On the cusp of a productivity boom?

The promise of AI and other reasons for optimism

Global Economics and Investment Analysis

Sebastian Vismara

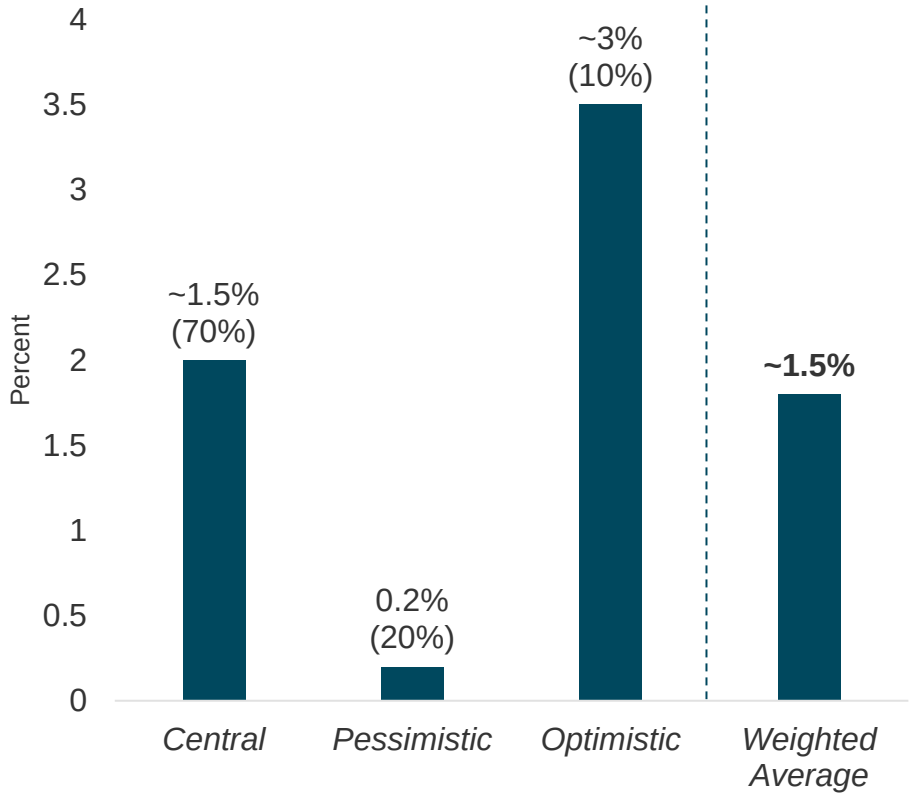
Senior Economist and Strategist

Global Economics and Investment Analysis (GEIA)

BNY MELLON
INVESTMENT MANAGEMENT

We think that productivity growth will rise in the next decade

Impact of Artificial Intelligence (AI) on Productivity growth - Scenarios (Probability)



Source: BNY Mellon Investment Management. Data as of September 2023.

1 Global productivity growth was low in recent decades, leading many to conclude that future productivity growth will also be disappointing. However, historically past weakness in productivity growth tells us little about the future.

2 Generative AI could spur a new industrial revolution as it can automate and augment many non-routine tasks less impacted by previous innovations. Like the steam engine, electrification, and computers, AI could fundamentally reshape industrial organization and work.

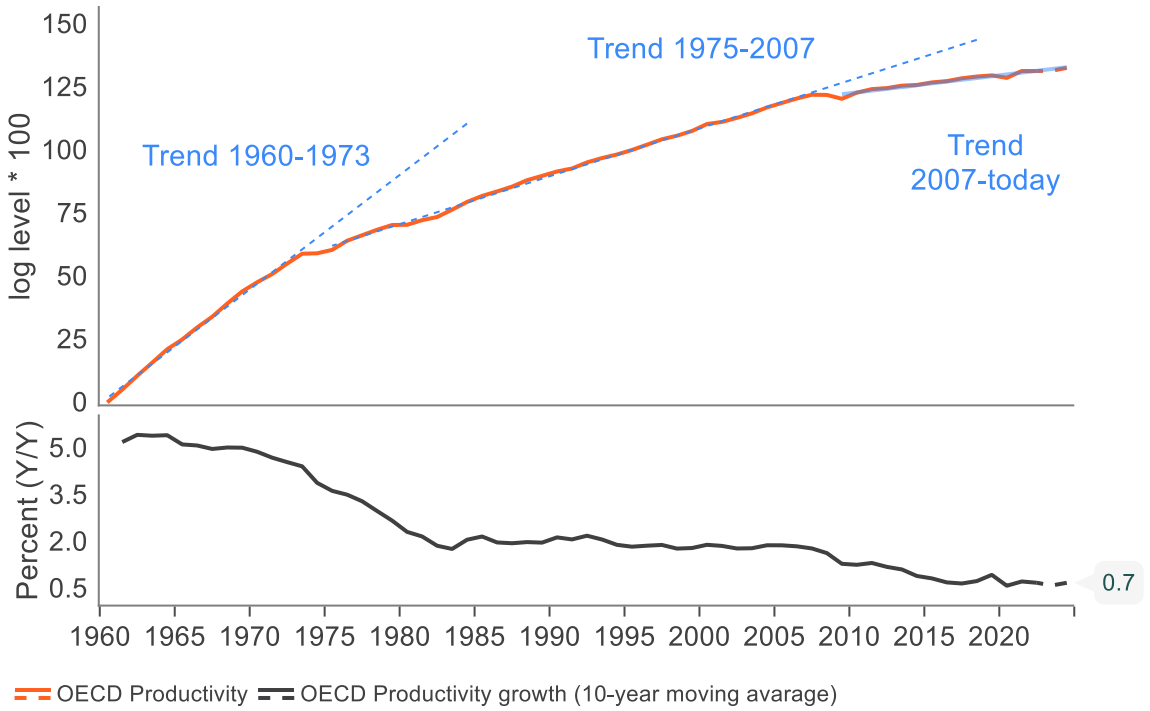
3 AI is advancing quickly, and in many tasks its performance is already either close or above that of the 'average' human. Generative AI has the potential to produce inaccurate results, but model advancement and complementary technology can help.

4 We estimate the impact of AI on productivity growth is likely to be substantial. There are also other reasons to be optimistic about productivity growth, namely the impact of a structurally tighter labor market and higher interest rates.

1. Productivity and AI

Global productivity growth was low in recent decades

Productivity growth has been slowing globally



Source: Macrobond, BNY Mellon Investment Management OECD (Organisation for Economic Co-operation & Development), Penn World Table, Growth & Development Centre, University of Groningen
Data as of 19 October 2023

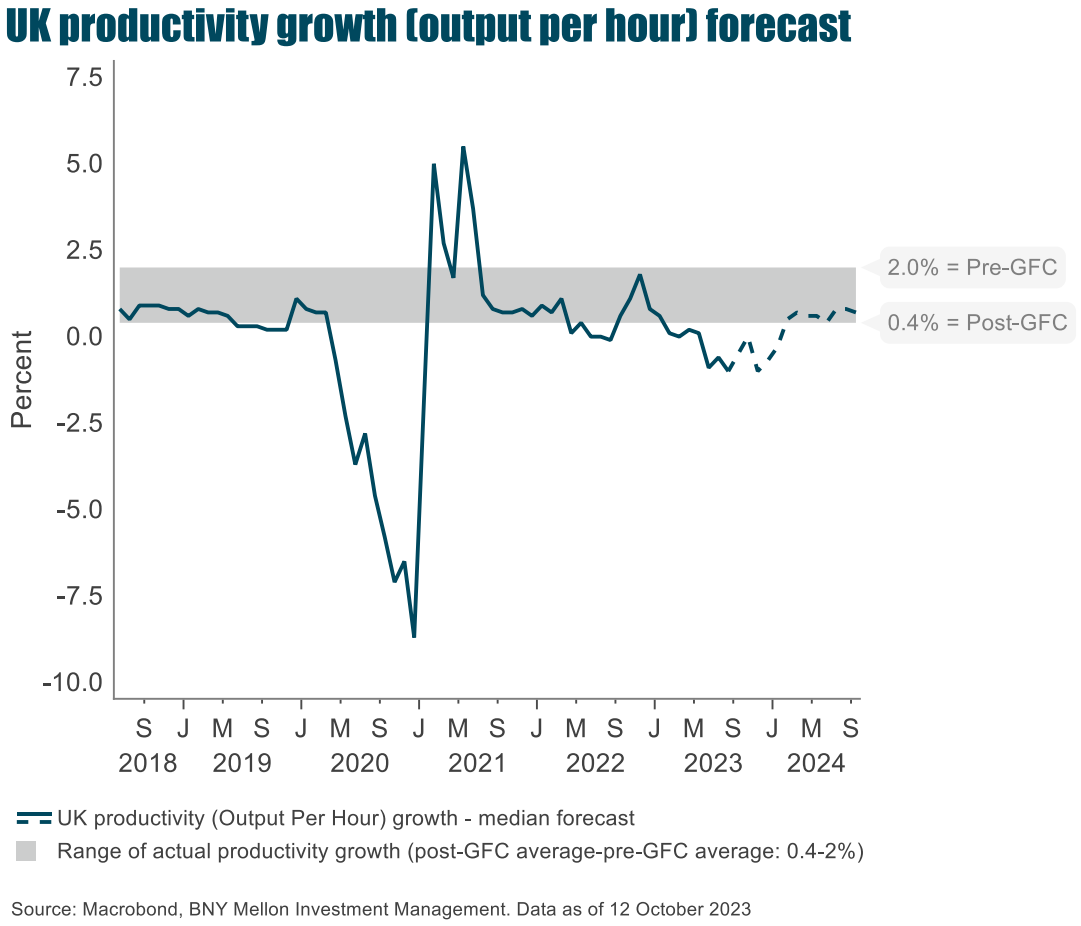
The primary determinant of average long-term growth is productivity

- Productivity growth fell in the early 1970s and again following the Global Financial Crisis (GFC) in 2007-2008.
- Total Factor Productivity (TFP), the long-term driver of productivity growth, which is a measure of how efficiently labour and capital are combined during the production process, has also been weak over this period.
- Many different explanations have been proposed, including that it is increasingly hard to innovate as the low hanging fruits have already been picked. Part of the problem relates to the fact that TFP growth isn't actually measurable and is usually treated as a residual in models.
- There are also some reasons to believe that the fall in TFP growth after the GFC may be due to long-lasting, but ultimately temporary, factors, as explained later in the note.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Leading many to conclude that future productivity growth will also be disappointing



Source: Macrobond, BNY Mellon Investment Management. Data as of 12 October 2023

Productivity growth is expected to remain close to what was seen post-GFC

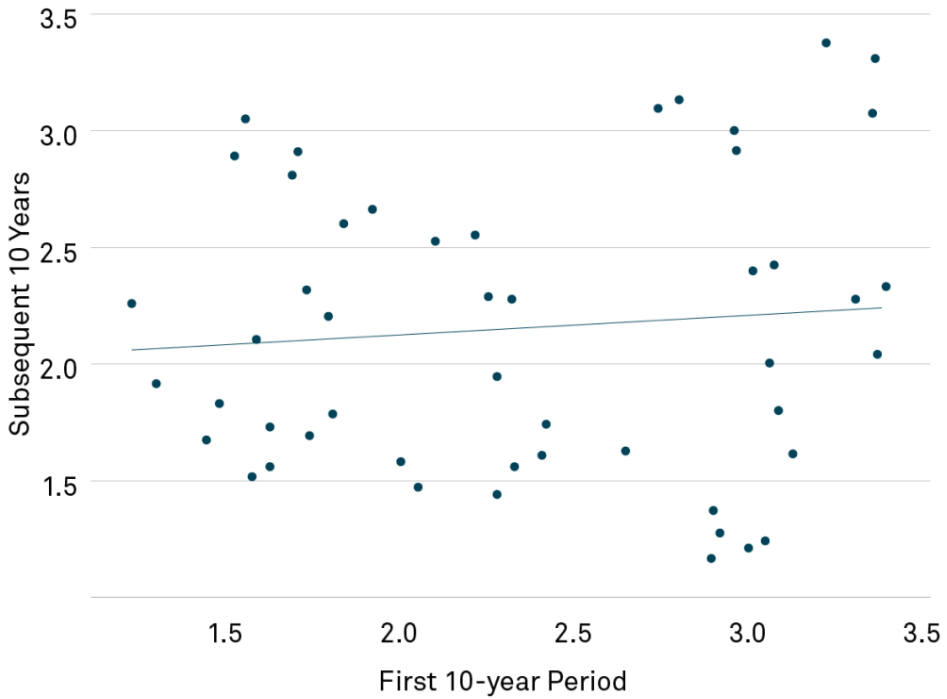
- Immediately following the Global Financial Crisis (GFC), many forecasting bodies were expecting productivity growth to revert to its pre-crisis trend, but that never happened.
- Projections have been gradually revised lower, and now exhibit a degree of forecasting pessimism.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

But past weakness in productivity growth tells us little about the future

One decade's productivity growth does not predict the next



Source: Brynjolfsson, Rock, Syverson (2019)

Evidence shows that current productivity growth is a poor predictor of future productivity growth

- We check whether expectations for low productivity from the pessimists are reasonable given what was seen in the past, and look at whether there is strong persistence in long run productivity growth. There is not.
- Past evidence suggests that a resurgence in productivity growth is possible, despite recent periods of weakness.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Extraordinary things do sometimes happen. AI may be one of those

Framework for the labor market impact of automation

	Manual	Cognitive
Routine	1st and 2nd industrial revolutions (steam, electricity etc.)	3rd industrial revolution (computing/ICT)
Nonroutine	4th industrial revolution (artificial intelligence & robotics)	4th industrial revolution (artificial intelligence)

Source: Autor et al. (2003), Fathom Consulting.

AI, and Generative AI in particular, could represent a very important technological innovation

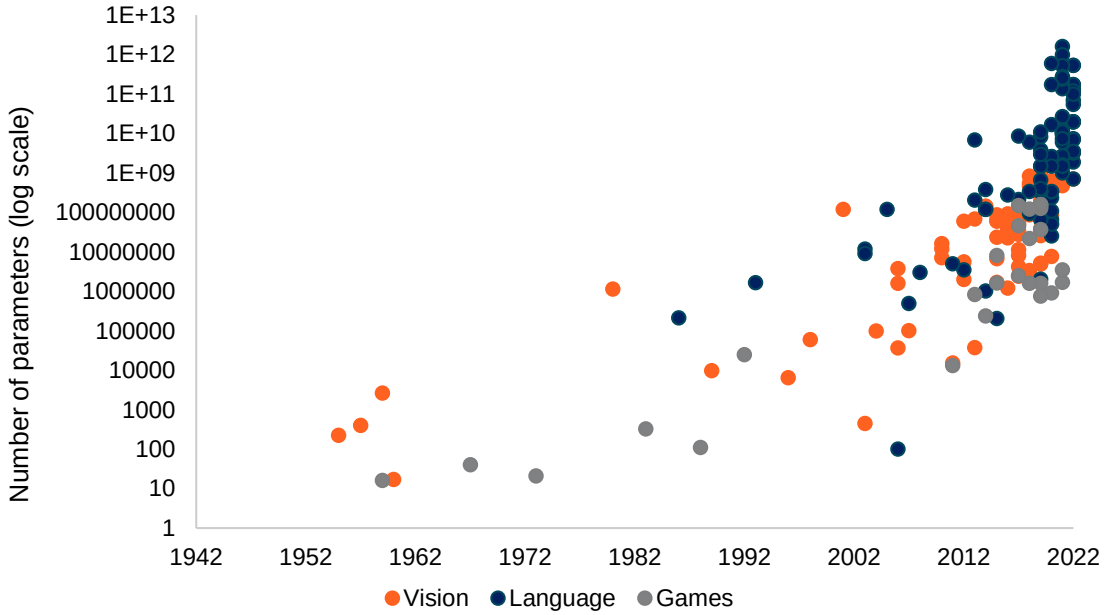
- Generative AI can be used in several use cases across every industry as it can create new, original outputs (e.g., content) based on patterns it learned during its training. It's a General-Purpose Technology (GPT).
- Like steam internal combustion engines, electrification, computers, it fundamentally reshapes industrial organization and the world of work; and stimulates the development of complementary technologies. It's extremely hard to predict how it will develop and its impact on the economy and societies.
- AI could have a large, direct impact on specific industries.
- AI is both labor-saving (e.g., autonomous vehicles), and labor augmenting (e.g., energy efficiency, materials usage and demand prediction). In extremis, it's a perfect substitute for all current human cognitive functions.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

AI development is advancing at an exponential pace

Number of Parameters of Significant AI Systems by Domain, 1950-2022



Note: Parameters are numerical values that are learned by machine learning models during training. The fact that AI systems are rapidly increasing their parameters is reflective of the increased complexity of the tasks they are being asked to perform, the greater availability of data, advancements in underlying hardware, and the demonstrated performance of larger models. Source: AI report Index (2023), Epoch (2022). Data as of end 2022.

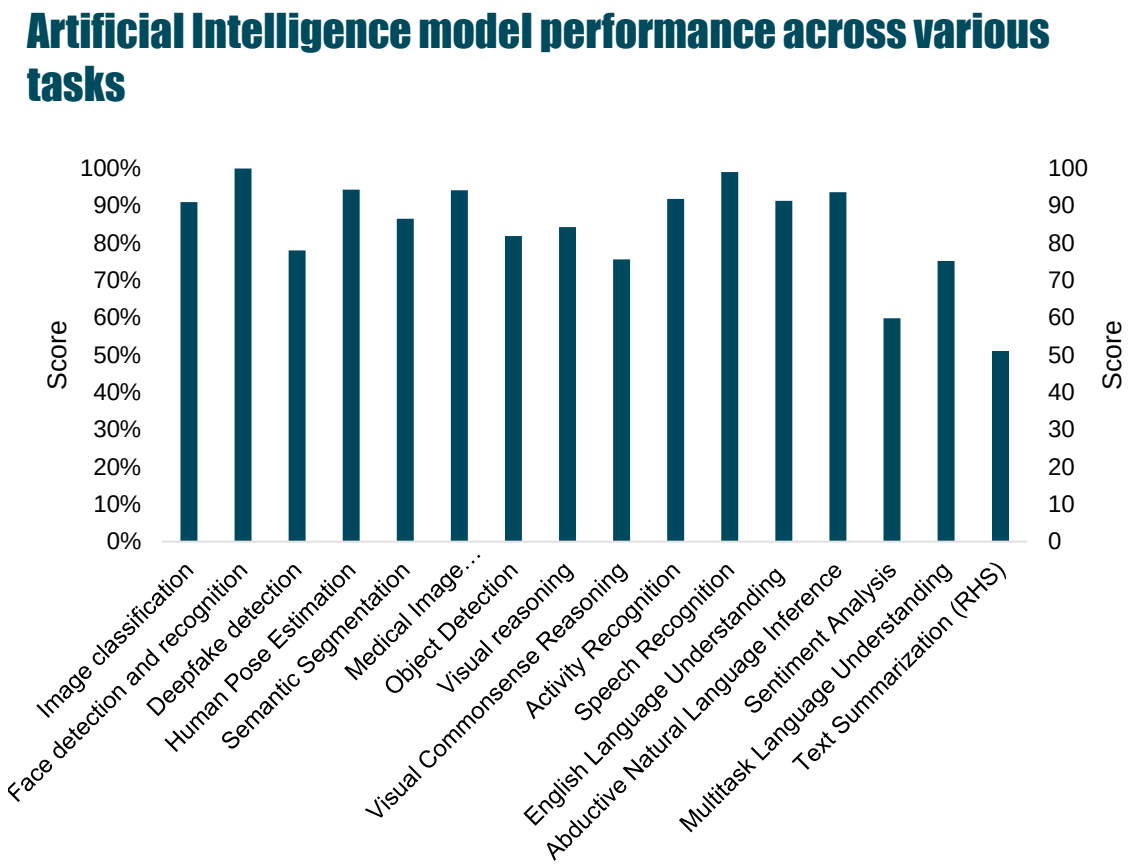
AI/robotisation developments could be following a 'J-curve' path, and their impact may soon be upon us

- Artificial intelligence (and robotisation – i.e., machines controlled by computers) are not 'new' innovations, so why should they start lifting productivity growth soon?
- Innovations can be subject to a J-curve before they boost productivity: their impact is absent or low for some time, but eventually it accelerates exponentially.
- The J-curve is consistent with the developments seen as AI systems are scaled up. Just by feeding them more data and dramatically increasing the number of parameters, AI systems have begun to develop multiple skills, some of which were never even intended for the technology (e.g., coding or foreign language translation).
- At the macro level, the J-curve framework is also consistent with the marked slowdown in productivity growth relative to research and development (R&D) expenditure over the past decades.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

The performance of existing AI systems is already either close or above that of the 'average' human



Source: AI Report Index (2023), as of end 2022

AI systems perform well across several tasks, including visual, speech and language tasks.

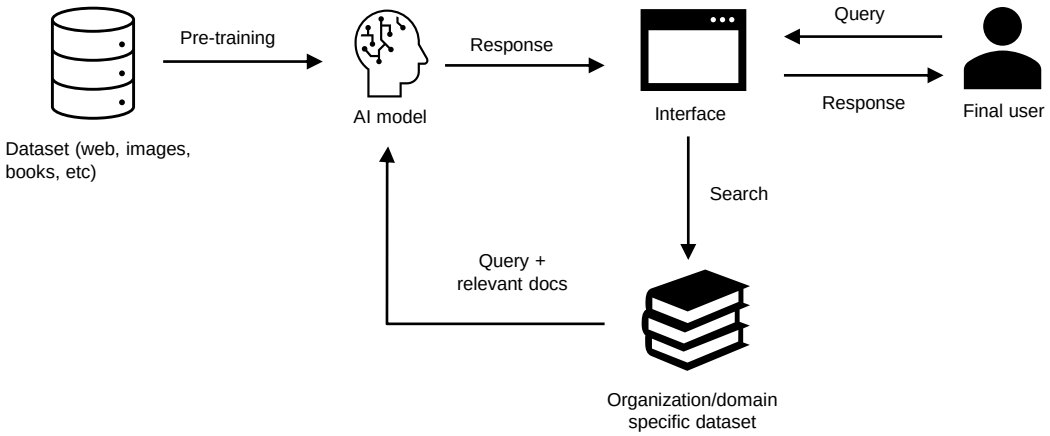
- Accessible AI models (e.g., ChatGPT) already exhibits human-level performance on various professional and academic benchmarks (in many cases outperforming the average human), including passing a simulated bar exam with a score around the top 10% of test takers. These scores were achieved without specific training for these exams.
- For more information around AI models performance across visual, language, speech and reinforcement learning tasks please see the AI Report Index (2023) and GPT-4 Technical Report.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Generative AI may sometimes be inaccurate, but we don't think this is a fatal flaw of the technology

Representation of a technique called Retrieval-Augmented Generation used to limit the tendency of LLMs to 'hallucinate'



Source: BNY Mellon Investment Management.

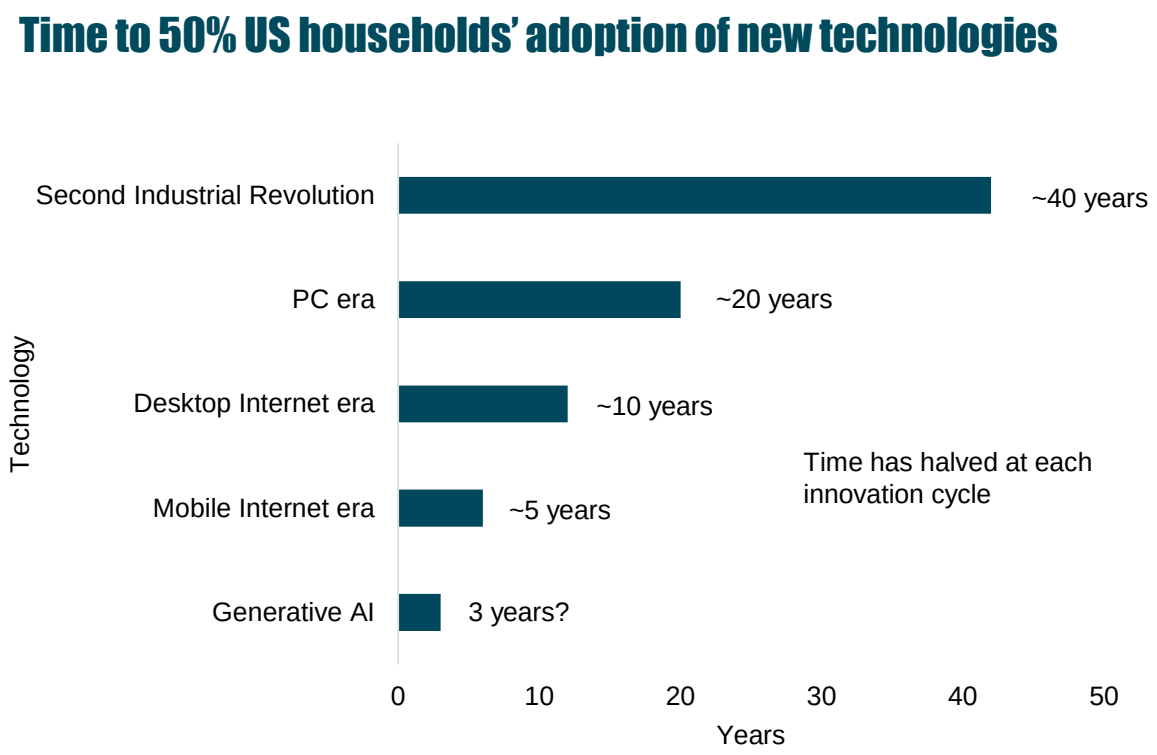
Currently, AI has the potential to produce inaccurate results. However, AI accuracy is increasing rapidly.

- 'Hallucinations', i.e., the potential to produce inaccurate results, are seen as a major problem of AI systems. For this reason, some have concluded that current generative AI models come with a fatal drawback, as they are capable of natural language processing but not understanding. The economist Gordon calls such models "stochastic parrots".
- But as the economist Brynjolfsson argues "their economic value depends not on whether they are flawless, but on whether they can be used productively".
- The accuracy of AI models has also been increasing rapidly, and should be expected to improve further.
- And there is scope for the development of complementary technologies that aim to reduce 'hallucinations', e.g., by enabling generative AI to access and incorporate external information we know is (very likely to be) correct.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Timing the impact of AI on productivity is hard but it could happen faster than many people assume



Source: Morgan Stanley

The pace of technological diffusion has accelerated significantly over time, and an 'arms race' has begun

- In case of other GPTs, the impact on US productivity became visible when ~50% of businesses adopted them. Roughly, that happened a handful of years after investment in the technology rose noticeably as a share of GDP.
- It's likely that AI will reach this threshold more quickly than in the past: there are fewer tech or cost barriers to access the technology, and the is an 'arms race' between companies and countries to gain an edge.
- While deployment of AI is not just about software - as companies need other capabilities to develop ad-hoc AI solutions, e.g., data systems and IT employees - little installation of new physical capital equipment is required.
- And some form of generative AI could be made available soon to half of global knowledge workers, via updates of Microsoft's and Google's office productivity software. Combined, MS Office and Google Workspace, reach 50% of the global knowledge workforce.

There remains a lot of uncertainty around the outlook for AI

Artificial Intelligence impact scenarios

Scenarios	Description
Pessimistic	No AI systems significantly more capable and efficient than GPT-4. Barriers such as computing power, resistance to change and regulation restrain speed of adoption of current AI.
Baseline	GPT-4 sees widespread adoption and develops somewhat but technology sees more limited improvement from here. Software updates from major tech companies (e.g. Microsoft, Google) make current AI widely available soon. User-friendly interfaces allows rapid adoption. Costs to develop proprietary AI models fall in line with recent historical trends. If a significantly more intelligent AI system is developed, it is controlled by a IAEA-like agency that caps its capability.
Optimistic	AI developments continues, interacting with other innovations, such as robotisation, and increasing the pace of innovation by reversing the decline in the productivity of R&D seen across the global economy in the last decades. If a super intelligent AI system is developed, it is controlled by an IAEA-like agency that caps its capability.

Source: BNY Mellon Investment Management, as of September 2023

Timing the impact of AI on productivity is hard but it could happen faster than many expect

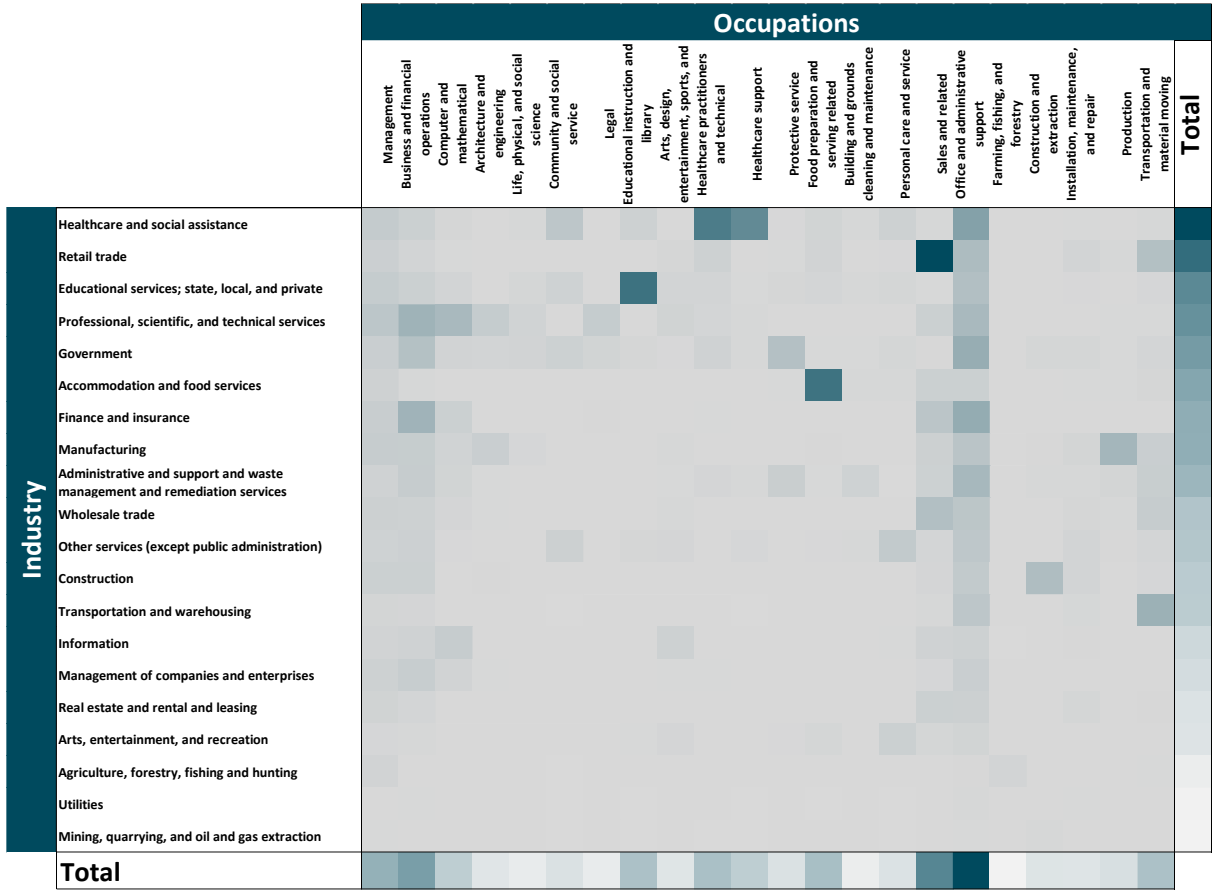
- The baseline scenario rests on the view that in line with faster diffusion trends over time, the adoption of current AI technology happens rapidly (i.e., approximately over the next 5 years). Peak impact on productivity only takes place later.
- The pessimistic scenario rests on the idea that barriers will eventually slow adoption and development of AI economywide in the coming decade(s). Such barriers include costs of developing/training proprietary models, organisational inertia, lack of internal expertise, regulation, or IP/cybersecurity risks.
- The optimistic scenario relies on the idea that AI will accelerate the pace of technological progress by making it easier to innovate across a very wide range of fields. It also relies on the view that the performance of AI models could further increase.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Our baseline view rests on an assessment of the performance of current AI on tasks performed across occupations and industries

Estimated impact of AI , by occupation and industry



Source: BNY Mellon Investment Management calculations using O*NET (Occupational Information Network), U.S. Bureau of Labor Statistics. Most recent data as of September 2023..

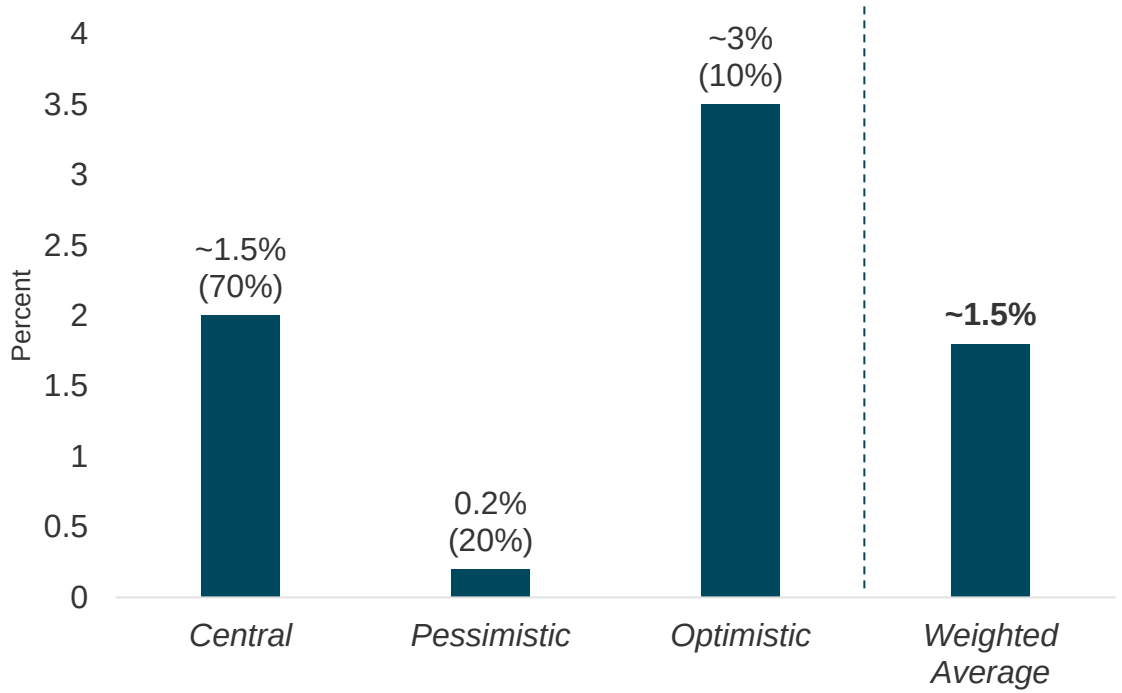
AI holds the potential to augment or automate several tasks, across occupations and industries.

- Our analysis involved making judgments (based on evidence, as the one presented in slide 9) around the extent to which AI can automate different activities. For example, we assume that:
  - There is very little automation for "providing personal assistance, medical attention, emotional support, or other personal care to others such as co-workers, customers, or patients."
  - There is large automation for "performing day-to-day administrative tasks such as maintaining information files and processing paperwork".
- We then trace the impact on the economy by mapping the 'activities' data to each occupation in the economy.
- Finally, we account for the relative contribution of each occupation to total employment.

Past performance is no guarantee of future results. Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

We estimate the impact of AI on productivity growth is likely to be substantial globally

Impact of AI on Productivity growth - Scenarios (Probability)



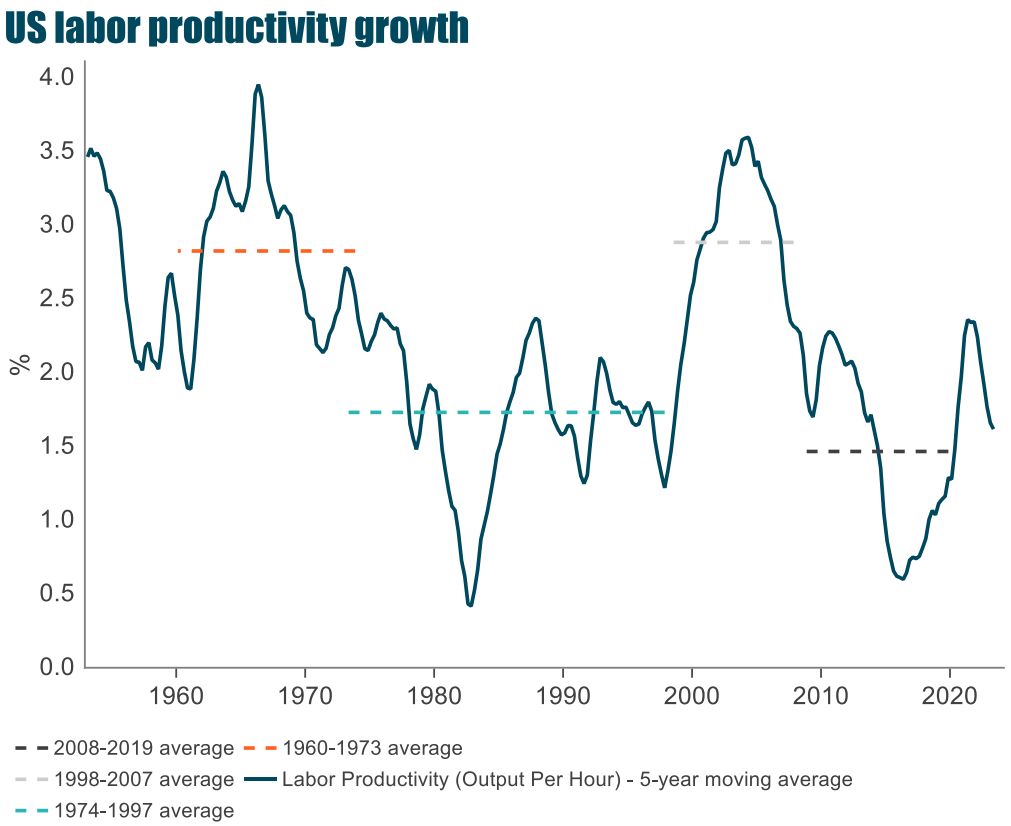
Source: BNY Mellon Investment Management calculations using O*NET (Occupational Information Network), U.S. Bureau of Economic Analysis, U.S. Bureau of Labor Statistics, World Bank. Most recent data as of September 2023..

We find that AI could lift productivity growth substantially over the coming decade(s)

- Given the inherent uncertainty around any given approach, we use a suite of approaches and cross-checks:
  - We produce an estimate based on a bottom-up assessment of the activities performed in various jobs and make sure it's consistent from a top-down perspective.
  - We look at external estimates, which also see a substantial impact of AI on productivity growth. The median estimate suggests a 1.8 pp / year impact.
  - We cross check the results looking at previous case studies, e.g., to the internet boom, and long run empirical evidence.

Past performance is no guarantee of future results. Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

A return to 3% productivity growth, and even higher peaks in growth, would not be out of line with what seen in the past



Source: Macrobond, BNY Mellon Investment Management. Data as of 11 October 2023

Estimates are not far from what observed for previous innovations

- In the US, productivity growth rose by around ~1.5pp/year in the 10 years after the personal computer was introduced.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

2. Productivity growth could rise regardless of AI

One could think of long run productivity (Total Factor Productivity, or TFP) growth as being driven by two forces

A simple framework to think about productivity growth

$$d \log A = \frac{\partial \log A}{\partial \log X} d \log X + \frac{\partial \log A}{\partial \log T} d \log T$$

Resource allocation

Technology (e.g., AI/robotisation)

TFP growth can be seen as driven by changes in the efficiency of resource allocation and technology

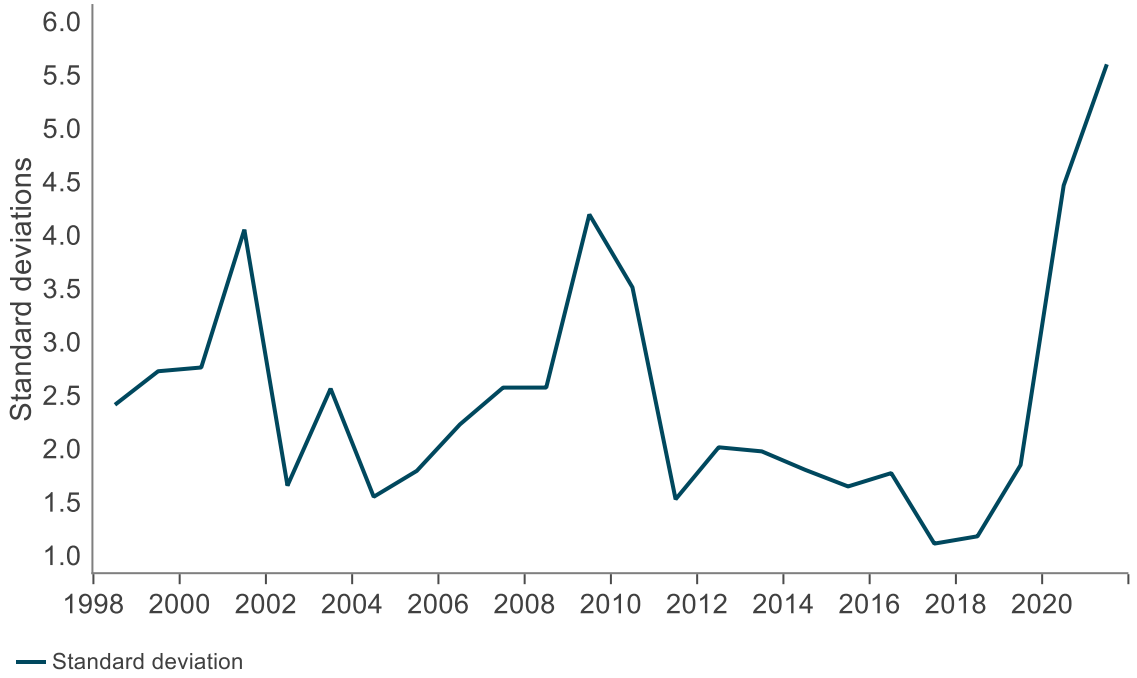
- TFP is a measure of how efficiently labour and capital are combined during the production process.
- In this work, TFP growth (*d* log *A)* reflects:
  - Changes in the allocation efficiency of resources (capital, labor): $\frac{\partial \log A}{\partial \log X} d \log X$ – e.g., due to the Pandemic, GFC.
  - Changes in technological innovation: $\frac{\partial \log A}{\partial \log T} d \log T$ - linked to R&D spending, the level of development, and any AI-specific technological innovation.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

a) Better resource allocation: GFC- and Covid-related misallocation of resources could have weighed on productivity growth

Dispersion of value add contribution to growth across US sectors



Source: Macrobond, BNY Mellon Investment Management U.S. Bureau of Economic Analysis (BEA), Conference Board
Data as of 27 June 2023

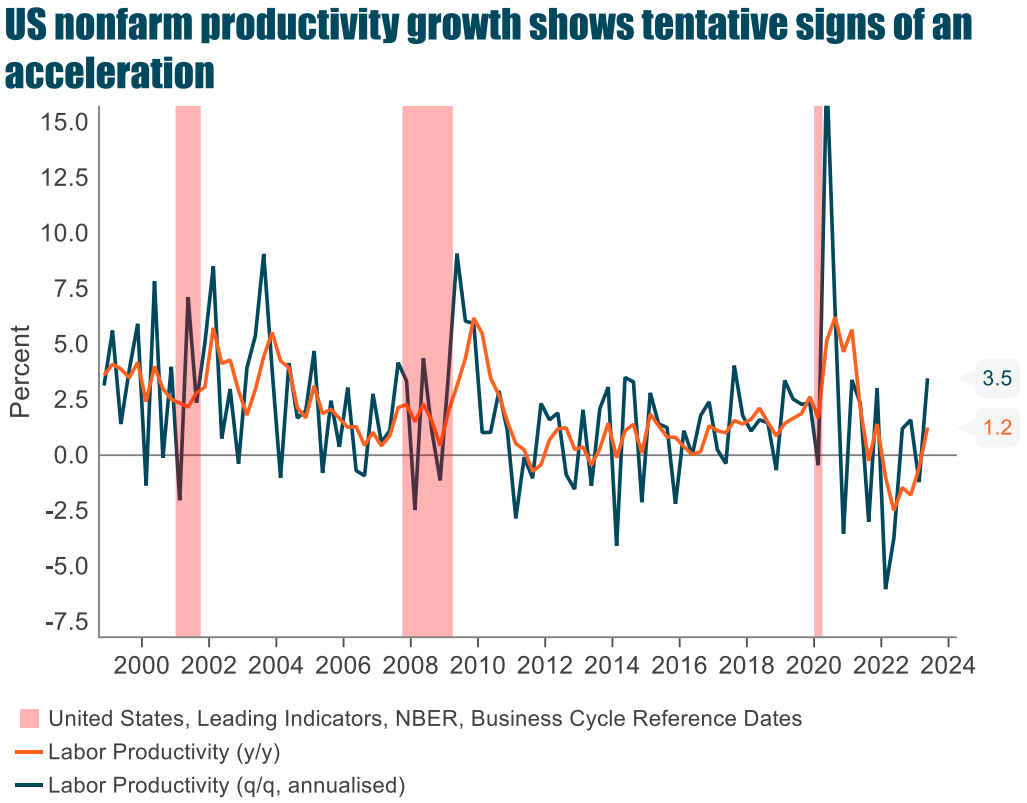
Heterogeneous hit to activity across sectors may increase misallocation of resources and weigh on TFP growth

- The efficiency of resource allocation is important for TFP in the short-to-medium run.
- When a shock hits, if there is high and persistent dispersion of value-added growth across sectors, the dispersion of "marginal revenue products" of capital and labour across producers may increase, requiring the reallocation of capital and labour towards more productive uses.
- The GFC and the pandemic shock saw a significant dispersion of value-add across economic sector.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Evidence, admittedly still tentative for now, suggest that the Covid-related fall in productivity growth was temporary and is reversing



Source: Macrobond, BNY Mellon Investment Management
Data as of 18 October 2023

BNY MELLON | INVESTMENT MANAGEMENT

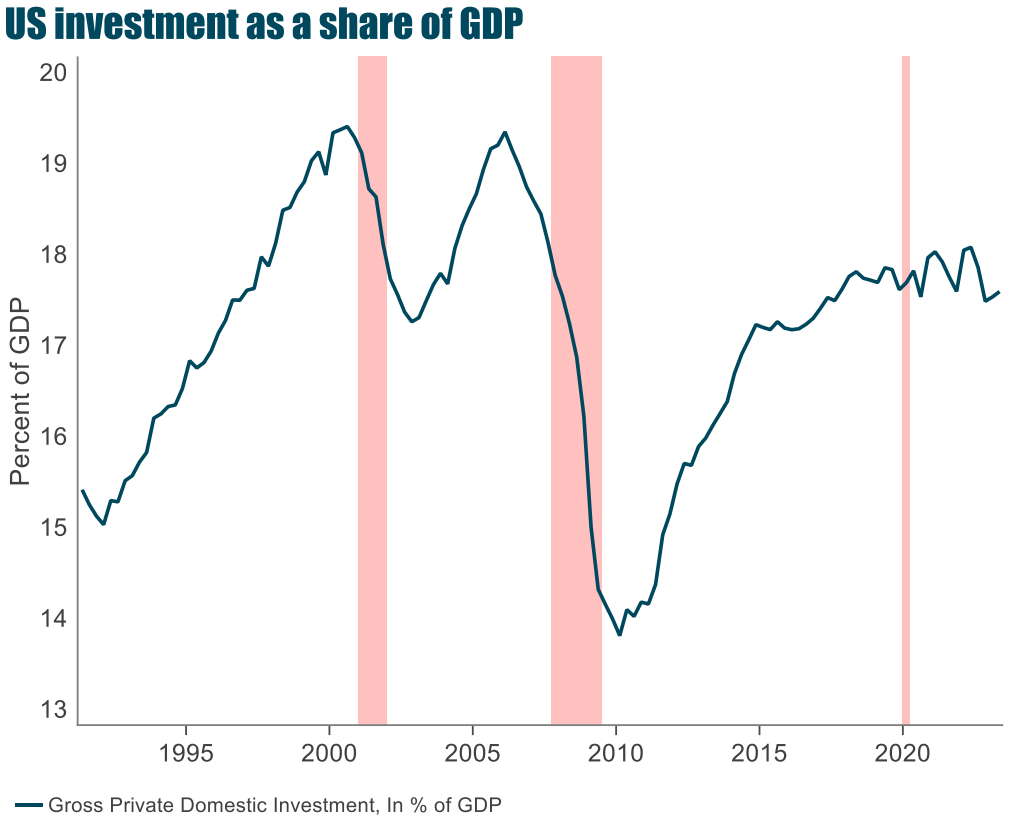
Productivity growth has accelerated in the US recently

- There may still be a negative drag on productivity related to the pandemic and the energy shock in some regions (e.g., the euro area), but there are signs that in other places (e.g., US) productivity growth is back what seen immediately pre-pandemic.
- In itself this would be already an achievement, as this level of productivity was itself 0.3% higher than what observed in the decade after the GFC.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Analysis shows that the weakness in productivity growth seen after the GFC was in part related to a fall in investment



Source: Macrobond, BNY Mellon Investment Management. Data as of 17 October 2023

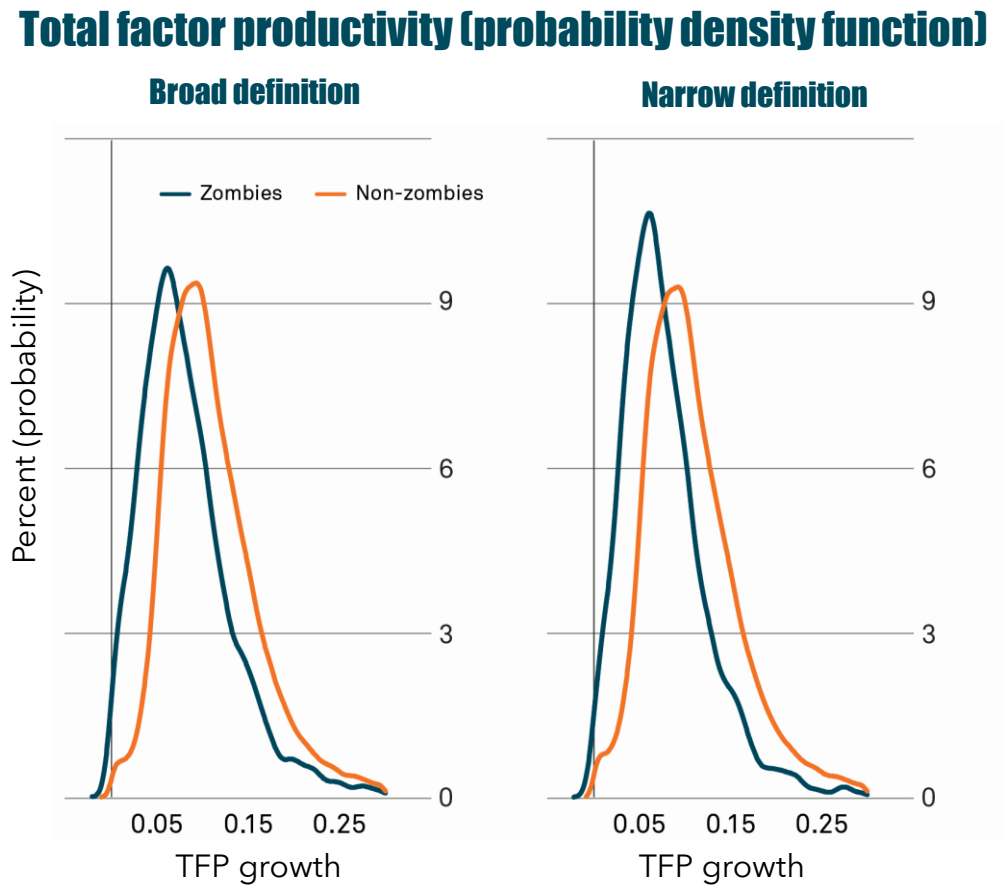
If temporary drags on productivity fade, productivity growth could rise somewhat regardless of any AI effect

- The GFC saw a persistent increase in the effective cost of capital for firms, as banks focused on re-building their balance sheets and were very reluctant to lend.
- At the same time, the balance sheet of private non-financial corporations was in poor health.
- As a consequence, the private sector went through a prolonged deleveraging phase and investment as a share of GDP remained weak for many years.
- A fall in the growth of capital per person employed was most likely a large contributor to the decline in productivity growth since the GFC.
- But the fall in investment may have also led to a sub-optimal flow of resources to most productive sectors for a prolonged period.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Post GFC, productivity might have fallen also due to a rise in 'zombie' firms and a fall in the efficiency of resource allocation



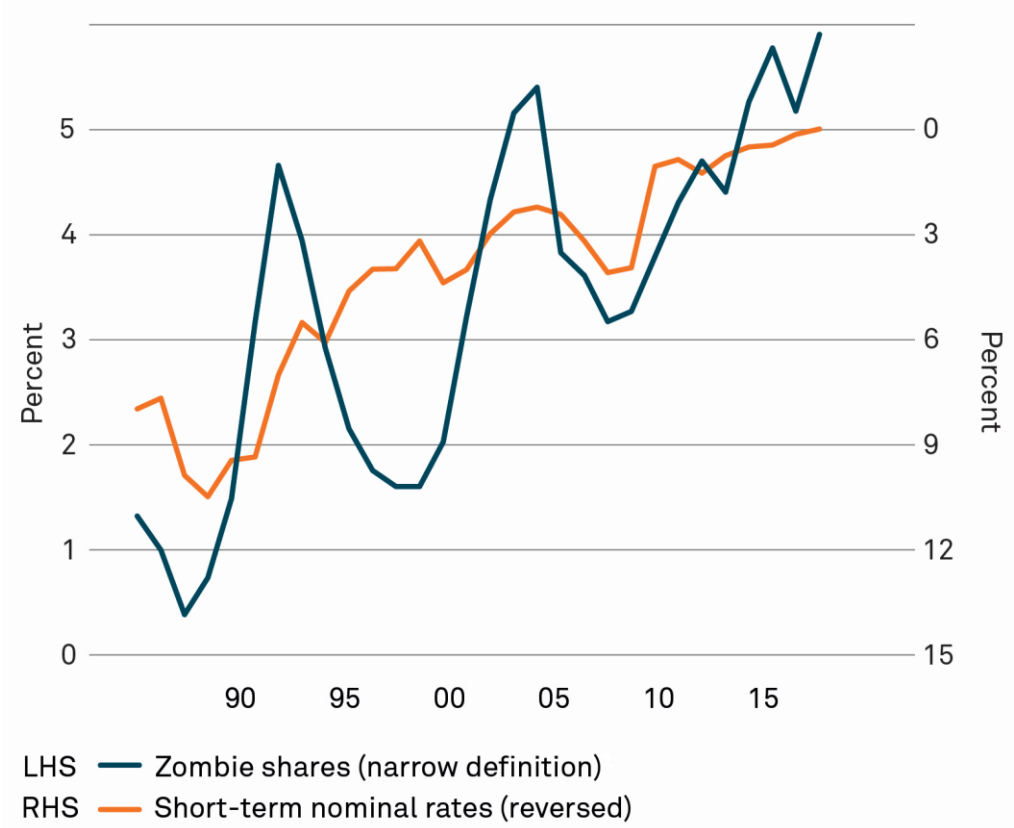
Source: Bank for International Settlements. Data as of 2018. Note: Broad zombies are defined as firms with an interest coverage ratio (interest expense divided by EBIT, or earnings before interest and taxes) less than one for three consecutive years and over 10 years old. Narrow zombies defined as broad zombies with a Tobin's q (market value less replacement value of assets) below the median firm in the sector in a given year, to capture expectations of low future profitability.

Zombie firms are less productive and have risen to account for a relatively large shares of the economy

- Zombie firms are defined as firms that are unable to cover debt servicing costs from current profits over an extended period. Definitions on what constitutes a 'zombie' vary based on different unprofitability thresholds and number of consecutive years a firm has remained unprofitable.
- Unprofitable firms account for +5-15+% of employment and capital spending in major economies.
- Evidence suggest that zombie firms weigh on economic performance because they are less productive and because their presence lowers investment and employment at more productive firms.

Higher interest rates could improve resource allocation efficiency, leading to some rise in productivity

Zombie share of firms and interest rates



Source: Bank for International Settlements. Data as of 2018. Note: Zombie shares and interest rates are simple averages from Australia, Belgium, Canada, Denmark, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the United Kingdom and the United States.

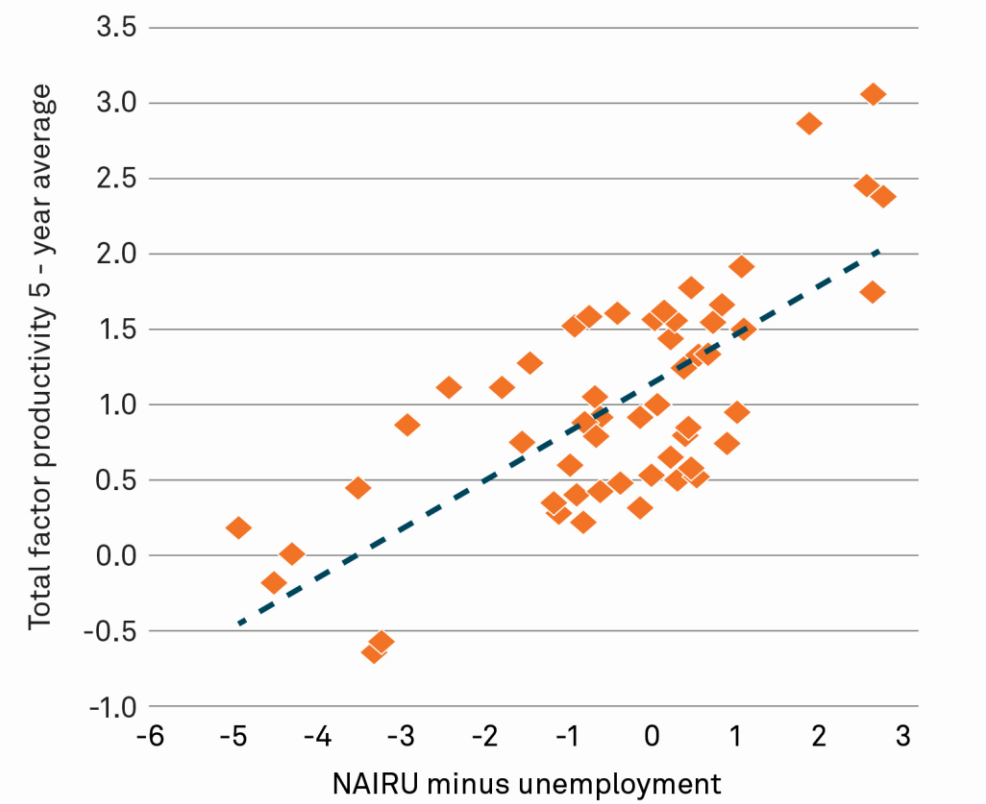
BIS estimates a 1% percent fall in the share of zombie firms in an economy, leads to ~0.3 pp rise in productivity

- Bank for International Settlements (BIS) analysis suggests that this increase is linked to reduced financial pressure, which in turn seems to reflect in part the effects of lower interest rates.
- At face value, using BIS estimates, assuming global rates stay around 4.5-5.5% on average for some time, we should expect a ~3-4pp fall in the zombie share in the global economy, potentially leading to an increase in productivity in the region of 1pp, all else equal.

Past performance is no guarantee of future results. Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

b) Greater technological adoption: Structurally tight labor markets could lead to greater investment in productivity-enhancing technology

US productivity in a high-pressure economy



Source: TS Lombard. Data as of 2021. Note: the NAIRU, or Non-Accelerating Inflation Rate of Unemployment, is the level of unemployment at which inflation is stable or constant in the economy.

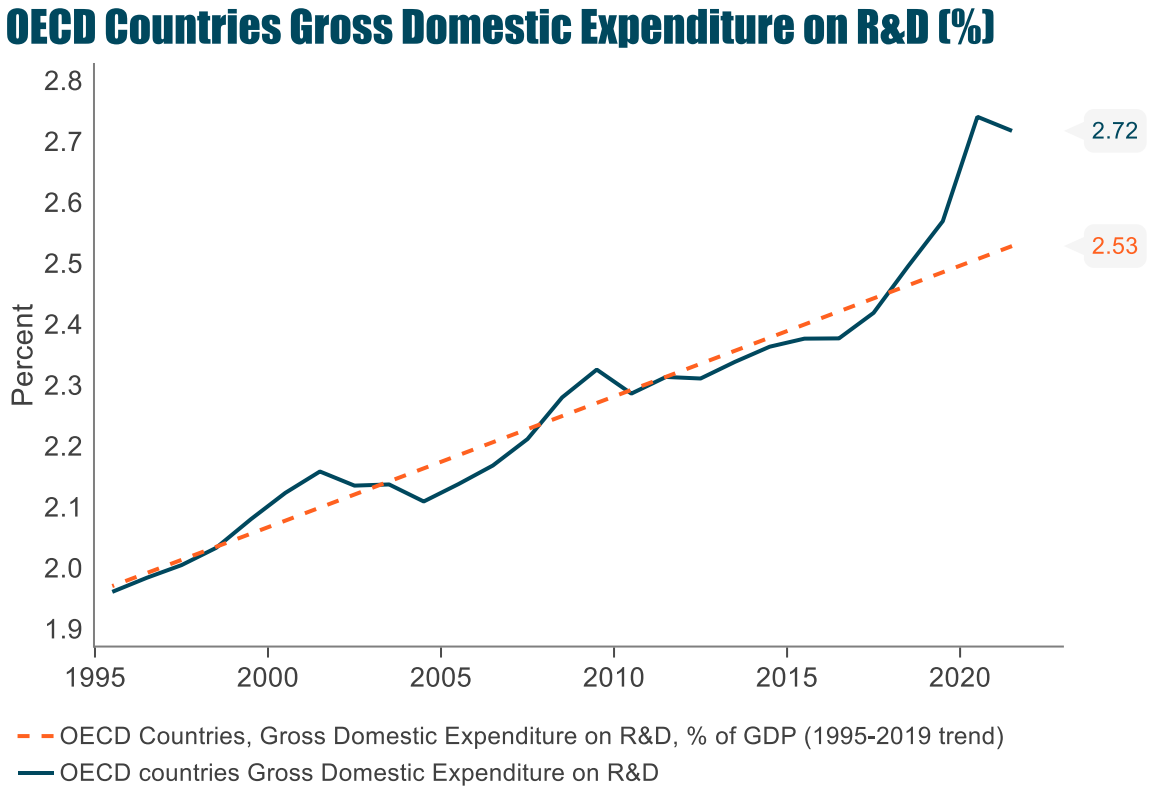
Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Research suggests that productivity growth is more linked to economic conditions than is often thought

- As pointed out by Yellen (2016), "persistent shortfalls in aggregate demand" during the Global Financial Crisis "could adversely affect the supply side of the economy. (…) If we agree that hysteresis is present after deep recessions, it might be possible to reverse these adverse supply-side effects by temporarily running a 'high-pressure economy,' with robust aggregate demand and a tight labor market."
- There is some evidence shows that tight labor markets lead to greater technology adoption and greater productivity, but the evidence remains mixed.
- Tight labor markets in many economies over the next years may facilitate the diffusion of new technologies. IT net spending expectations for the next three years are ~2.5x above pre-COVID levels.

Evidence suggests that firms have increased the amount spent on R&D



Source: Macrobond, BNY Mellon Investment Management
Data as of 12 October 2023

BNY MELLON | INVESTMENT MANAGEMENT

Post-pandemic the rate at which R&D expenditure is increasing has picked up

- R&D investment (on ICT and intangibles) as a share of expenditure has been increasing for years, but is now rising much faster than the pre-pandemic trend.
- Central estimate we use imply that if R&D spending rises by one dollar, output would increase by ~60 cents each subsequent year.
- Assuming the level of growth stabilises at around current levels, global TFP growth may rise by an additional ~0.1pp in the coming years.

Past performance is no guarantee of future results.

Charts are provided for illustrative purposes and are not indicative of the past of future performance of any BNY Mellon product.

Definitions

Robotization	The act or process of introducing robots (= machines controlled by computers) to do work that was previously done by people
General Purpose Technology (GPT)	General Purpose Technology (GPT) refers to a set of technologies that have a wide range of applications across different industries and sectors. Examples of GPT include electricity, the internet, and artificial intelligence.
Generative Artificial Intelligence (Gen AI)	Generative AI is general-purpose AI that can be used in several use cases across every industry as it can create new, original content based on patterns it learned during its training. Instead, non-generative AI is designed to respond to a particular set of inputs and focuses on analysing and interpreting the data it was trained on. For example, it can identify an object in a photo but cannot create a new photo.
Artificial Intelligence	Artificial intelligence (AI) is the intelligence of machines or software. It is also the field of study in computer science that develops and studies intelligent machines
ChatGPT	ChatGPT, stands for Chat Generative Pre-trained Transformer, is a large language model-based chatbot developed by OpenAI.
Large language model (LLM)	LLM is a deep learning algorithm that can perform a variety of natural language processing (NLP) tasks. Large language models use transformer models and are trained using very big datasets
Deep learning algorithm	It is a type of computer model that works based on the structure and function of the human brain. Deep learning algorithms train machines by learning from examples.
Natural language processing (NLP)	Natural language processing is an interdisciplinary subfield of computer science and linguistics. It is primarily concerned with giving computers the ability to support and manipulate speech
OECD	The Organisation for Economic Co-operation and Development is an intergovernmental organisation with 38 member countries, founded in 1961 to stimulate economic progress and world trade.
Research and development (R&D)	Research and development (R&D) is a term to describe the effort a company devotes to the innovation, and improvement of its products and processes.
ICT	Information and communication technology, abbreviated as ICT, covers all technical means used to handle information and aid communication. This includes both computer and network hardware, as well as their software.
Intangibles	An intangible asset is an asset that lacks physical substance. Examples are patents, copyright, franchises, goodwill, trademarks, and trade names, as well as any form of digital asset such as software
Bank for International Settlements (BIS)	The Bank for International Settlements is an international financial institution which is owned by member central banks. Its primary goal is to foster international monetary and financial cooperation while serving as a bank for central banks.
COVID	Coronavirus disease 2019 (COVID-19) is a contagious disease caused by the virus SARS-CoV-2. Covid refers to the global pandemic caused by this virus.
Zombie firms	Zombie firms are defined as firms that are unable to cover debt servicing costs from current profits over an extended period. Definitions on what constitutes a 'zombie' vary based on different unprofitability thresholds and number of consecutive years a firm has remained unprofitable.
IAEA	The IAEA is the world's centre for cooperation in the nuclear field, promoting the safe, secure and peaceful use of nuclear technology.
Global Financial Crisis (GFC)	The global financial crisis (GFC) refers to the period of extreme stress in global financial markets and banking systems between 2007 and 2009
MSCI All-Country World	The MSCI All-Country World Index is an index that tracks the performance of both Developed and Emerging Market equities
MSCI World - DM	The MSCI World Index is an index that tracks the performance of Developed Market equities
MSCI EAFE	The MSCI EAFE Index is an index that tracks the performance of Developed Market equities across Europe, Australasia and the Far East excluding the US and Canada
MSCI EM	The MSCI EM index tracks the performance of Emerging Market Equities
US (S&P 500)	The S&P 500 is an index designed to track the performance of the largest 500 US companies
US (NASDAQ)	The Nasdaq Composite Index is the market capitalization-weighted index of approximately 3,000 common equities listed on the Nasdaq stock exchange
US (Russell 2000)	The Russell 2000 Index is a small-cap stock market index of the bottom 2,000 stocks in the Russell 3000 Index
Japan (Nikkei 225)	The NIKKEI 225 is an index that tracks the performance of the largest 225 companies traded in the Japanese market
EU (STOXX 50)	The EURO STOXX 50 Index, Europe's leading blue-chip index for the Eurozone, provides a blue-chip representation of supersector leaders in the region
UK (FTSE 100)	The STOXX 600 is an index that represents the performance of 600 large, mid and small capitalization companies across 18 countries in the European Union
France (CAC 40)	The CAC 40 is an index that tracks the performance of the largest 40 companies traded on the Paris Stock Exchange
Germany (DAX 30)	The DAX 30 is an index that tracks the performance of the largest 30 companies traded on the Frankfurt Stock Exchange
China (MSCI China)	The MSCI China Index captures large and mid cap representation across H shares, B shares, Red chips, P chips and foreign listings. With 459 constituents, the index covers about 85% of this China equity universe.
China Caixin Services PMI	In China, the Caixin Services Purchasing Managers' Index measures the performance of the services sector.
Global Treasury ex US	The Bloomberg Barclays Global Treasury ex US index tracks fixed-rate local currency government debt of investment grade countries excluding the US and represents the Treasury sector of the Global Aggregate Index
US Treasury	The Bloomberg Barclays US Treasury Index is the US Treasury component of the US Aggregate Index and uses public obligations of the US Treasury with a remaining maturity of one year or more
Global Investment Grade - Corp.	This Index reflects the Corporate component of the Bloomberg Barclays Global Aggregate Index which is designed to provide a broad-based measure of the global investment-grade fixed income markets
Global High Yield	The Bloomberg Barclays Global High Yield Index is a broad-based measure of the global high yield market
US Leveraged Loans	The S&P/LSTA Leveraged Loan Total Return Index is designed to measure the performance of the US leveraged loan market
S&P Municipal Bond IG Intermediate	The S&P Municipal Bond Investment Grade Intermediate Index consists of bonds in the S&P Municipal Bond Index that are rated at least BBB- by Standard & Poor's, Baa3 by Moody's or BBB- by Fitch Ratings. All bonds must also have a minimum maturity of three years and a maximum maturity of up to, but not including, fifteen years as measured from the rebalancing date.
EM USD Denominated	The Bloomberg Barclays EM USD Aggregate Index includes USD denominated debt from sovereign, quasi-sovereign, and corporate EM issuers
Bloomberg Commodity Index	The Dow Jones UBS Commodity index is designed to provide diversified commodity exposure with weightings based on the commodity's liquidity and economic significance
Oil (WTII, USD / Barrel)	Generic West Texas Intermediate crude oil spot price
Gold (USD / Troy Ounce)	Gold London Bullion Market spot price, quoted in USD per Troy Ounce

References to specific securities are for illustrative purposes only, and are not intended as recommendations to purchase or sell securities (Google and Microsoft, page 11)

FOR INSTITUTIONAL, PROFESSIONAL, QUALIFIED INVESTORS AND QUALIFIED CLIENTS. FOR GENERAL PUBLIC DISTRIBUTION IN THE U.S. ONLY.

This material should not be considered as investment advice or a recommendation of any investment manager or account arrangement, and should not serve as a primary basis for investment decisions. Any statements and opinions expressed are those of the author as at the date of publication, are subject to change as economic and market conditions dictate, and do not necessarily represent the views of BNY Mellon or any of its affiliates. The information has been provided as a general market commentary only and does not constitute legal, tax, accounting, other professional counsel or investment advice, is not predictive of future performance, and should not be construed as an offer to sell or a solicitation to buy any security or make an offer where otherwise unlawful. The information has been provided without taking into account the investment objective, financial situation or needs of any particular person. BNY Mellon and its affiliates are not responsible for any subsequent investment advice given based on the information supplied. This is not investment research or a research recommendation for regulatory purposes as it does not constitute substantive research or analysis. This information may contain projections or other forward-looking statements regarding future events, targets or expectations, and is only current as of the date indicated. There is no assurance that such events or expectations will be achieved, and actual results may be significantly different from that shown here. The information is based on current market conditions, which will fluctuate and may be superseded by subsequent market events or for other reasons. References to specific securities, asset classes and financial markets are for illustrative purposes only and are not intended to be and should not be interpreted as recommendations. Past performance is no guarantee of future results. Information and opinions presented have been obtained or derived from sources which BNY Mellon believed to be reliable, but BNY Mellon makes no representation to its accuracy and completeness. BNY Mellon accepts no liability for loss arising from use of this material.

All investments involve risk including loss of principal.

Not for distribution to, or use by, any person or entity in any jurisdiction or country in which such distribution or use would be contrary to local law or regulation. This information may not be distributed or used for the purpose of offers or solicitations in any jurisdiction or in any circumstances in which such offers or solicitations are unlawful or not authorized, or where there would be, by virtue of such distribution, new or additional registration requirements. Persons into whose possession this information comes are required to inform themselves about and to observe any restrictions that apply to the distribution of this information in their jurisdiction.

Issuing entities
This material is only for distribution in those countries and to those recipients listed, subject to the noted conditions and limitations: For Institutional, Professional, Qualified Investors and Qualified Clients. For General Public Distribution in the U.S. Only. **United States**: by BNY Mellon Securities Corporation (BNYMSC), 240 Greenwich Street, New York, NY 10286. BNYMSC, a registered broker-dealer and FINRA member, and subsidiary of BNY Mellon, has entered into agreements to offer securities in the U.S. on behalf of certain BNY Mellon Investment Management firms. **Europe (excluding Switzerland)**: BNY Mellon Fund Management (Luxembourg) S.A., 2-4 Rue EugèneRuppertL-2453 Luxembourg. **UK, Africa and Latin America (ex-Brazil):** BNY Mellon Investment Management EMEA Limited, BNY Mellon Centre, 160 Queen Victoria Street, London EC4V 4LA. Registered in England No. 1118580. Authorised and regulated by the Financial Conduct Authority. **South Africa:** BNY Mellon Investment Management EMEA Limited is an authorised financial services provider. **Switzerland:** BNY Mellon Investments Switzerland GmbH, Bärengasse 29, CH-8001 Zürich, Switzerland. **Middle East:** DIFC branch of The Bank of New York Mellon. Regulated by the Dubai Financial Services Authority. **Singapore:** BNY Mellon Investment Management Singapore Pte. Limited Co. Reg. 201230427E. Regulated by the Monetary Authority of Singapore. **Hong Kong:** BNY Mellon Investment Management Hong Kong Limited. Regulated by the Hong Kong Securities and Futures Commission. **Japan:** BNY Mellon Investment Management Japan Limited. BNY Mellon Investment Management Japan Limited is a Financial Instruments Business Operator with license no 406 (Kinsho) at the Commissioner of Kanto Local Finance Bureau and is a Member of the Investment Trusts Association, Japan and Japan Investment Advisers Association and Type II Financial Instruments Firms Association. **Brazil:** ARX Investimentos Ltda., Av. Borges de Medeiros, 633, 4th floor, Rio de Janeiro, RJ, Brazil, CEP 22430-041. Authorized and regulated by the Brazilian Securities and Exchange Commission (CVM). **Canada**: BNY Mellon Asset Management Canada Ltd. is registered in all provinces and territories of Canada as a Portfolio Manager and Exempt Market Dealer, and as a Commodity Trading Manager in Ontario.

BNY MELLON COMPANY INFORMATION

BNY Mellon Investment Management is one of the world's leading investment management organizations, encompassing BNY Mellon's affiliated investment management firms and global distribution companies. BNY Mellon is the corporate brand of The Bank of New York Mellon Corporation and may also be used as a generic term to reference the corporation as a whole or its various subsidiaries generally. **Mellon Investments Corporation** (MIC) is a registered investment advisor and subsidiary of The Bank of New York Mellon Corporation. MIC is composed of two divisions: **Mellon**, which specializes in index management, and **Dreyfus**, which specializes in cash management and short duration strategies. **Dreyfus** is also a division of BNY Mellon Investment Adviser, Inc. (BNYMIA), a registered investment adviser. **Insight Investment** - Investment advisory services in North America are provided through two different investment advisers registered with the Securities and Exchange Commission (SEC) using the brand Insight Investment: Insight North America LLC (INA) and Insight Investment International Limited (IIIL). The North American investment advisers are associated with other global investment managers that also (individually and collectively) use the corporate brand Insight. Insight is a subsidiary of BNY Mellon. **Newton Investment Management** - "Newton" and/or the "Newton Investment Management" brand refers to the following group of affiliated companies: Newton Investment Management Limited (NIM) and Newton Investment Management North America LLC (NIMNA). NIM is incorporated in the United Kingdom (Registered in England no. 1371973) and is authorized and regulated by the Financial Conduct Authority in the conduct of investment business. Both Newton firms are registered with the Securities and Exchange Commission (SEC) in the United States of America as an investment adviser under the Investment Advisers Act of 1940. Newton is a subsidiary of The Bank of New York Mellon Corporation. **ARX** is the brand used to describe the Brazilian investment capabilities of BNY Mellon ARX Investimentos Ltda. ARX is a subsidiary of BNY Mellon. **Walter Scott & Partners Limited** (Walter Scott) is an investment management firm authorized and regulated by the Financial Conduct Authority, and a subsidiary of BNY Mellon. **Siguler Guff** - BNY Mellon owns a 20% interest in Siguler Guff & Company, LP and certain related entities (including Siguler Guff Advisers LLC). **BNY Mellon Investor Solutions, LLC** is an investment adviser registered as such with the U.S. Securities and Exchange Commission ("SEC") pursuant to the Investment Advisers Act of 1940, as amended. BNY Mellon Investor Solutions, LLC is a subsidiary of The Bank of New York Mellon Corporation.

NOT FDIC INSURED | NO BANK GUARANTEE | MAY LOSE VALUE |

IS-441513-2023-10-18
GU-496 - 18 October 2024