast information that these corporations oversee. However, it is not obvious that AI will be contained to such corporations and the internet also provides access to vast information already used to train current AIs.

The degree of eventual industry concentration may also be a function of the technology itself. If AI develops quickly, it may be easier for its developers to quickly expand ensuring a dominant position to exclude later competition – a more monopolistic outcome. However, if it develops slowly, it is likely progress would not be limited to one initial developer, creating a more competitive and likely disinflationary landscape.

Government and regulation

Plausible largescale disruption to labour markets could have a major impact on governments. In previous technology waves, governments have played an active role in boosting the education of the workforce, including in proactive mass education in the US from the mid-19th century and the UK's 1880 Elementary Education Act, both helpful in providing increased skills for the workforce to undertake new manufacturing roles. The US went further in promoting tertiary education after World War II with the Servicemen's Readjustment Act – or GI bill. Governments may have a further role to play this time by increasingly providing re-training opportunities for workers displaced by AI. Such education provision would also manage the pace of income inequality, something that has historically been driven by the relative pace of growth of technology and education[13].

Yet even allowing for increased education there is a risk that unemployment increases, weighing on aggregate demand. In most developed economies this would result in a rise in income support and unemployment benefits – potentially over the long term as unemployment of this type may well prove structural. In such cases, this might also further the calls for a more fundamental shift, for example towards Universal Basic Income.

Yet this larger role for government would present severe challenges for public finances, with social security and education both among the largest items of government expenditure. Affording such expenditure increases would rely on government revenues also rising given the current, stretched nature of public finances. A productivity-driven boost to GDP should improve this outlook, although as discussed below, the outlook for GDP is not so clear. Moreover, broad disinflationary pressure from AI technology could weigh on nominal growth – the ultimate driver of government revenue.

More specifically, government finances will be affected by how much they benefit from rising corporate taxation as companies profit from the implementation of AI. Insofar as these companies contribute to governments tax revenues, they should provide additional funds to ameliorate the impact of any disruptive AI. However, the less physical nature of digital companies has allowed more fluid corporate tax structures, enabling companies to shift funds to low-tax jurisdictions, often paying far lower taxes than in areas where income is generated – not to mention where markets have been disrupted. This could present very specific risks to governments of individual countries but may be a broader challenge to national governments in general.

Given such risks, it is likely that global regulatory regimes will have to adapt. Previous technological waves have typically achieved golden eras only after regulatory reforms following incoming technology. We would therefore expect regulatory development over the long run. However, given the far-reaching potential of AI, governments have already started discussing what AI regulation should be implemented, and co-ordinated. The urgency of such regulation would likely increase if AI were to develop quickly or in a network structure that suggested greater concentration of market power. The question would then be how effectively it addressed such AI complications and how much it might delay or divert AI implementation.

AI may also have a marked impact on the political outlook. Lessons of the 1930s – that significant macroeconomic

[13] Goldin, C. and Katz, L. F., "The race between education and technology", Harvard University Press, Oct 2009.

turbulence can result in material political change – have been retaught over the last 15 years. The European debt crisis resulted in the emergence of extremist parties across Europe, and in the US, where economic stagnation contributed to the election of President Donald Trump, now indicted for trying to overturn 2020's election result. Such political developments have had material impacts on economic activity: Trump engaged in trade wars, and in the UK, populist Prime Minister Boris Johnson delivered a hard Brexit, creating long-term structural headwinds for the UK economy.

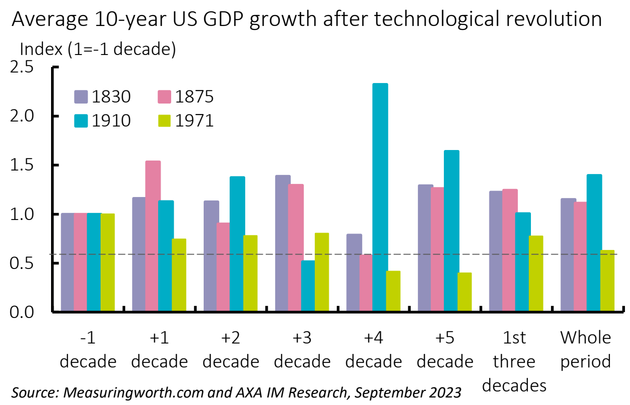
UK journalist Martin Wolf documents the historic relationship between market capitalism and liberal democracy[14] and describes both as in crisis. Looking ahead, a period of disruptive AI implementation might lead to a further radicalisation of politics in some areas, which could raise additional risks for the economic and political outlook.

Growth – a function of the above

The ultimate impact on growth is perhaps most difficult to fathom. A material positive supply shock should lift the trend rate of growth for the global economy, all else being equal, quickening expansion across many sectors. This would likely be the initial impact during the irruption phase.

Exhibit 4shows this was indeed the experience of the US economy after the last four technological revolutions, barring the latest digital revolution. In each instance, the first decade – roughly coinciding with the irruption phase – saw growth average a higher pace than in the decade prior to the revolution, again except during the IT revolution where a combination of oil shocks, war and inflation contributed to slower growth. This also illustrates that growth over the next 50 years was also on average higher than the decade prior to the advent of the new wave, except for the IT revolution.

Exhibit 4: US growth after different technology waves



Source: Measuringworth.com and AXA IM Research, September 2023

To some extent this only proves that the assumption "everything else equal" rarely holds. The period since the 1970s has seen material deceleration of population and educational growth, even if IT-driven productivity improved. It also urges a more careful consideration of growth. The age of oil, cars and mass production that started around 1908 did not lead to faster growth until after the third decade (the 1930s). Admittedly, World War I interrupted the initial implementation phase. However, growth was strongest in this period only during and following World War II. This phase also included the depression – visible in Exhibit 4 – arguably an aggravated turning point phase following the frenzy leading to the Wall Street Crash.

In terms of where such an impact evolves, we would consider those economies most involved in the development of AI, including the US, Japan and South Korea as part of the necessary hardware provision of semiconductor supply and Europe, including the UK, which will include some of the markets most likely to be impacted by AI as the first prime beneficiaries. This first-mover advantage provides a further interesting context for US-led restrictions on high-performance semiconductors to China, something that could delay China's own push for AI development.

AI should provide a meaningful boost to economic activity. However, the precise impact is likely to depend on each of the factors above: What degree of job displacement and recession does it cause – do we see another depression? Does it cause industry concentration or dilution? Are the returns shared broadly across society or concentrated in a wealthy elite? Does government regulation hold back AI implementation or its benefits? Does societal disruption result in bad political outcomes that negatively impact global growth?

The rates outlook – a bias to higher neutral rates

Over the medium-to-longer term there are broadly two issues to address with regards to interest rates: The impact of AI on the neutral rate (r*) and how cyclical developments might influence this.

It is a simplification to suggest that r* is simply driven by the evolution of trend growth in an economy[15]. However, as Exhibit 5 illustrates, changes in trend productivity growth – the most volatile component of trend growth – do correlate with movements in estimated r* in the US. On the face of it, this suggests that an AI productivity boost would tend to push the level of the neutral rate higher. Yet Exhibit 5 also illustrates the uncertainty around such a conclusion. The current vintage of US labour productivity (output/hour) clearly shows the boost

[14] Wolf, M., "The Crisis of Democratic Capitalism", 2023.

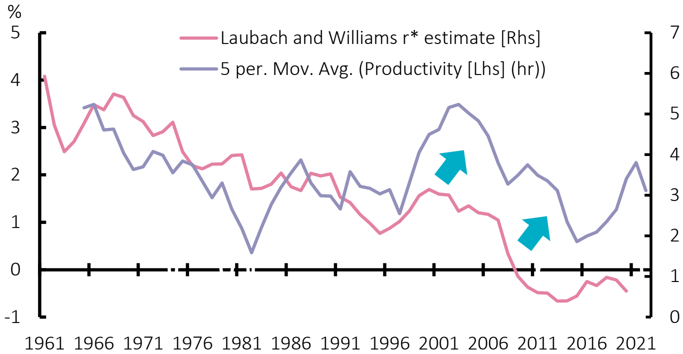
[15] This arrives from a simplified, linear specification focusing on the mean of the intertemporal marginal rate of substitution, the inverse of which economic

associated with the late 1990s IT growth – something that was far from obvious in contemporary data. However, there is a step shift in relationship, highlighted below, where r* does not fully reflect the improvement.

We may also focus on the underlying drivers of rates: Ex ante savings and investment. We would expect the onset of a new technology wave to unpin a significant rise in planned investment, which should also drive the neutral rate higher.

Exhibit 5: Productivity a key contributor to r*

Estimated R* and 5y MA US productivity (output/hr)



Source: Federal Bank of New York, Bureau of Economic Analysis and AXA IM Research, Sept-2023

From a cyclical perspective, a broad boost to supply potential risks leaving demand growth behind. Historically, concerns of secular stagnation have arisen as an unwelcome side-effect of a new technology – in the 1930s after the mismanaged correction from the Wall Street Crash – and more recently in the aftermath of the dot com crash and the 2008-2009 financial crisis – around the turning point of the latest wave. A combination of falling investment good prices, elevated income inequality and rising savings – perhaps in response to elevated concerns about job security – could create persistently subdued demand, resulting in a perpetual headwind to actual rates relative to neutral rates. This would likely depend on other institutional responses at the time. And different circumstances could give rise to a preponderance of rates exceeding neutral.

The new wave

The emergence of generative AI offers the promise of a new technological revolution that could be as far reaching as previous great technological revolutions. That is a truly exciting prospect and suggests material change in technology, the economy and society. But previous examples suggest these changes roll out over relatively long periods of time – typically over a half a century – as society and its institutions take time to adapt to the faster-moving techno-economic developments.

Previous waves also suggest that these periods of transition can lead to significant gains in productivity and growth, but also material disruption. These disruptions have historically resulted in a divergent range of outcomes from strikes and revolutions, to playing a role in some of history's darker outcomes.

Moreover, hard and fast predictions of the economic outcomes of a given technological revolution are hard to make. The new technology itself promises material gains in productivity, a positive supply shock that should be associated with faster growth and lower inflation. However, we caution not to consider the outlook in isolation. Economic and institutional context has historically proven important in determining whether these dynamics emerge consistently over the implementation of the technological wave – avoiding another great depression – or at all, in the case of the digital revolution.

We conclude that there is "no fate but what we make": The way AI impacts our economies and societies over the coming decades will be a product of the institutional choices that we make as societies and co-ordinate globally. AI appears to offer the possibility of a material boost to productivity, one that can help raise living standards, reduce inequality and benefit in the fight against climate change. But such outcomes are not given – and we have identified several challenges which will need to be managed to avoid alternate and less universally beneficial outcomes emerging.

theory defines as r*. The fuller, non-linear definition includes measures of volatility and skew. For a fuller explanation see Page, D., "The best guide for US Treasury yields points upwards", AXA IM Research, March 2018, pg 4.

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